# The Annals of Social and Behavioural Sciences (ASBSJ)

Volume 5 (1), 2023

Chinhoyi University of Technology

# Review of some aspects of the ecology, population trends, socioeconomic complexities and conservation options for Temminck's pangolins in Zimbabwe

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## Abstract

*Temminck's pangolin, Smutsia temminckii (Smuts), 1832 is a widespread mammal in eastern and southern Africa, and is the most trafficked animal in Zimbabwe despite enforcement of stringent laws and regulations. Nonetheless, there has been little research on the pangolins in Zimbabwe. The aim of this literature review was to assess some ecological aspects, population trends, socioeconomic and cultural complexities and conservation options for Temminck's pangolin in Zimbabwe. The review found that despite intense focus on poaching and trafficking threats affecting Temminck's pangolins, there were few attempts to assess the ecological behaviour and establish accurate population estimates and exact distribution inside and outside of protected areas. Furthermore, decades of economic meltdown in tandem with politically-driven land-use and land-cover transformations have disintegrated previously intact pangolin habitats, and societal and cultural endearment and reverence for pangolins in the country. Consequently, the lure of lucrative poaching and trafficking syndicates has outpaced law enforcement and usurped well-meaning conservation efforts, in the process threatening the pangolin population. Commercial pangolin farming for ecotourism, pangolin product substitution and explanatory and informative pangolin education awareness initiatives are new potentially viable, but unexplored future research, options for conserving pangolins in the country. It is recommended to use valid indirect methods for long-term assessment of the ecology, population trends and distribution of pangolins for sustainable conservation. Citizen science integration in developing a cogent National Pangolin Policy is vital to redress ecological and socioeconomic, cultural and political complexities threatening Temminck's pangolin conservation in Zimbabwe.*

**Key words:** *Smutsia temminckii*, myrmecophagous, pangolin trafficking, human-pangolin instantiation, pangolin farming, sustainability

## Background

In Zimbabwe, only the Temminck's pangolin, *Smutsia temminckii* (Smuts), 1832 (hereafter referred to as Temminck's pangolin or just pangolins) occurs (Smithers and Wilson, 1979; Coulson, 1989; Heath and Coulson, 1997, 1998; Pietersen et al., 2019). It is terrestrial and sleeps on earthen burrows, under bushes, in logs and between rocks preferring arid and mesic savannah eastern and southern African regions, and is absent in desert environments (Smithers, 1983; Kingdon, 2015; Zukal, 2020). In Zimbabwe, most historical sightings of the Temminck's pangolin have been largely concentrated inside the protected but mesic savanna areas e.g. Sengwa Wildlife Research Area, Hwange National Park, Gonarezhou National Park and Mana Pools National Park among others (Richer et al., 1997; Heath and Coulson, 1997). This, however, only reflect areas where pangolin studies were mostly concentrated as Coulson (1989) conducted a pangolin survey which showed that the species was widely distributed across Zimbabwe occurring outside protected areas and even in wetter habitats e.g. Manicaland region. However, due to their secretive nature, low population densities and predominantly nocturnal habits, Temminck's pangolins have not enjoyed nearly as much research attention as many of the larger and more charismatic species such as African lions (*Panthera leo*), and African elephants (*Loxodonta africana*) in Zimbabwe.

Currently, there is an upsurge in research in pangolins in Africa where they are starting to receive the attention that they urgently deserve (Challender, 2020a). Suffice to indicate that the unfounded allegations of pangolins as the chief transmitters of SARS-CoV-2 which cause COVID-19 has shifted attention onto the species from an ecological to a predominantly medical, biochemical and physiological perspective although this has largely focussed on Asian pangolins (Challender, 2020a; Frutos et al., 2020a, b; Heighton and Gaubert, 2021). Nonetheless, most ecological research on African pangolins have focussed on Temminck's pangolin, predominantly because a majority of the studies have occurred in southern Africa (Willcox et al., 2019; Heighton and Gaubert, 2021).

