An analysis of the effect of COVID-19 pandemic on wildlife protection in protected areas of Zimbabwe in 2020

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ABSTRACT

The COVID-19 pandemic brought about unprecedented effects on the conservation and protection of wildlife in protected areas. In response to the COVID-19 pandemic, the government of Zimbabwe imposed lockdown measures to prevent and control the spread of the pandemic. The inability of researchers to conduct field-based research led to office-based research to determine the impacts of the pandemic on conservation. The objective of this study was to find out how the pandemic had affected the security of wildlife in protected areas of Zimbabwe in 2020. The researchers divided 2020 into three periods, 'no' lockdown, 'full' lockdown, and 'partial' lockdown. Data on wildlife protection, illegal activities and tourism performance was collected at the station level using a similar format and submitted to a central place for consolidation and analysis. Parametric and non-parametric tests were conducted based on the normality status of the data variables. The study findings are that (i) The number of rangers conducting law enforcement activities in 2020 remained the same, (ii) Rise in local poaching of wildlife with a peak in the dry season, increase in illegal fishing, and illegal mining activity during the period of 'full' lockdown, (iii) Tourist arrivals and revenue generated from regional and international tourism showed a significant decline during 'full' lockdown and 'partial' lockdown (iv) Domestic arrivals increased as expected during 'partial' lockdown. This study corroborates the potential negative implications of the COVID-19 pandemic on wildlife protection which would continue to worsen with the prolonging pandemic. One lesson from this study is that the Zimbabwe Parks and Wildlife Management Authority (ZPWMA) wildlife protection efforts in 2020 were sustained using financial reserves as a safety net and support from conservation partners. There is a need to ensure conservation safety nets through diversifying funding sources and creating financial reserves for conservation.

Introduction

The Coronavirus (COVID-19) is a novel viral infectious disease whose causes are assumed to be related to human population growth and environmental degradation [24,23,20]. The reasons advanced by researchers to explain this link between

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human activity and the COVID-19 viral disease include human encroachment into natural areas, deforestation, disruptions to ecological relationships, humans coming into close contact with disease-carrying wildlife species, trafficking of wildlife and compromised human health due to poverty [20]. The COVID-19 disease was brought to global attention in December 2020 by the World Health Organization (WHO) [31]. On 11 March 2020, WHO declared Covid-19 a global pandemic [31]. The novel COVID-19 disease spread widely that by June 2020, this viral disease had infected over 20 million people and caused over 500 000 human death [12]. This scourge has severely affected the lives of communities and has posed enormous health, economic, environmental, and social challenges [29,26]. In response to the pandemic outbreak, like other governments, the Zimbabwean government passed various national regulations to prevent the spread of the COVID-19. These include the Statutory Instrument 77 of 2020 Public Health (COVID-19) Prevention, Containment, and Treatment regulations (Government of Zimbabwe, 2020). Travel restrictions were imposed in phases throughout 2020 to control the spread of the disease.

Sustainable wildlife-based tourism is an increasing driver of national economies [7]. In developing countries, tourism revenue forms a great source of conservation funding. In Zimbabwe, approximately 80% (US$25 million) of the Zimbabwe Parks and Wildlife Management Authority's (ZPWMA) annual revenue budget comes from photographic tourism in 11 national parks and 16 recreational parks (approximately 54% of the total area covered by protected areas) and trophy hunting in 16 Safari Areas (38% of the areas covered by protected areas) [17]. Other sources of conservation funding include donor aid which contributes up to 32% of protected areas (PAs) funding across Africa and reaching 70–90% in some countries [17]. Apart from conservation funding, tourism is one of the highest sources of employment, one of the main contributors of gross domestic products (GDP) and foreign exchange-earners. By the end of the first quarter of 2020, the COVID-19 pandemic had brought international travel to an abrupt halt affecting tourism revenue received by many countries.

The illegal exploitation of wildlife resources has been one of the challenges for many decades. Studies have shown that illegal hunting is usually associated with loss of livelihood that comes with disturbances such as political unrest and economic collapse [9,14,25,33]. In Zimbabwe, for instance, during the 2000–2008 political crisis and economic collapse, many communities were left suffering from high unemployment, loss of income, and shortages of food and other essential daily supplies [8]. Scholars have highlighted the vulnerability of less-resourced communities in Africa from the global COVID-19 pandemic [21]. In Zimbabwe, such an impact on economic and societal welfare has been dramatic [22]. The COVID-19 negative impact on PAs budgets and management effectiveness has been significant in the same way it has been on the livelihoods of communities living in and around these areas [28]. The economic crisis caused by the COVID-19 pandemic has increased biodiversity threats such as poaching, wildlife trafficking and forest logging during and following its outbreak [7]. Conservation advocates believe the real risk to critical wildlife species is poaching activities if funding for patrols declines or anti-poaching programmes are affected due to a lack of tourism brought about by COVID-19 [20]. In many ways, the outbreak of the COVID-19 pandemic also impaired collaborations with conservation partners to tackle burning conservation issues such as human-wildlife conflict through conservation education, awareness, social engagements and work that require close contact between people. The lockdown measures and regulations prohibited social gatherings. Social distancing was enforced to prevent and control the spread of COVID-19.

The scientific literature has focused on the causes and consequences of the pandemic from an anthropocentric viewpoint [1]. The inaccessibility to field sites by researchers has resulted in office-based research. The inability of researchers to conduct field-based assessments during the period of lockdown created gaps in the scientific evidence on the potential impacts of the lockdown on species and the conservation of ecosystems [1]. The objective of this study was to find out how the COVID-19 pandemic had affected wildlife protection in protected areas in Zimbabwe. The researchers studied the impact of the COVID-19 pandemic on wildlife protection using law enforcement and tourism data derived from gazetted protected areas under the administration of ZPWMA. We hypothesized that in terms of wildlife protection (1) prevalence of poaching of wildlife fluctuate with law enforcement effort, resource availability and would be expected to increase due to loss of livelihood (2) there will be a significant difference in regional and international tourism arrivals and receipts before and after lockdown (3) domestic tourism will increase with reduced lockdown restrictions.

