Open Access Library Journal
2022, Volume 9, e9287
ISSN Online: 2333-9721
ISSN Print: 2333-9705

Seasonal Trend and Distribution of Wire-Snaring Activities and Possible Hotspots in the Sengwa Wildlife Area (SWRA), Zimbabwe

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How to cite this paper: Mahakata, I. (2022) Seasonal Trend and Distribution of Wire-Snaring Activities and Possible Hotspots in the Sengwa Wildlife Area (SWRA), Zimbabwe. *Open Access Library Journal*, **9**: e9287.
https://doi.org/10.4236/oalib.1109287

Received: September 6, 2022
Accepted: October 25, 2022
Published: October 28, 2022

Abstract

One salient method of poaching is the use of wire snares to kill wild animals. The study sought to determine seasonal trend and distribution of wire snaring in Sengwa Wildlife Research Area (SWRA) and predict possible seasonal hotspots areas. Presence-only data from law enforcement patrols done by field rangers between January, 2018 and December, 2021 was used. Descriptive statistics was used to establish trend in wire-snare occurrence from 2018 to 2021. Kruskal Wallis test was performed to determine if there was significance difference on number of wire snares removed in different season. Kernel Density Estimation (KDE) analysed in R was used to highlight the relative probability of snaring hotspot based on wire snare GPS coordinates and number of snares removed at the site in ArcMap 10.3. Total effort from January, 2018 to December, 2021 was 4767 patrol sessions, with 2314 wire-snares recovered. Of the snares recorded, 14.5% (n = 335) were recovered in wet season, 29. 4% (n = 680) in cool dry season while 56.1% (n = 1299) in hot dry season. Of the removed wire-snares, 1573 were set targeting small animals, 602 for medium size animals while 139 were meant for large animals. There was no significant difference on number of wire snares removed in wet, cool dry and hot dry season (Z-Value = 4.654, p = 0.086). Based on present only data collected for this study, the results showed seasonal variation of hotspot areas. This study recommends that well-designed scientific inquiry performed in concert with anti-poaching team has the potential to substantially decrease the threat of snaring in SWRA.

Subject Areas

Wildlife Conservation

Keywords

Wire Snare, SWRA, Patrol, Trend, Season

1. Background

Illegal hunting for bush-meat by local people around wildlife areas continues to threaten wildlife conservation in Southern Africa and beyond. Although protected areas (PAs) are designed to prevent natural resource over-exploitation, threats from illegal activities are rising for many species, leading to extensive population declines of different targeted species (Laurance *et al.*, 2012) [1]. Worldwide, law enforcement as a tool has been put in place to controlling illegal activities that seeks to negatively affect biodiversity conservation (Rauset *et al.*, 2016) [2]. However, use of law enforcement as a tool to reduce illegal over exploitation of biodiversity can be limited, especially where conservation budgets are small (Tranquilli *et al.*, 2012) [3] and where effect of unlawful exploitation of wildlife species is gradually perceived (Harrison, 2011) [4].

PAs are losing wildlife often from illegal activities such as poaching (Laurance *et al.*, 2012) [1]. While some forms of poaching are for commercial purposes for example rhino poaching using guns, others, such as wire snaring for bushmeat, are widespread but their effects are underappreciated by responsible authorities in many PAs (Bruner *et al.*, 2001) [5]. However, the use of wire snares (Here-in refer to those targeting wild mammals for bushmeat) is one of the simplest but most effective hunting techniques practised and they pose the highest threat to species survival (Fa & Brown, 2009) [6]. Wild animal snaring is a persistent conservation problem in PAs across Southern Africa, (Becker *et al.*, 2013) [7]. Snaring trends are increasing especially in Southern Africa and constitute one of the severest threats to a wide range of species. Due to their non-selective nature, however, snares can inflict significant loss within a group of targeted animals. The impacts of snaring on wildlife species have been quantified primarily for the target species utilized in the bushmeat trade; however, given the non-selective nature of snares, a number of non-target threatened species can be affected also.