It is imperative to note that this upsurge in pangolin research in Africa owes in part to historical data availability and increased pangolin conservation awareness (Heighton and Gaubert, 2021).

In Zimbabwe, the Temminck's pangolin is a culturally revered and significantly respected animal listed as a Specially Protected Species since 1975, yet it is persecuted and one of the most trafficked species in the country (Government of Zimbabwe, 1975; Coulson, 1989; ZPWMA, 2020). There are mixed local perceptions towards the species ranging from adulation, myth, amazement, mystification, reverence, adoration and fear (Manwa and Ndamba, 2011). It is traditionally accepted that when you come across a pangolin you must capture it (not kill it) and present it to a Chief in Zimbabwe (Manwa and Ndamba, 2011). The pangolin's fate was often doomed, as it was either eaten by the Chief, its body parts used in traditional medicine, or it would have died from starvation or injury. Regardless, the modern national conservation impetus enforced by the Zimbabwe Parks and Wildlife Management Authority (ZIMPARKS) strictly forbids the capture, poaching, hunting, killing and utilisation of pangolins and their derivatives such as scales, blood, bones, foetuses, tails and claws (Shepherd et al., 2017; ZPWMA, 2020). Ambiguity in local perceptions and misalignment between modern conservation requirements and traditional local knowledge and belief systems towards pangolins instead of protecting actually endangers it. Thus, there is a need for a complete review of the cultural perspectives and their impacts on pangolin conservation in Zimbabwe.

Suffice to indicate that the country's pangolin population estimates have never been established and documented clearly (Challender and Hywood, 2012). Rather, Coulson (1989) considered the pangolins to be fairly common across the country. In fact Coulson (1985, 1989) indicated that although pangolins may be secretive they are not rare as a substantial population occurs in protected and unprotected areas of Zimbabwe. Since the study by Coulson (1989) which primarily aimed to establish the distribution of the pangolins, there has never been a census of the species in Zimbabwe. In fact there has never been a census of pangolin populations in any country in the world because there are no known techniques to conduct such a survey (Willcox et al.,

2019). Thus, it implies that future pangolin censuses must integrate different population survey techniques and consider potential habitats in and outside of protected areas (Coulson, 1989). Radical shifts in land-use patterns, development and urban encroachment and socio-economic complexities makes it foolhardy to assume that the population sizes and distribution of the Temminck's pangolin have remained constant almost three decades later.

A Temminck's pangolin just after its release into the Gonarezhou National Park.

For conservation of the Temminck's pangolin there has been an emphasis on the effects of poaching and habitat loss (Pietersen et al., 2014, 2019) and assessing the dynamics of the trafficked pangolin numbers, tracking intended and possible markets and establishing the funding trails (CITES, 2017). Trends in pangolin contraband seizure rates are carefully analysed to detect any inferred increases in poaching (IUCN SSC Pangolin Specialist Group, 2016; Shepherd et al., 2017). Though it is significant to note that an increase in pangolin contraband seizure rate in part indicates concerted vigilant efforts by the wildlife authorities. Subtly, it reflects an increase in poaching incidences by increasingly sophisticated and well-equipped, trained and funded poachers (IUCN SSC Pangolin Specialist Group, 2016; CITES, 2017). Hence pangolin contraband seizure rates and trends in poaching incidences are reflective of the pangolin population and may indicate that the pangolin population is under threat and maybe declining (Ingram et al., 2018; Willcox et al., 2019). This review aimed to assess the population trends, socioeconomic complexities and

conservation options for the Temminck's pangolin in Zimbabwe. The significance of this review is to highlight the current knowledge on the population, threats and conservation options for an endangered species.

## Study area and methods

Zimbabwe (Figure 1) is a landlocked southern African country which shares its borders with South Africa, Botswana, Mozambique and Zambia and has a human population of 14 million with mining, agriculture and wildlife-based tourism being the mainstay of the economy (ZIMSTATS, 2020). Most (89%) of the population are impoverished and live on less than one American dollar daily (ZIMSTATS, 2020). Available but erratic economic statistics indicated a Gross Domestic Product of 5.1% in 2020 (CSO, 2020).