Methodology

Study design

This study focused on 63 gazetted protected areas (Appendix 1) on state land under the jurisdiction of the ZPWMA, a government agency with a national mandate for wildlife conservation in Zimbabwe. The gazetted protected areas in Zimbabwe fall into six categories that included 11 national parks, 16 safari areas, 13 recreational parks, 6 sanctuaries, 3 botanic gardens, and 14 botanical reserves (Government of Zimbabwe, 1996). The protected area system covers an estimated area of 5.11 million hectares (range is from 3 to 1 465 100 ha; the average is 76 272 ha) which is about 12.7% of the total area of Zimbabwe. Fig. 1 shows the distribution of various protected areas in Zimbabwe.

For this study, we divided the year 2020 into three different periods, 'period of no lockdown, period of full lockdown and period of partial lockdown. The period of 'no lockdown' was from 01 January to 29 March; 'full lockdown' was from 30 March 2020 to 01 July, and 'partial lockdown' was from 02 July to 31 December 2020. During the 'no' lockdown period, tourism business and conservation activities were operating as usual. During the 'lockdown period,' there was a virtual stoppage of all key economic activities. The period of 'partial' lockdown was constituted by the re-opening of domestic
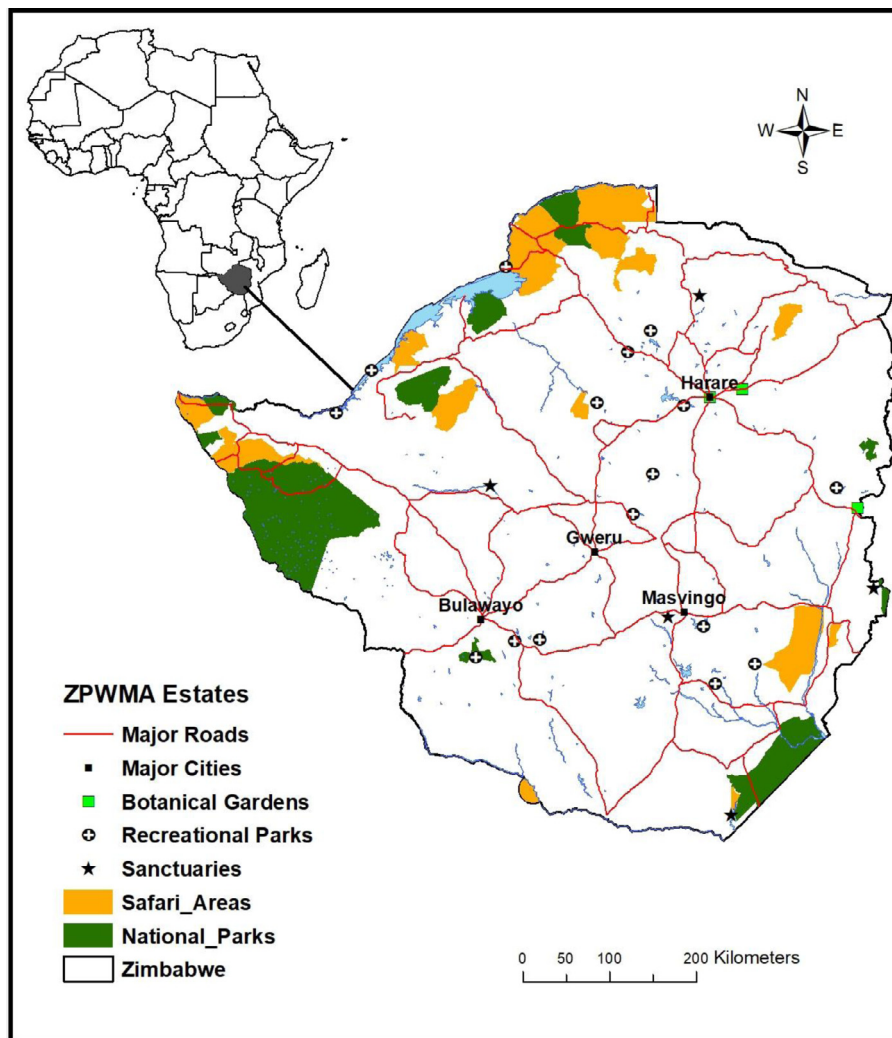
Fig. 1. Gazetted protected areas in Zimbabwe managed by ZPWMA. List of gazetted protected areas (Appendix 1).

tourism from 04 September 2020, re-opening of international tourism 01 October 2020, and border posts on 01 December 2020.

Data collection

Data were obtained from the stations, as mentioned above, on resources available for law enforcement, law enforcement effort and outcomes, the illegal activity incidences and the tourism arrivals monthly using a standardized reporting format. Resources available for wildlife protection were in the form of human resources (rangers on the ground) and fuel (diesel and petrol) for activities such as ranger deployments, reaction to incursions, and wildlife crime reports. Daily patrols refer to the number of days a ranger sets out on patrol from and return to the station on the same day, irrespective of the number of hours spent in the field on patrol. The extended patrol days refer to the number of nights each ranger spent out on patrol in the bush. Illegal wildlife activity data included the number of incursions, arrests made, and wildlife courts cases recorded. Further data on illegal wildlife harvested, the number of dogs shot, illegal inshore fish and kapenta fish recoveries, fishnets recoveries and snares removed, and impounded vehicles, bicycles, boats, canoes, and fishing rigs.