Reducing threats to biodiversity is the key objective of ranger patrols in SWRA. However, efforts can be hampered by rangers' poor understanding of threat abundance and distribution in a landscape. Snares are particularly problematic due to their cryptic nature and limited selectivity with respect to captured animals' species, sex, or age. Given this, managers need to consider whether intensive snare-removal efforts are the best use of limited resources. A primary tool available to PA managers to address threats is patrolling by ranger teams (Hilborn *et al.*, 2006) [8]. Through regular patrolling, rangers monitor adherence to conservation rules, deter potential perpetrators, and punish infractions when detected (Keane, *et al.*, 2008) [9]. To design optimal patrol strategies, PA managers require robust information about the distribution and abundance of threats in a landscape (Critchlow *et al*., 2017) [10].

In Sengwa Wildlife Research Area (SWRA), wire-snare poaching is fueling the rapidly growing illegal bushmeat trade in the adjacent communities. Given the area's relatively abundant wildlife, impact of climate change on agricultural outputs and increasing human populations and settlement on the hard-edge of the SWRA, understanding snaring trends and seasonal occurrence is critical to addressing this crisis. Around SWRA, wire-snare poaching is widespread given the easy acquisition of materials, low risk of arrest, and effectiveness of animal capture. Usually made from wire, cable, or nylon, snares are affordable, accessible by local people, and can trap a wide range of terrestrial species, whether diurnal or nocturnal (Ingram *et al*., 2017) [11]. Data collected by rangers are increasingly used to map spatio-temporal trends in threats and evaluate patrol performance. Subsequently, the data can be used to map threats and prioritize patrol effort within conservation landscapes (Hötte *et al*., 2016) [12].

Recurring wire snaring in SWRA poses a major threat to the survival of terrestrial species. Effective monitoring and understanding of wire-snare occurrence and distribution is critical to reducing massive killing of animals targeted as well non-targeted species in SWRA. The primary objective of this study was to determine seasonal trend and distribution of wire-snares using data collected from January, 2018 to December, 2021 in SWRA. It was anticipated that this would yield valuable baseline data on the potential hotspot areas to concentrate law enforcement effort during patrols. This type of information is critical for the future development of more large-scale systematic snare surveys, which could function as part of a threat monitoring program aimed at assessing law enforcement effectiveness. Specifically, the study tested the hypothesis that wire-snare trends and distribution in SWRA is not influenced by seasons.

2. Material and Methods

Study Site

This study focused on determining seasonal trend and distribution of wire snares in SWRA. SWRA is situated at the southern end of Chirisa Safari Area (18˚10"S, 28˚14"E) in Gokwe South District, north-western Zimbabwe (**Figure 1**). Covering a size of 373 km^2, the area was set aside in the late 1960s for long term wildlife and ecological research (Tafangenyasha, *et al*., 2018) [13].

SWRA is semi-arid ecosystem with low and irregular rainfall averaging 612mm per year (Mahakata and Mapaure, 2021) [14], high evapo transpiration and cyclical droughts are experienced (Tafangenyasha *et al*., 2018) [13]. A diverse of large mammal community consisting of eighteen species of large herbivores with common species including elephant, buffalo, zebra, impala, kudu, eland and waterbuck are found in SWRA. Approximately 90 percent of the park share boundary with highly populated communal area of Gokwe South and Binga while the remaining 10 percent is shared with Chirisa Safari Area on the northern side. Once completely fenced on the southern part bordering the communal area, the fence was later removed. SWRA still holds one of the largest