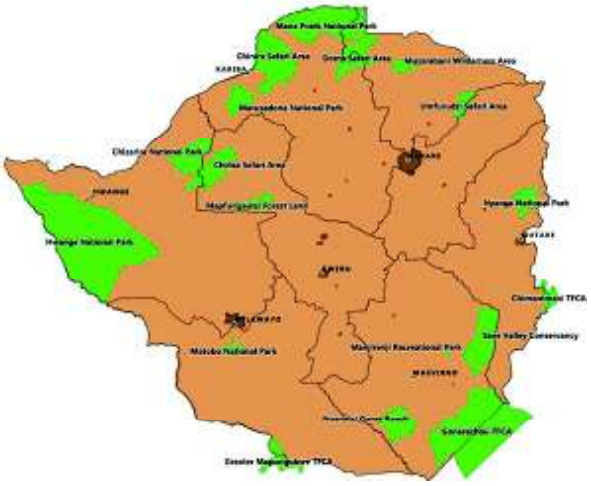


Fig. 1. Map of Zimbabwe showing the main protected areas for Temminck's pangolin conservation.

## Data collection

This study applied a purposive scoping review method, a synthesis based approach, to examine Temminck's pangolin conservation in Zimbabwe through rigorous analysis and examination of existing literature following

methods by Arksey and O'Malley (2005), Woodhead et al. (2018) and Utete (2020). The initial point was formulating the research question: what is the conservation status of Temminck's pangolin in Zimbabwe? Afterwards, a protocol was generated and a systematic selection of relevant information and its examination were done. Then critical appraisal of results, data extraction and contextual synthesis and dissemination were done. The section below summarises each of the steps carried out for this research:

***Defining the search strategy and predocument selection***

The initial point was to frame the review in the main key question. Afterwards exploratory searches of relevant literature were done in Google Scholar, Scopus, Science Gov., WorldWideScience, PubMed, Bing and GiveWater, and the Boolean operators in order to combine the words AND, NOT, OR and the commonly used ISI Web of Knowledge (ISI WoK) databases with no historical cut-off dates for Zimbabwe (and its time as Rhodesia before independence where relevant) following methods by Utete (2020). The choice of the search engines was based on their extensive and interdisciplinary coverage and high recognition as standardised databases for conducting meta-analyses. This study explicitly searched for literature focusing on Temminck's pangolin, *Smutsia temminckiii* (Smuts, 1832) or *Manis temminckii*, Cape pangolin with further searches for African pangolins and human-pangolin conflicts in all coupled (using AND, NOT, OR) subgroups which comprised: ''scaly anteater'', “spiny anteater'', ''conservation-pangolins'', ''endangered species-conservation'', “poaching-pangolins'', ''illegal trade-pangolins'', ''wildlife crimes-pangolins'', including ''traditional beliefs-pangolins'', ''habitats-pangolins'', “COVID 19-pangolins'', ''traditional medicines-pangolins'', together with technical reports on pangolins in Zimbabwe following recommended methods by Arksey and O'Malley (2005) and Woodhead et al. (2018). In the literature search coupled confounding terms e.g. ''spiny anteater” produced background noise and conjoined other non-relevant information for the study pertaining to the pangolin gene which is present in the genome of *Drosophila* and the Echidna genus, *Tachyglossus* often referred to as “spiny anteater” and were subsequently removed.