Data analysis

We examined whether law enforcement effort, resource allocation, illegal activities and tourism performance differed in the three periods, i.e., no lockdown, full lockdown, and partial lockdown. Descriptive statistics, graphical presentations and statistical analysis results are presented. Data was consolidated and sorted in a Microsoft Excel Version spreadsheet. The
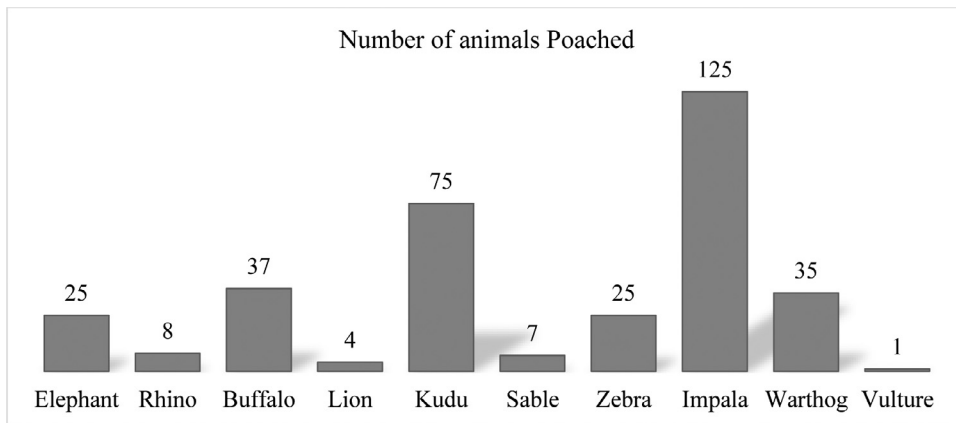
Fig. 2. Summary of illegally killed wildlife species.

resources available for wildlife protection and the illegal activity data were tested for normality in distribution using the Shapiro-Wilk test at a significance level of $p = 0.05$. To explore the effect of COVID-19 lockdown on wildlife protection, we conducted one-way ANOVA using law enforcement resources and illegal activity data for three periods used in this study. In addition, post hoc analyses using Fisher Least Significance Difference (LSD) were done in the one-way ANOVA analysis to further explore resource protection status in 2020. All statistical analysis was done using IBM SPSS Version 20.0 software package (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.).

Results

Resources available for law enforcement

A total of 1 430 rangers were available for law enforcement duties for the year 2020 and this was 81.8% of the ideal requirement. The percentage of actual rangers available for law enforcement were 84.6%, 86.5% and 78.2% for the periods of no lockdown, full lockdown, and partial lockdown, respectively. A total of 262 349 litres of diesel and 98 967 litres of petrol were allocated and used for law enforcement operations in 2020. It amounted to 51.2% and 47.8% of budgeted fuels, respectively. The diesel allocation was 48.5%, 52.6% and 51.8%, while petrol allocation was 48.4%, 56.1% and 44.8% in the period of "no lockdown", "full lockdown" and "partial lockdown" respectively. The diesel and petrol allocations did not differ during the period of no, full and partial lockdown (Table SM1).

After conducting a normality test on the resource allocation data, the data was found to conform to normality assumptions, except for diesel allocation during the period of partial lockdown $p<0.021$. To explore resource allocation status across the categories, a one-way ANOVA was done. There were no significant changes in the actual rangers available for wildlife protection ($F_{2,9} = 0.679$, $p = 0.531$). The one-way ANOVA test results for actual rangers were significantly different for combined and within groups ($F_{2,9} = 24.606$, $p = 0.000$) (Table SM1). The LSD post hoc multiple comparisons, however, showed significant differences in the actual number of rangers during periods of 'no' and 'partial' lockdown with a difference of 93 (1 211±20 and 1 118±31, $p = 0.001$) as well as during 'full' and 'partial' lockdown with a mean difference of 119 (1 237±0 and 1 118±31, $p = 0.000$). The number of rangers available for resource protection did not differ during the period of 'no' and 'full' lockdown ($p = 0.238$).

There were significant differences noted in daily law enforcement efforts for the period of 'no' lockdown and 'partial' lockdown as detected by one-way ANOVA ($F_{2,9} = 10.871$, $p = 0.004$). Further LSD post hoc test revealed 'no' lockdown and 'partial' lockdown (1 547±81 and 1 927±137, $p = 0.001$) mean difference 383 man-nights as well 'full' and 'partial' lockdown (1 737±137 and 1 927±122, $p = 0.046$) mean difference of 193 man-days. However, no significant difference was observed for 'no' and 'full' lockdown, $p = 0.080$. The test statistics for extended patrol nights was also significant ($F_{2,9} = 6.762$, $p = 0.016$). The LSD post hoc test further revealed a significant difference between 'no' lockdown and 'partial' lockdown (9 255±57 and 10 100±330, $p = 0.012$) mean difference of 845 man-nights. Significant differences were noted between 'no' and 'full lockdown' (9 321±339 and 10 100±330, $p = 0.018$) mean difference of 779 man-nights. However, were no significant differences noted for 'no' and 'full' lockdown, $p = 0.837$.

Illegally poached wildlife

A high number of plains games were lost to poaching activity as indicated in Fig. 2.