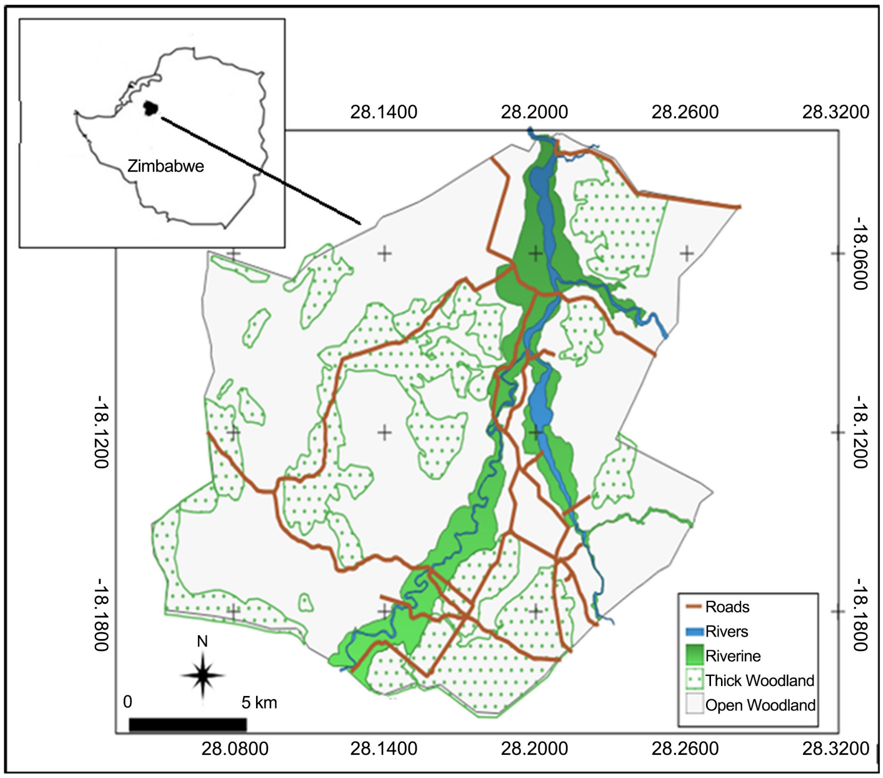


Figure 1. Location of the study area showing major habitats types.

remaining assemblages of wild ungulates in the Kavango-Zambezi component of Zimbabwe, but continues to face pressures from illegal activities for bushmeat. The major source of livelihood in the adjacent communities is subsistence farming and livestock production which often are impacted by drought and climate change.

3. Data Collection & Analysis

3.1. Data Collection

In this study, present only data recorded from law enforcement patrols was used. Wire-snare data were collected over a period of four (4) years (January, 2018-December, 2021) from field observations during patrols conducted by field rangers on their routine patrols on daily basis. The patrols were planned to cover all areas of the park over a specific period. Data on type and number of wire snares located and removed, targeted species, GPS coordinates where the wire snares were removed and vegetation type and status were recorded. Wire snares removed were grouped into three i.e. for small size targeted species (impala and other small mammals), medium size targeted species (kudu and waterbuck) and large size targeted species (buffalo, zebra and eland). Other non-target species snared at the site were also recorded. Wire snares classification were based on type of material used, size of trap ring, species caught and whether the wire snare is singular or cable. Seasonal occurrence of wire-snares were categorised as wet season (December-March), cool dry season (April-July) and hot dry season

(August-November). Secondary data on law enforcement effort were retrieved from annual law enforcement reports for 2018, 2019, 2020 and 2021 to determine total effort during the study period.

3.2. Data Analysis

Before testing for any trends in the data set and significant difference in number of snares removed in different seasons, data was tested for normality and auto-correlation using auto-correlation function in Paste-3 and Shapiro-Wilk test. Data was not normally distributed (W = 0.86, p-value = 0.29) and did not exhibit any autocorrelation. Descriptive statistics was used to establish seasonal trend in wire-snare occurrence from January, 2018 to December, 2021. Kruskal Wallis test was performed to determine if there was significance difference on number of wire snares removed in different seasons. To understand if there was any seasonal patterns with snaring, the study first divided the seasons as wet (December-March), cool dry (April-July) and hot dry (August-November). GPS locations of wire-snares removed during law enforcement by field rangers were downloaded and superimposed on SWRA map in ArcMap 10.3 to map seasonal distribution. Kernel Density Estimation (KDE) analysed in R was used to highlight the relative probability of snaring hotspot based on wire snare GPS coordinates and number of snares removed at the site using the optimized hot spot analysis tool in ArcMap 10.3. The Hotspot analysis takes into account the spatial clustering of wire snares and reveals statistically significant hot and cold areas of clustering (Loveridge *et al.*, 2020) [15].

4. Results

This study sought to establish seasonal trend and distribution of wire snare in SWRA from January, 2018 to December, 2021 and to predict possible hot spot sites using present only data collected during field ranger patrols during the study period.

4.1. Monthly Wire Snare Trends in SWRA (2018-2021)

Total effort from 2018 to 2021 was 4767 patrol sessions. Trend in wire snare occurrence varied by year and month (**Figure 2**). Of the removed wire-snares in SWRA, 1573 were set targeting small animals, 602 for medium size animals while 139 were meant for large animals. The snares were either found near water sources, along animal tracks or under fruiting trees where wild animals were active.