### *Document selection and data analysis*

After the realisation that there was a paucity of literature on pangolins in Zimbabwe for item and document selection, the whole document (including the title, abstract, keywords and main text) search method was used. Reliable and relevant hardcopy and online media articles including daily, weekly and monthly news bulletins in the main languages of the country i.e. English, Shona and Ndebele were collected from the Online News Summary Dashboard in GDELT (Global Database of Events, Language, and Tone; https://www.gdeltproject.or) with "(Cape pangolin, *Temminckii Smutsia*, Temminckii pangolin, Africa pangolins, AND, OR Zimbabwe)" starting from 01/01/1965-22/11/2020. The daily relative value (DRV) of pangolins in Zimbabwe was obtained by the equation:

The obtained DRV (0.00002) was too low for any meaningful quantitative analysis, therefore a qualitative thematic cluster analysis was adopted for an in-depth assessment of the frequent themes. An initial list of 2034 journal articles and technical reports mentioning African pangolins was obtained, further screening with Zimbabwe for contextual relevance as the main screener item yielded only 64 articles which covered the breadth and scope of the review and these were examined in detail. An article was included if it met the following criteria: (a) it was published in a reputable journal, international organisation technical report or a book, (b) relevant conference proceedings on Temminck's pangolin or (c) credible human-pangolin interaction reports in citable technical reports and media articles of reputable organisations.

## Results and discussion

Literature scoping surveys indicated that most research on pangolins in Zimbabwe were skewed towards pangolin poaching, trafficking, and socioeconomic and cultural perceptions. Some research focussed on pangolin conservation aspects although there was a paucity of data on population trends and contextual ecological tenets e.g. do pangolins still exist outside protected areas in Zimbabwe, and if so, are their home size ranges (normally averaging 0.17-11.07 $km^2$ in protected areas, Heath and Coulson, 1997) in and outside of protected areas similar? What may be the drivers of significant differences in home ranges for different sexes in both protected and unprotected areas? The

main recurrent themes were further examined, and emerging trends, and paradigms established in relation to the conservation status of the Temminck's pangolin.

***Population trends and distribution of Temminck's pangolins in Zimbabwe***

Available literature on pangolins indicated that there were no definite or deliberate attempts to accurately estimate their populations inside or outside of protected areas in Zimbabwe (Coulson, 1989). What is available are a few studies in protected areas Coulson (1989), Heath and Coulson (1997a, b, 1998) and Richer et al. (1997). In a study of the home range size of the pangolin, Heath and Coulson (1997) estimated an overall density of 0.11 individuals/km$^2$ in the Sengwa Wildlife Research Institute. This Institute is a 373 km$^2$ conservation area devoted solely to wildlife research. This translated to an estimated population of 41 pangolins in the whole area. Suffice to indicate that the on-going land-reform program initiated in Zimbabwe in 2000 onwards led to encroachment into some sections of the wildlife research area, possibly restricting potential habitats (in terms of quality and size) with, negative ramifications for Temminck's pangolin populations in this reserve.

Coulson (1989) instituted a nationwide assessment of pangolin distribution using a questionnaire survey targeting mainly rural areas in Zimbabwe. Coulson (1989) showed that the number of pangolin sightings from 303 respondents with a mean residence time of >21 years was 263. This translates to a person sighting a pangolin once in 24.2 years or 41.3 pangolins per year per 1000 people (Coulson, 1989). Using available pangolin population data a possible estimate arise. Considering that the total size of protected areas is 46 504 km$^2$ (12% of the total national surface area) see ZPWMA (2015), then using an overall density of 0.11 individual pangolins/km$^2$ indicated from Heath and Coulson (1997) it implies that there are an estimated minimum (46 504 km$^2$ x 0.11 pangolins/km$^2$) of 5 116 Temminck's pangolins inside protected areas in Zimbabwe. Notwithstanding there are protected areas like the lake side of Kariba and relatively unsuitable colder areas of Nyanga, and Chimanimani where pangolins do not normally live. Nonetheless, the term protected area also includes private owned conservancies such as Bubye and Save Conservancies and hunting concessions. This discrepancy in terms of including

all protected areas may either overestimate or underestimate the national pangolin population.

Challender and Hywood (2012) indicated that Temminck's pangolin populations in Zimbabwe have decreased over the years citing the increased seizure statistics of pangolin contraband, an observation supported by Shepherd et al. (2017), and habitat loss as a causal effect and evidence for a reduction in population size. Secondly, Temminck's pangolin conservation status is deemed Vulnerable (Pietersen et al., 2019). Considering the five IUCN Red List quantitative criteria on: population declines, geographic range, possession of a small population size, and restriction or distribution or endemicity of a species and the global IUCN Red List classification there are some salient points to be noted for Temminck's pangolins.