No significant differences were noted for poached high-value species such as African elephants ($F_{2,9} = 0.731$, $p = 508$) and Black rhinoceros ($F_{2,9} = 0.000$, $p = 1.000$). Only lion poaching data showed a significant difference across study periods
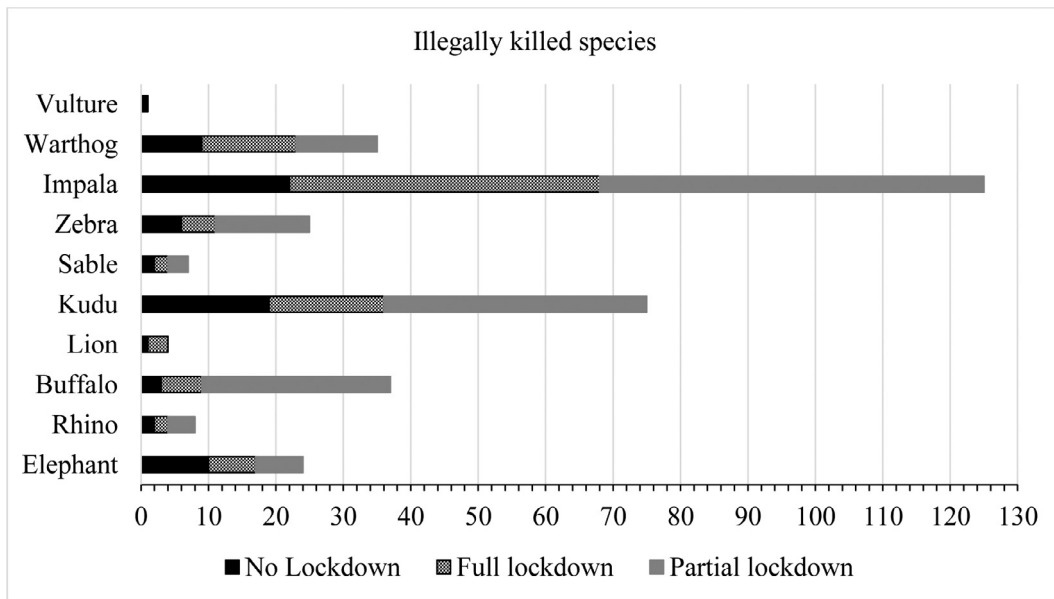
Fig. 3. Number of illegally killed wildlife species per lockdown period.

Table 1
Summary of other law enforcement indicators, illegal activities, and recoveries.

Variable	No Lockdown Mean Monthly	Sum	Full Lockdown Mean Monthly	Sum	Partial Lockdown Mean Monthly	Sum	Annual Sum
Court Cases Finalized	22	65	37	111	33	198	374
Armed Contacts	1	3	2	7	2	11	21
Inshore Fish Recovered (kgs)	3 511	10 534	6 898	20 693	10 332	61 987	93 214
Kapenta Fish recovered (kgs)	113	341	161	485	381	2289	3115
Length of fishnets recovered (m)	64 488	19 3464	72 213	21 6640	73 270	43 9625	84 9729
Canoes impounded	81	244	120	359	85	507	1 110

($F_{2,9}$ = 6.075, p = 0.021). Of the 25 poached elephants, four died from cyanide poisoning in an area adjacent to parks and wildlife estate. One vulture died from poisoning. One elephant succumbed from poisoning during the period of partial lockdown in the park's estate. The illegal harvesting of common wildlife species was high during the dry months (Figure SM3). The situation was not the same for high-value like African elephants and Black rhinoceros (Figure SM4). There was high illegal harvesting of plains game during 2020. Illegal poaching of high-value species was low with only 25 elephants in 2020 compared to 53 in 2019 (Unpublished ZPWMA 2019 Annual Report). Rhinoceros poached were 8 (five white and three black) in 2020 compared to 29 (6 and 23) in 2019 (Unpublished Parks 2019 Annual Report) (Fig. 3).

While the number of people arrested for poaching wildlife declined (Fig. 4a), that of arrested illegal miners (Fig. 4b) and fishers (Fig. 4c) went up from 'no lock down' to 'partial lock down' period. The highest number of bicycles impounded for being used to commit wildlife offences was highest during the full lockdown period (Fig. 4d).

In Table 1, the illegal activities increased from the time when there was full and partial lockdown.