4.2. Seasonal Variation in Wire Snare Occurrence in SWRA

In total, 2314 wire snares were recovered between January 2018 and December 2021. Of the total snares recorded, 14.5% (n = 335) were recovered in wet season, 29. 4% (n = 680) in cool dry season while 56.1% (n = 1299) in hot dry season. Seasonally, the number of wire snare recovered during law enforcement patrols also varied (**Figure 3**). The highest number of wire snares removed was recorded in 2019 in hot dry season while the lowest were removed in 2020 in wet season. However, the Kruskal Wallis test showed no significant difference on number of wire snares removed in different seasons (Z-Value = 4.654, p = 0.086).

4.3. Wire Snaring Hotspot Areas in SWRA

Based on present only data collected from January 2018 to December, 2021, the results showed seasonal variation of hotspot areas for possible targeted wire snaring (Figure 4). Generally, hotspot areas occur in the central part of the park regardless of season.

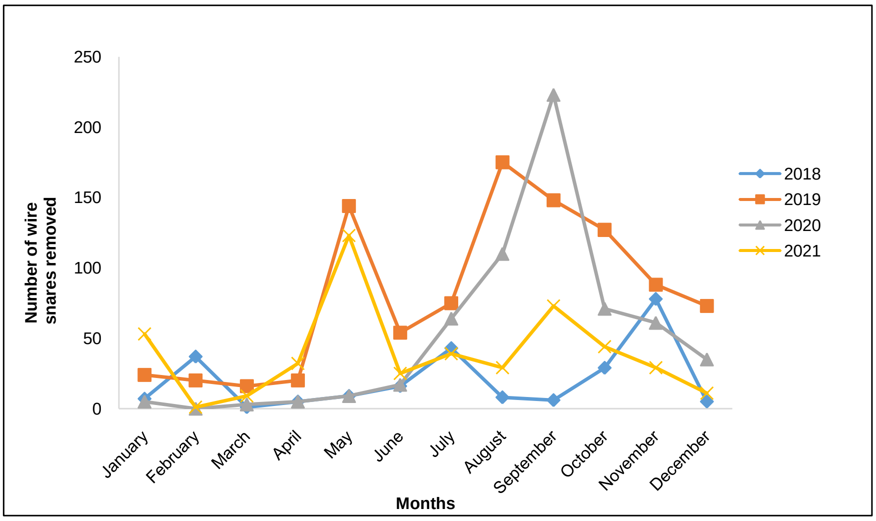


Figure 2. Trend in monthly occurrence of wire snares in SWRA from January, 2018 to December, 2021.

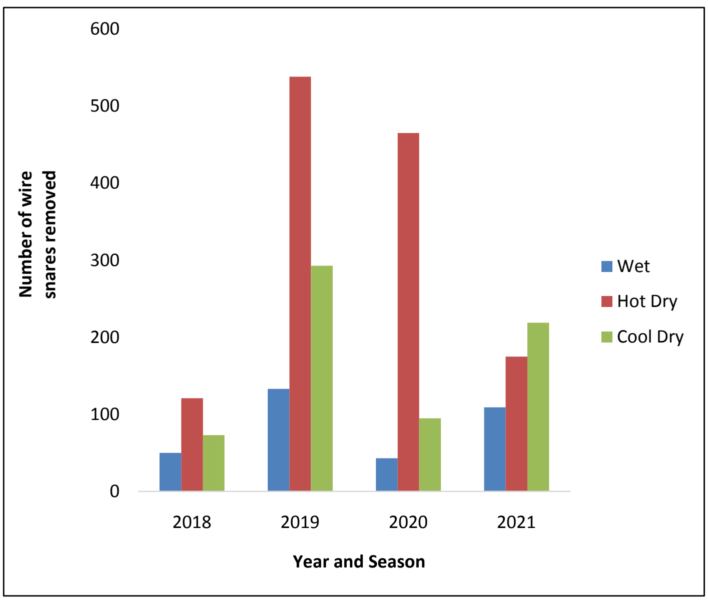
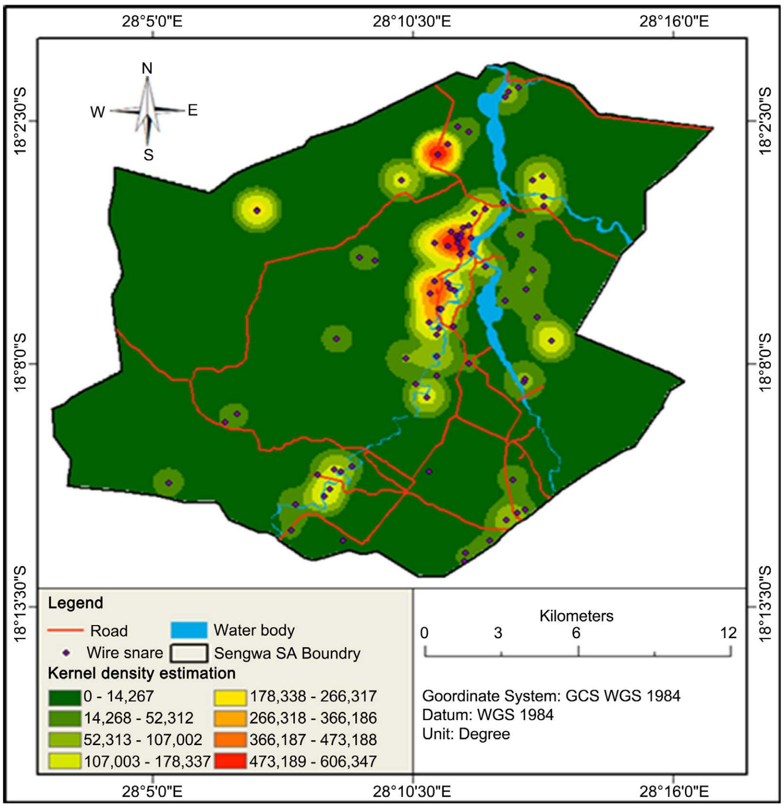