For Zimbabwe, there is no clear data on Temminck's pangolin populations' trends although there are some inferred declines (allowable in the IUCN Red List classification criteria) see Challender and Hywood (2012). Further, Coulson (1989) reflected that the Temminck's pangolin had a wide distribution in Zimbabwe (showing either adaptation to a wider range of habitats or simply abundance of suitable habitats at that time). However, Coulson (1989) indicated that the gaps on the distribution map of Temminck's pangolins represent areas where the questionnaires were not returned. Since the survey by Coulson (1989) which covered the whole of the country, almost 32 years later, there has been no subsequent concerted Temminck's pangolin population surveys in Zimbabwe with no clear data on the distribution of the species whatsoever. Thus, there is no national conservation classification for Temminck's pangolins in Zimbabwe. There is only a Global assessment, and a national assessment for South Africa. By default, if no national assessment exists then the global assessment is used, as it is for any species. What is significant is that Temminck's pangolin in Zimbabwe is listed as Vulnerable and a Specially Protected Species (ZIMPARKS, 2015). Therefore it enjoys a high level of protection that is probably equivalent to the protection enjoyed by rhinos.

The IUCN Red List classification in its design is meant to be objective and a true reflection of the global conservation status of a species (IUCN, 2019). Thus, for

its proper functioning, the flow of ecological and ancillary information on a species must follow a hierarchy comprising: local (zonal e.g. district, area, provincial, state) < national < regional (continental-ecosystem) < global. At each stage both formal and informal credible sources of information, and after a thorough evaluation preferably overseen by an expert in a species would an evaluation be acceptable and play a critical role in the ultimate classification of the species (IUCN, 2019). What this review implores is for member states to institute local assessments using the IUCN criteria to contribute towards the global conservation classification status of the species.

Besides Coulson (1989) no other studies on the distribution and status of Temminck's pangolin have been done in Zimbabwe. However, the ZIMPARKS authorities have a tendency of using the sighting incidences and poaching reports to indicate the potential distribution of the species inside or outside of protected areas (ZPWMA, 2015). This is scientifically logical in the absence of long-term distribution records for the species. The challenge with assessing the Temminck's pangolin is that even with night surveys there is no guaranteed physical sightings (Willcox et al., 2019). Thus, other less accurate methods of estimating population sizes and distribution such as the Pangolin Occupancy Survey (OS) which involves analysing for pangolin foot-prints, pangolin feacal pellets and earthen burrows are employed (Willcox et al., 2019). However, other attributes such as the home range, feeding ecology and related correlates including vegetation cover and type, soil type, and potential prey can be used to deduce the potential habitats in similar areas and map distribution hotspots of the pangolin (Willcox et al., 2019).

This review clearly indicated that there are no accurate population estimates for the pangolin in Zimbabwe. Mostly, there is a tendency to use poaching incidence data, habitat loss and other factors to infer population declines to enable classification of the species. A recent pangolin distribution data review by Mahakata et al. (2021) indicated that historical pangolin sightings are mainly concentrated in the hotter and arid or mesic marginal protected areas of the country excluding the colder regions of Nyanga and its surroundings. Examination of the study indicated that the period for which the data were considered i.e. 2011-2021 and historical literature highlights a medium-term picture of the effects of key environmental variables particularly climatic ones e.g temperature, rainfall and even vegetation type on the distribution of the