Tourism performance

During the first quarter before the COVID-19 outbreak, tourism arrivals followed the expected trajectory. Domestic tourist arrivals were high, followed by Europe, Asia, America, the United Kingdom, the Southern African Development Community (SADC) region, other African countries, and Australia-New Zealand. During the period of complete lockdown, there were no tourist arrivals for the regional and international market in contrast to the 192 domestic tourists. (Fig. 5). Overall, there was a high variance in mean domestic tourist arrivals across the three periods as indicated by the Welch robust test for equality of means ($t_{14.757}$) =3.81, p = 0.016) (Figure SM7). The LSD post hoc test result revealed no significant difference for the period before and during partial lockdown (p = 0.912). However, a significant difference was noted in mean domestic tourist arrivals for the period before and during 'full' lockdown (19 098±8 830: 64±110, p = 0.05) as we as during full and partial lockdown (64±110:18 266±12 559, p = 0.035). The rest of the source markets arrivals were significantly different throughout 2020 (Levenes Homogeneity of variance, p<0.05 (Figure SM6). The decline in tourist arrivals adversely affected tourism revenue
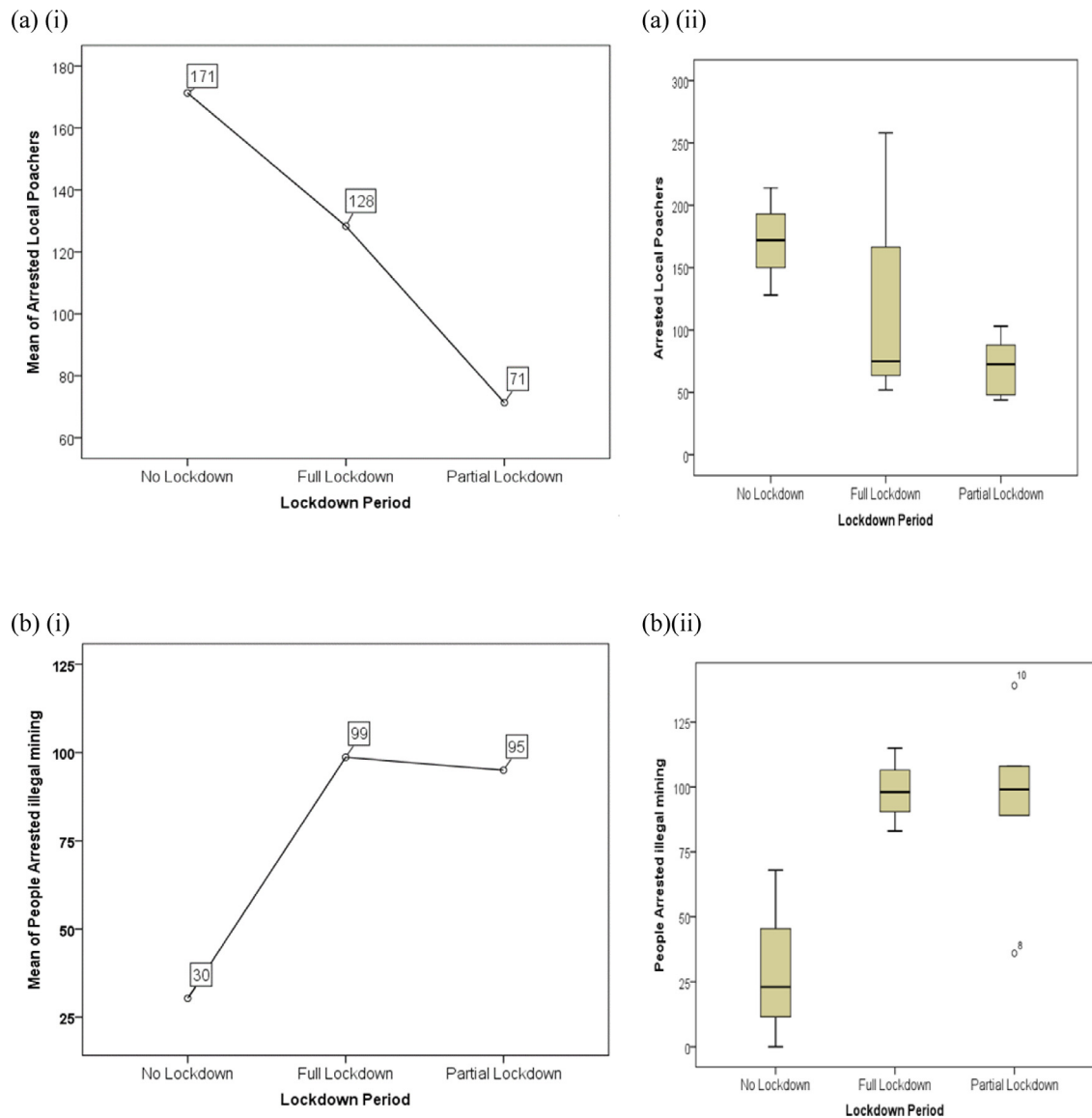
Fig. 4. (a) The number of local poachers arrested was not significant ($F_{2,9} = 0.100$). However, a significant difference between 'no' and 'partial' lockdown ($171\pm43;71\pm23$). The mean number of people arrested for illegal mining was statistically significant ($F_{2,9} = 3.012$, $p = 0.034$). Much variation was noted between 'no' and 'full' lockdown ($30\pm34:9916$, $p = 0.025$) as well as during 'no' and 'partial' lockdown ($30\pm34:95\pm34$, $p = 0.017$). No difference was noted on poachers arrested for illegal fishing ($F_{2,9} = 2.670$, $p = 0.123$. The number of impounded bicycles was statistically significant ($F_{2,9} = 12.034$, $p = 0.003$), with a mean difference of ($12\pm5:37\pm13$, $p = 0.003$) during 'no' and 'full' lockdown as well as ($37\pm13:13\pm4$, $p = 0.001$) during 'partial' and 'full' lockdown.

received by 60% against the expected total earnings of US$20 126 600 in 2020. International and regional tourism received 65% of the tourism revenue generated (US$8 024 239) compared to 35% contribution from domestic tourism.

Discussion

Resources for wildlife protection, wildlife protection performance indicators, and threat indicators