Figure 3. Comparison of seasonal variations on number of wire snares removed (2018-2021).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Legend
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Water body
Wire snare
Sengwa SA Boundry
Kernel density estimation
0 - 14,267
14,268 - 52,312
52,313 - 107,002
107,003 - 178,337
178,338 - 266,317
266,318 - 366,186
366,187 - 473,188
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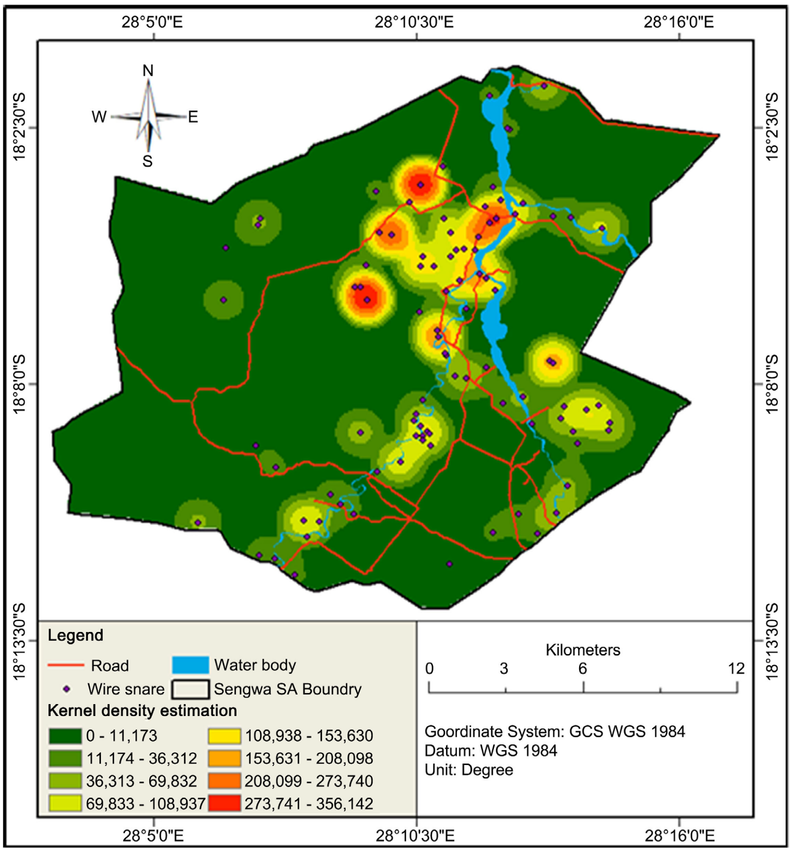
(a)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Kernel density estimation
0 - 11,173
11,174 - 36,312
36,313 - 69,832
69,833 - 108,937
108,938 - 153,630
153,631 - 208,098
208,099 - 273,740
273,741 - 356,142
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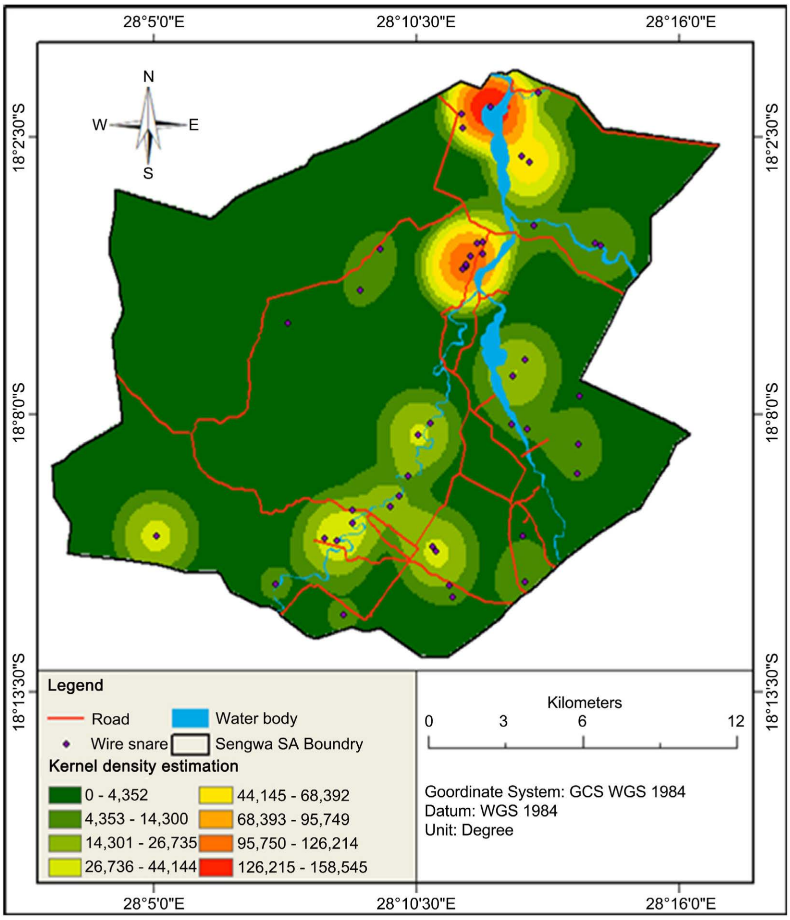
(b)