pangolins in the sampled 48 protected areas in Zimbabwe. Suffice to indicate that pangolin sightings were only reported in 19 of the 48 protected areas (PAs) in Zimbabwe (Mahakata et al. 2021). The use of a range of favourable temperature (22°C) and rainfall (400-1000mm or 500-900 mm per annum) is rather an oversimplification as the authors did not indicate the length of the data sets used besides the tentative 2011-2021 records used which are not adequate to give a clear long-term picture of the effects of climate on the distribution of the species in different regions of Zimbabwe. The Pearson correlation tests used in the study did not indicate any significant relationship ($P>0.05$) between the distribution of the pangolins and any of the climatic variables. In fact the authors (Mahakata et al. 2021) indicated that the distribution of *S. temminckii* in Zimbabwe were more related to the vegetation of the Zambezian and Mopane woodlands characteristics more dominant in the outer marginal protected areas and less dominant in the central parts of Zimbabwe relative to other vegetation types. What is interesting though is that Mahakata et al. (2021) indicated that based on altitude analysis the pangolins have the potential to occur anywhere in Zimbabwe. Prudent to indicate that the use of data from protected areas and other historical literature provides a clearer explanation of the distribution of the species but not of the population as the study did not cover areas out of the PAs where pangolins occur (Coulson, 1989).

In future it is advisable for the country to instigate population monitoring surveys practically using a cocktail of indirect methods such as POS, incidental sighting and any other affordable suitable techniques starting from the protected zones radiating into unprotected areas simultaneously mapping distribution and potential suitable habitats for Temminck's pangolins. Disregarding the security sensitivity of issues around the species, and the bureaucratic nature of wildlife authorities in the country, the absence of clear population trends and distribution maps for the solitary and nocturnal pangolins which attract mixed perceptions among the populace poses serious conservation threats for its sustainability in Zimbabwe.

## Existential threats and human-pangolin conflicts (HPC) driving pangolin populations

### *Ecological threats to pangolin populations*

Coulson (1989) indicated that Temminck's pangolins were absent from areas with intense agricultural activity e.g. tobacco and horticultural farms and highly populated urban and peri-urban and even rural settlements in Zimbabwe. In these areas, anthropogenic activity degrades and reduces suitable habitats and the preferred food i.e. ants and termites and thus, greatly influences the distribution of the species (Coulson, 1989). However, a lack of past and contemporary distribution data makes it complex to estimate the effects of the magnitude and extent of transformations in the land-use and land-cover patterns on the future distribution of Temminck's pangolin. The land reform program which started in 1998 and is still on-going resulted in radical transformations in land-use patterns with settlements encroaching into protected national parks and conservancies (Gandiwa, 2012). This resulted in destruction of habitats e.g. dens, burrows and above-ground debris to create arable land, consequently, reducing potential suitable habitats for pangolins (Gandiwa, 2012). Probably more importantly it diminished or entirely removed the prey sources, and together with this encroachment came increased poaching rates.

There are no direct studies if any that assessed the long-term linear causal-effect relationships of transforming land-use patterns, use of inorganic additives on the land and ant-termite prey dynamics and the actual shifts on the population trends and distribution of the pangolin in Zimbabwe. For the Zimbabwean situation, future research needs to first assess the distribution of the species and relate it to the contextual natural and anthropogenic threats e.g. predation, climate change, road kills, and mortality from traps such as snares, gin traps, nets, and pits, electrocution by electric fences, poisoning, diseases, and parasites.

### *Social and economic variables on pangolin populations in Zimbabwe*

Hunting pressure, trade dynamics, and the attitude or perceptions of local people towards pangolins form part of the major societal direct and indirect threats facing the species globally (IUCN, 2019). In fact, the primary threats to