The effectiveness of protected areas in conserving biodiversity continues to face many challenges. The global economic recessions, climate change, disease pandemics, and political instability are potential factors, among many others, that undermine the efforts geared towards the management of the protected areas [15]. In times of stochastic events that lead to economic crises, local people near protected areas in tropical ecosystems adapt to resultant hardships by engaging in diversified income means that includes illegal wildlife harvesting and fishing [4,5,9–11]. Law enforcement and anti-poaching patrols require frequent deployments for the continued presence of rangers on the ground to detect and prevent illegal ac-
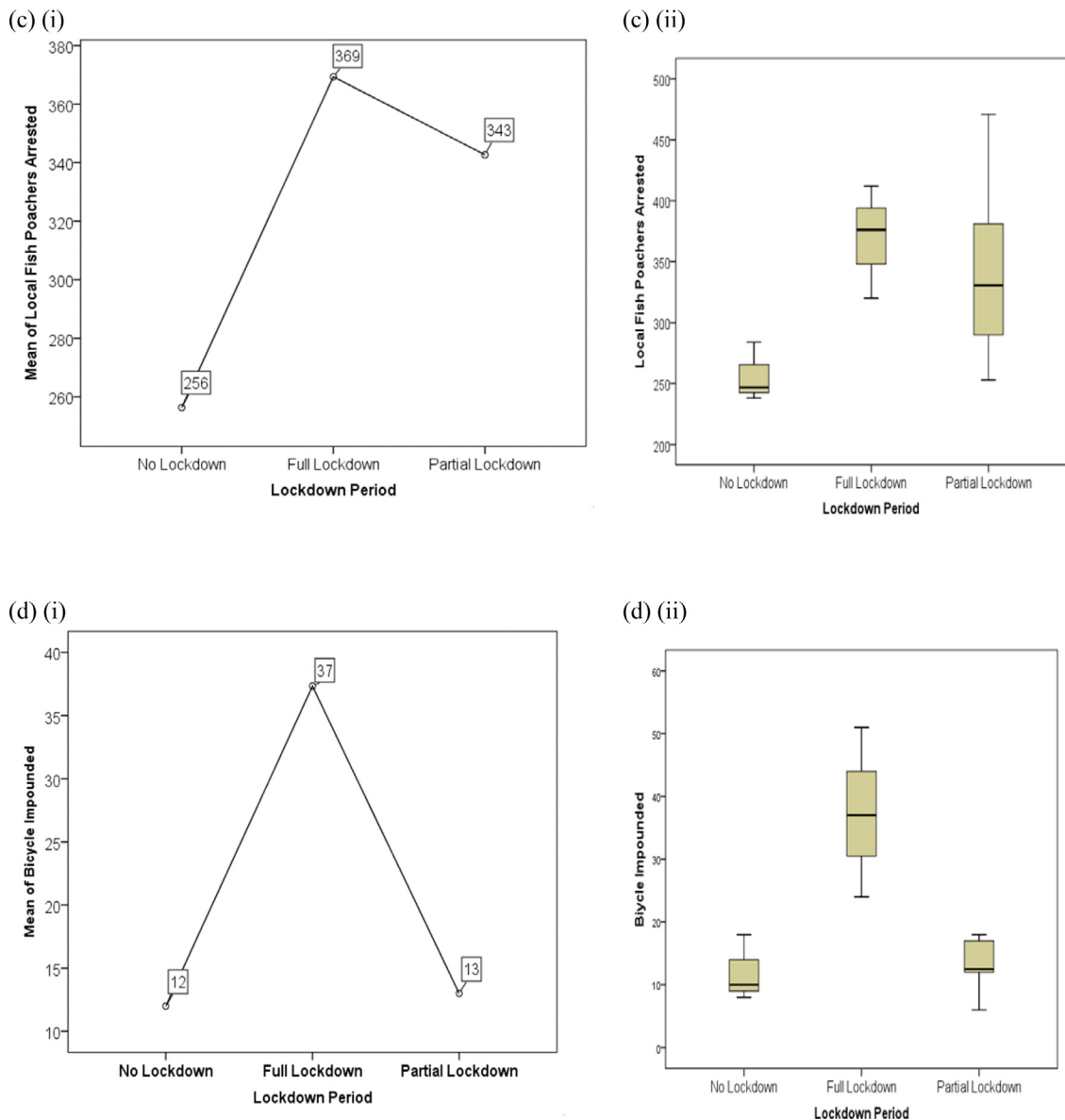
(c) (i)

(c) (ii)

(d) (i)

(d) (ii)

Fig. 4. Continued

tivity. Under COVID-19 conditions, such ranger deployments would be affected due to reduced operational budgets resulting in gaps in the deployment patterns exposing protected areas to more incidences of illegal hunting, mining, and logging [1].

Wildlife protection effectiveness largely depends on resource availability to address multiple threats and conservation issues facing PAs. Logistical resources such as diesel and petrol are critical in driving wildlife protection activities such as ranger deployments, monitoring illegal activities on hot spots, responding to wildlife incursions, carrying out wildlife research, fire management, and game water management. During 2020 resources to conduct wildlife protection such as rangers on the ground, diesel and petrol did not differ significantly despite a fall in tourism arrivals. This availability of resources is because the ZPWMA was still utilizing its financial reserves. During times of adequate funding, one would expect fuel allocations to increase in the early to late dry season (which correspond to full and partial lockdown period) because of increased illegal activities and law enforcement monitoring. The trend in wildlife poaching usually peaks after the crop harvesting season when some people from communities near parks become less occupied. Despite such increased need, inadequate resource allocation is often a challenge in most African parks. For instance, in Tanzania, the annual expenditure is estimated at $6 billion against the ideal $24 billion required for effective protected management [15]. The effects of limited funding in the quest of halting biodiversity loss have been brought forward [30]. The COVID-19 pandemic will further reduce
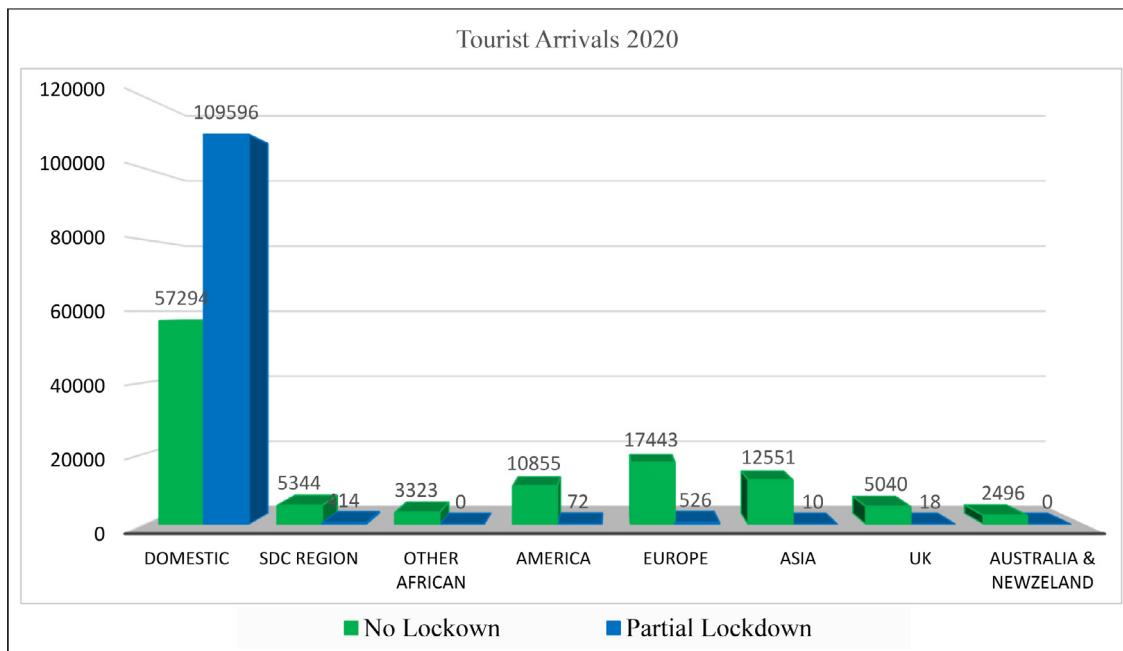
Fig. 5. Total number of tourist arrivals recorded before, during the period of complete lockdown and the partial lockdown in parks and wildlife estates, Zimbabwe. Only 192 domestic tourists were recorded during 'full' lockdown and zero for the other source markets.