(c)

Figure 4. (a) Kernel Density hotspot analysis map for cool dry season in SWRA; (b) Kernel density hotspot analysis map for hot dry season in SWRA; (c) Kernel density hotspot analysis map for wet season in SWRA.

Figures 4(a)-(c) show Kernel density (low light black dots) which depicts sites where wire snares were removed, whereas the Hotspot analysis (Red hotspots) identifies the significant regions based on the clustering of wire snares to non-significant (dark green) at the 1km distance band.

5. Discussion

5.1. Wire-Snare Trend and Seasonal Fluctuation in SWRA

This study provided an analysis on seasonal trend and distribution of wire snare in Sengwa Wildlife Research Area (SWRA). The study observed variability on wire snare occurrence in the SWRA from 2018 to 2021. Building on the number of wire snares recovered during the study period, the most targeted species were small animals (n = 1573 wire snares), medium sized species (n = 602 wire snares) and large sized species (n = 139 wire snares) respectively. Cable wire snares were mostly used to target wild animals like eland and buffalo and are set in small numbers along animal tracks. For medium sized animal, copper wires in single or paired together were used while for small targeted species, small sized single strands wires of small diameter were used and were set in large numbers. Of the cables removed, most could have been stolen from the previously available veterinary fence and powerline supporting cables which connect the park and Gokwe town while copper wires could have been removed from telephone lines.

Species which were recorded caught on the snares by field rangers between January 2018 and December, 2021 were impala, bushbuck, kudu, waterbuck, zebra, buffalo and eland and elands. Impala recorded the highest loss in all seasons. Non-target species also recorded were elephant and hyena during the study period. The findings support observation by Becker *et al.*, (2013) [6] in Zambia's Luangwa valley where he reported that wire snares are used to poach wild herbivores for meat but the traps also affect non-target species like carnivores.

The study also reviewed that setting of wire snares were targeting traditionally known sites although differ with season. The targeted sites include around waterpoints, wildlife tracks, resting sites and under fruiting trees. The findings agree to research by Watson *et al.*, (2013) [16] who examined spatial patterns of wire snare poaching and noted influence of variables such as water availability and forage availability. For example, in the study area, along the riverine, Faidherbia albida and acacia species dominate the vegetation types and they drop pods which are utilised by impala, kudu and eland in cool dry season stretching to early mid-hot dry season. During the period, the highest number of wire snares was removed under fruiting trees targeting frequent visiting impalas and kudu at the sites.

Findings of this research also noted that around water sources, equally, wire snares were removed more often during dry season when most pen and rivers dry up. However, a distant from the water points, wire snares were also set along animal tracks. The results of the study noted that for large species like eland and buffalo, wire snares were recorded high in areas of rest which were far from water source compared to those targeting small animals.

Analyses of seasonal variation on wire snare data, provided evidence of increasing snare detection during cool dry to hot dry season, however the strength of evidence from the three seasons could not show any significance difference (Z-Value = 4.654, $p = 0.0976$), hence the results supports study working hypothesis that wire-snare trends in SWRA is not influenced by seasons. The results also concur with findings by Tumusiime *et al.*, (2010) [17] who also observed no change in the number of snares confiscated over the progressive years in Budongo Forest Reserve, Uganda between 2004 and 2006 although more snares were recovered during the rainy months of April–June and August–October. Snare detection and removal incidence increased seasonally, with the onset of the cool dry to end of dry season. Becker *et al.*, (2013) [6] mentioned that increase in wire snare during dry season could be due to either higher actual snaring intensity in the hot dry season, or higher detection probability as a result of clear visibility. As the dry season progresses, wild animals species increasingly concentrate around water points and along riverine in search of forage giving illegal wire snare hunters more predictable and localised areas to set successful snares on animal tracks surrounding water sources. Elsewhere, Lindsey, *et al.* (2011) [18] also noted in Save Valley Conservancy that during dry period wire snares and snared animals are easily detected, due to reduced vegetation cover.

5.2. Seasonal Distribution and Predicted Hotspots of Wire Snaring in SWRA

Findings of the study clearly demonstrated that wire-snare poaching was abundant within the central part of the park particularly along the riverine and around permanent waterpoints. Wire-snaring was low at the periphery of the park except in areas with waterpoints. This point to view that illegal wire snare hunters could be concentrating in the central part of the park compared to the edges especially during dry season when water and forage will be low in other parts of the park. The observation of the study showed that more wire snares were removed along the riverine and in thick woodland compared to open woodland areas in the study area. The observation points to suggestion by Noss (1998) [19] who mentioned that wire snare hunting tends to overexploit the most common species and density of snares is predicted to be high in areas with a high density of targeted species. Small animals which are water dependent mostly concentrate around water points compared to large animals which require enough space for foraging and escaping from its enemies. Wire snares targeting large mammals were recorded a distant away from waterpoints, some 15km as well from their feeding ground basing on known buffalo, eland and zebra tracks they use while heading to water sources. The results support to support findings by Gadgil *et al.*, (1993) [20] who mentioned illegal hunters use their indigenous knowledge about suitable habitats for targeted species when placing wire snares.

Seasonal variation on possible hotspot areas of wire snare point to some extent, overlapping of the targeted sites by illegal hunters. Wire snares in some parts of the park were recovered in all seasons that i.e. wet, cool dry and hot dry. However, the results also content that wire snare trends in SWRA follow a predictable pattern that could be influenced by seasonal surface water, shed and forage availability for wild animals. Hence, analysis of snaring hotspots revealed incidents of snaring were highly clustered in the central area of the park near waterpoints, along wildlife tracks and under fruiting trees across seasons. Similar findings were recorded by Kimanzi *et al.*, (2015) [21], in Ruma National Park, Kenya where he noted snare hotspots occurred near essential resources such as water which animals visit frequently. According to Gadgil *et al.*, (1993) [20] the clumped wire snare patterns suggest that hunters have identified sites with high potential for snaring their targeted species based on their previous experience.