the already limited conservation funding that one would expect the effect to become more acute as the pandemic continue to ravage the world.

Law enforcement staffing is a challenge in ZPWMA managed parks. We report, however, that the actual rangers available for wildlife protection was high during the period of full lockdown. Ranger availability was due to the reason that travels restriction limit staff movements. In the absence of the pandemic, some rangers would usually do tourism-related duties but owing to the closure of tourism, the rangers were available for law enforcement duties. With the easing of restrictions (partial lockdown), the rangers available became reduced as other staff returned to their tourism duties. We expected the patrol to increase corresponding to high ranger numbers during the period of full lockdown. However, this was the opposite as the mean monthly local patrols and extended patrols conducted were low during full lockdown but high during the partial lockdown. Overall, we noted significant differences in the daily and extended patrols conducted before and during the lockdown. It indicates that the high number of rangers availability does not necessarily equate to increased patrol effort. The efficient and effective use of the available resources, therefore, requires meticulous planning.

Success and shortfalls in wildlife protection measures are measured using several indicators such as arrests of offenders. During the period of full lockdown the trend of local poachers arrested, illegal miners arrests increased consistent with an envisaged increase in these conservation threats as a consequence of the impacts of COVID-19 [17]. During the period of full lockdown, the nature of wildlife crime became local and subsistence. It is due to a large extent explained by the loss of livelihood of the local communities. The complete shutdown during full lockdown affected the fisheries sector alike with exposure of vulnerable social groups and an increase in illegal fishing activity reported in coastal and marine areas [3]. Court cases peaked in April and then dropped to an average of 98 in May and June as courts were partially closed for wildlife criminal cases not being tried in courts due to COVID-19 measures such as decongestion of workplaces. Illegal wildlife harvesting of plains game also rose during the full lockdown. The general assumption is that if the number of ranger patrols substantially increases, there is a high probability that poaching-related threats would decline at the site level if threats were originally present [19]. However, the issue of evaluating the presence or absence of illegal activities is subject to debate as it may be a direct result of effective or ineffective law enforcement. Although the number of rangers available was high during the full lockdown, mean daily and extended patrols were low. The wildlife-related crime became more prevalent with increased illegal activity incidences and recoveries, undoubtedly triggered by the loss of livelihood. The number of rangers alone may therefore not be a reliable benchmark in evaluating wildlife protection performance.

One salient characteristic of local poaching is the use of wire snare to kill animals. There was no significant statistical difference noted in wire snare recovery during no, full and partial lockdown. The trend in the recovery of snares used for poaching reveals a higher number during the dry season. Poaching with snares during the dry season has been noted to increase due to many factors such as easy detection of snares due to thinning vegetation and increased incidences of wire snare setting at the remaining few surface water sources where wildlife congregates [2,16]. Although at the international level, poaching of species of low economic value (plains game) are regarded as species of Least Concern on the IUCN red

list, snaring at a large scale is detrimental for wildlife conservation. Snares are wasteful as many animals, including non-target species, are trapped and not recovered by poachers. It also depletes the source of food for apex predators such as lions (*Panthera leo*), leopards (*Panthera pardus*), and wild dogs (*Lycaon pictus*) which are tourism flagship species and species of conservation concern.

The goal of resource protection is to ensure ecosystem resilience and long-term biodiversity conservation. A look at the target species during full and partial lockdown reveals selection towards plains game. It may have been motivated by the need for bushmeat for subsistence (food) and or sale. The illegal harvesting of species of economic value for commercial purposes was marginally low. Illegally harvested elephants were high during the period of no lockdown due to a poisoning incident that occurred in a Community Conserved Area (CCA) outside of the parks and wildlife estate. Only one elephant was killed from cyanide poisoning in parks and wildlife estates during the partial lockdown. Rhinoceros poaching was noted before and during the period of partial lockdown. It undoubtedly reveals the nature of commercial poaching that is associated with trafficking across national borders. Despite the economic impacts of COVID-19, the travel restrictions to some margin reduced commercial poaching. The reduction is consistent with predictions made at the onset of lockdown [18]. Other experts, however, warned that although there will be some localized disruptions, the pandemic will not significantly diminish illegal wildlife supply availability, smuggling modes, or demand patterns in short to medium terms [32]. Without external support, a prolonged crisis would see the conservation situation deteriorating further in 2021.