5.3. Impact of Wire Snare on Targeted and Non-Targeted Animals

In addition to ecological explanations on wild animal snaring in SWRA, concentration of wire snares around water sources during dry season have the potential to wanton kill large number of species. This support idea by Noss, (1998) [19] who mentioned that snare hunting is a wasteful hunting method with high losses to scavengers and decomposition. Injuries sustained and death caused by snaring have significant negative demographic effects given that snaring does not discriminate but target all ages. The impacts of snaring of wild animals leads to disproportionate declines of some species, to severe wildlife declines in areas with inadequate anti-poaching. In Lower Zambezi National Park, Zambia, for example, snaring has been prevalent and even led to local extirpation of wild dogs while in Zimbabwean conservancies, similar observation were recorded especially on non-target species like painted dogs and lions (Leigh, 2005 [22]; Pole, 1999 [23]). In Zimbabwe's Savé Valley Conservancy, at least 1410 animals perished from wire snaring between 2001-2009 (Lindsey *et al.*, 2011a) [24] signifying a large loss to wildlife, hence threatening ecosystem stability and functioning.

The study admit the results may undoubtedly give an underestimate due to low detection because snares share many of the characteristics of the species they target, being habitat specific and difficult to detect due to well concealed by people who set them. In a nutshell, while analyses of snaring data give insights into seasonal trend and distribution of wire snares in SWRA, anti-poaching patrols are not usually conducted to address questions about snaring trend and distribution only but minimize immediate illegal activities in PAs. However, findings of the study give some baseline information on trend and spatial distribution of wire-snares in SWRA and predicting possible hotspots.

6. Conclusion

This study used data collected from January 2018 to December, 2021 recorded during patrols by field rangers. Total effort from 2018 to 2021 was 4767 patrols sessions. A total of 2314 wire-snares were recovered during the study period. Of the total snares recorded, 14.5% (n = 335) were recovered in wet season, 29.4% (n = 680) in cool dry season while 56.1% (n = 1299) in hot dry season. A total of 1573 snares were set targeting small animals, 602 wire snares targeting medium size animals while 139 wire snares were meant for large animals. Based on present only data collected from January 2018 to December, 2021, the results showed seasonal variation on wire snare possible hotspot areas in SWRA.

7. Recommendation

Of key importance is accurately and effectively adopting anti-snaring measures. Improvement of snare detection efficiency and non-random searching by patrols via application of wire detectors gargets helps identify all wire snares at a point hence reducing the chance of leaving others behind. Season and landscape targeted patrols can prove to be effective in detecting and removing wire snares in SWRA considering, in most cases illegal hunters use repeated sites in setting wire snares. While wire snares are widely available from power supply supporting cables and telephone lines, it is also pertinent that conservation actions must also consider reducing availability of wire in adjacent community through removing all abandoned fence and burn and bury recovered snares. Well-designed scientific inquiry performed in concert with anti-poaching and community conservation activities has the potential to substantially decrease the threat of snaring.

8. Implications for Conservation

SWRA is a strong hold of African herbivore in Sebungwe Region and beyond. Use of wire-snares as a hunting tool by illegal hunters remains widespread and frequent in SWRA and in the adjacent landscape in Sebungwe region. Understanding seasonal trend and distribution of wire snares provides insights into fighting and reducing its occurrence in the PA since it has impact on wildlife populations. Patterns of wire snare activities observed in SWRA mirror some existing situations in other PAs faced with poaching across Africa and beyond. The results of the study could thus be useful to improving law enforcement strategies in PAs elsewhere particularly in small isolated PAs surrounded by areas of high human density.

Acknowledgements

The author wishes to thank the Director General Dr. F.U. Mangwanya (Zimbabwe Parks and Wildlife Management Authority) for permission to use data from the SWRA and the Chief Ecologist Mrs. R. Mandisodza-Chikerema for her long-term support. Great appreciation to Mr. K. Mawere for his assistance in the processing of hotspot maps. I thank anonymous reviewers for their inputs which improved the manuscript.

Funding

The author received no financial support for the research, authorship, and/or publication of this article.

Data Availability Statement

Data sharing is not applicable to this research article on wire snare coordinates as this is treated as confidential data for wild animal protection.

Conflicts of Interest

The author declares no conflicts of interest.

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