Tourism performance

During the period of "no lockdown", the tourism arrivals were higher. The total shut down of local, regional, and international travel had unprecedented impacts on tourism compared to previous disease outbreaks [13]. In Zimbabwe, the domestic tourists visiting national parks were higher than those from European, Asian, American, African, United Kingdom, Australian, and New Zealand. Tourists' arrival during partial lockdown was low as the disease status fluctuated in different countries. Domestic tourists contributed a higher proportion of the arrivals at tourist destinations. This study highlights the potential contribution of local tourists as a viable market and a viable springboard for tourism recovery from external shocks such as the COVID-19 pandemic.

The COVID-19 pandemic has shown the risk and fragility of reliance on one income source [27]. Analysis of tourism performance in 2020 reveals this vulnerability in the context of Zimbabwe. The status of tourism under the COVID-19 crisis provides a valuable lesson on the dangers of over-relying on international tourism to finance conservation while ignoring domestic tourism and other sources of revenue for wildlife management. Although protected areas continue to receive substantial amounts of external donor funding and or development partner funding, the crisis has allowed conservation decision-makers and managers to rethink how they plan conservation financing and management of financial reserves for use in times of resource limitations [18].

Tourism and wildlife protection

The tourism and the wildlife industry as many other industries have been affected by the COVID-19 pandemic [7]. Conservation advocates believe the real risk to critical wildlife species is poaching activities when funding for patrols declines or anti-poaching programmes scale down due to a lack of tourism brought about by COVID-19 [20]. Sustainable tourism programmes provide more opportunities for wildlife protection. In many instances, it has resulted in good conservation outcomes such as improved conservation perceptions and approaches, reduction of poaching, participation in conservation projects, increased species densities and or range, habitat improvement and community development have been registered [7,20]. Wildlife protection efforts and level of funding are associated with tourism [20,27]. The effects of COVID-19 have been felt more in areas and economies reliant on international and regional tourists. With an almost 100% reduction in revenue from tourism and therefore no resources to pump back into ecosystems, wildlife resource protection was severely affected. This situation inevitably led to an increase in poaching and illegal offtake of resources. The impact on an African scale has reportedly been relatively huge and extensively reduced regional collaboration and support in dealing with the aftermath of the crisis and the effect on wildlife conservation and the wildlife economy [18]. The diversion of funds to more immediate societal and economic needs and travel restrictions have affected the tourism revenue generation necessary to support conservation activities [1]. The implication of decreased conservation funding includes inefficient conservation programs resulting in increased vulnerability of protected areas, biodiversity and habitat loss.

Conclusion

The spatial spread of the coronavirus crippled national and local economies that have triggered the worst economic and humanitarian crisis. In conservation, the illegal exploitation of wildlife resources has been one of the challenges for many decades. Many studies have shown that illegal hunting is usually associated with loss of livelihood that comes with disturbances such as political unrest and economic collapse [9,14,25,33]. In the previous crisis, communities experienced high unemployment, loss of income, and shortages of food and other commodities [8]. Scholars have highlighted the vulnerability of less-resourced communities in Africa from the global pandemic [21]. In Zimbabwe, such an impact on economic and societal welfare is dramatic [22]. The current pandemics negative impact on the budgets, management effectiveness for

many protected areas, and the livelihoods of local communities living in and around these areas have been significant [28]. Other factors such as weak policy instruments associated with poor management of natural resources also create security loopholes leading to incidences of illegal exploitation tendencies [6]. The economic crisis caused by the COVID-19 pandemic has increased biodiversity threats such as poaching, wildlife trafficking and forest logging [7].

Recommendations

The strategic human resources management and improving welfare, health, and safety of workers become more pronounced in the pandemic environment. Further, the increased financing and resourcing of the workforce is of critical importance to maintain the ranger presence on the ground. The adoption of modern technology-aided field operations should aim to improve the effectiveness and efficiency of the field workforce. National planning should institutionalize strategies for and be inclusive of natural disasters and pandemics. The ZPWMA should continue to broaden its revenue generation streams as a package and move away from relying on international tourism to finance the conservation of the park's estates. Government should put in place financial relief packages for wildlife conservation to help the struggling national wildlife agency affected by pandemics to avoid the risk of a long-term loss of the wildlife heritage. Relief packages should be inclusive of local communities to cushion them from the impact of pandemics on their livelihoods so that they do not resort to crimes for survival. Finally, government and or national wildlife agencies should build resource reserves for use in times of crisis.

Author contribution

Ndlovu Mukululi: Writing original draft, Formal anaylsis, review and editing.
Geoffreys Matipano: Conceptualization, Methodology, writing review and editing.
Robert Miliyasi: Data curation and writing.

Declaration of Competing Interest

The authors declare no competing interest.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.sciaf.2021.e01031.

Appendix 1. Appendix

Study Protected Areas

National Parks: Hwange, Gonarezhou, Mana pools, Chizarira, Matusadonha, Matobo, Nyanga, Chimanimani, Kazuma pan, Zambezi and Victoria Falls.
Safari Areas: Matetsi, Umfurudzi, Chirisa, Chete, Hurungwe, Tuli Cycle, Chegutu, Charara, Dande, Doma, Chewore, Sapi, Deka, Malipati, Sibilobilo and Chipinge.
Botanical Gardens: Ewanrigg and Vumba
Botanical reserves: Sebakwe Acacia, Sebakwe Mount, Tolo River, South Camp, Mawari Raphia, Tingwa Raphia, , Chisekera Hot Spring, Pioneer-Tuli and Rusitu.
Recreational Parks: Lake Kariba, Chibwatata, Mupfure, Ngezi, Lake Chivero, Chinhoyi Caves, Lake Cunningham, Manjirenji, , Lake Kyle, Mazikadei, Osborne, Matobo, Umzingwane, Sebakwe, Kariva, Bangala and Darwendale Dam.
Sanctuaries: Chimanimani, Mushandike, Nyamaneche, Maniinii Pan, Eland Pan and Mbaze Pan

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