Temminck's pangolin comprise poaching for local use and illicit international trade (ZPWMA, 2015; Challender et al., 2020; Pietersen et al., 2019, 2020). Shepherd et al. (2017), in a study analysing pangolin seizures in Zimbabwe from 2010–2015, reported that banning the hunting, possession and trade of Temminck's pangolin and its derivatives such as scales did not eliminate hunting of the species, but enforcement led to a higher number of confiscations. It is noteworthy that in 1975, the Temminck's pangolin was given full protection on Zimbabwe's Specially Protected Species List (Government of Zimbabwe, 1975; ZPWMA, 2020). As a result there was a nationwide ban on hunting, possession and trade in pangolin live specimens or its derivatives such as scales, blood, bones and foetuses from 1975. Consequently, there was a positive effect with a decrease in pangolin trade and poaching in the country until 1988-1992 when drought-induced poverty, accelerated by the drastic economic reforms, forced locals into wildlife poaching with high value species such as Temminck's pangolin a prime target (ZPWMA, 2015). However, there was more strict enforcement of the 1975 ban from 2010 onwards when crucial changes were effected on the wildlife regulations in Zimbabwe to align them with CITES requirements which had listed all eight extant pangolin species on Appendix II. Afterwards, a total of 65 Temminck's pangolin seizures were made in 2010–2015. The number of pangolins confiscated increased over this period from 2/year in 2010–2011 up to 20/year in 2014–2015 (Shepherd et al., 2017). Of the 53 live pangolins seized, 32 were released back into the wild (Shepherd et al., 2017).

Analyses suggest that the seizure data is grossly underestimated as a majority of the rural people in remote communities (in particular where there is poor communication, road networks and lax law enforcement) either do not declare or under declare the pangolins as a deceptive and cunning means of gaining the trust of the wildlife authorities whilst continuing with the illegal trade of the species (Shepherd et al., 2017; Fopa et al., 2020). Intense focus on the trafficking of pangolins has led to multiplicity of role allocation and ambiguous delineation of collective efforts in curbing the vice in Zimbabwe. In most cases, ZIMPARKS, the wildlife authorities, as the key players are supposed to oversee relatively more powerful agencies e.g. national police, army border patrol units, immigration agencies and other covert state security departments in curbing pangolin hunting and illegal trade. Multiplicity of roles and

overlapping authority and the logjam in the wildlife court schedules imply that there is delayed justice for traffickers. It is important to note that Zimbabwe has one of the best and most stringent pangolin protection laws globally (Shepherd et al., 2017). Upon conviction for possession of a pangolin or its derivatives a person faces an imprisonment for not less than nine years (first offence) or 11 years (second offence), and/or a fine equal to four times the economic value of the poached animal [approximately USD 28 000] (CITES, 2017). Although there has been an increased pangolin seizure rate and conviction of offenders, hunting and illegal trade of the species has not declined and is in fact increasing in Zimbabwe (Shepherd et al., 2017). This is largely driven by the economic malaise ravaging the country with total unemployment hovering around 88-91% and the majority being youths aged 18-35 (CSO, 2020; ZIMSTATS, 2020). Thus, the illegal trade of pangolins and its derivatives is lucrative with poachers guaranteed USD7000-9000 per pangolin (CITES, 2017) and naturally attracts impoverished citizens who risk freedom and partake in pangolin poaching and trafficking threatening the conservation status of the species.

***Cultural and local perceptions on pangolin trafficking and population trends***

Historically, culture has played a leading role in championing pangolin conservation efforts in Zimbabwe. According to local culture, pangolin meat is a delicacy reserved for chiefs, and is believed to strengthen the leader's rule (Manwa and Ndamba, 2011). It is taboo for a commoner to eat pangolin meat, while it spells good fortune for a person who captures the animal and presents it to the chief. However, in recent times, the Chiefs Act in 2013 has been realigned to the Wildlife Act 2012, 2014, to halt the hunting, killing and eating of the pangolin even by the chiefs (ZPWMA, 2015, 2020). Interestingly, after a person presents a pangolin to the Chief, the traditional leaders conduct rituals to cleanse the animal and bless the person responsible for handing over the animal who in most cases is given a substitute, normally a domesticated beast (e.g. a cow) as a token of appreciation (Manwa and Ndamba, 2011). Thereafter, the traditional leaders are directed by the 'spirits' to kill another celebratory/sacrificial animal which may be a domesticated species e.g. goat, cow, sheep or another more abundant wild game species in the area. This practice is actually intended to protect and conserve the pangolin population using traditional local knowledge (as the Chief normally does not eat the

pangolin but releases it back into nature or surrender it to ZIMPARKS authority) at the same time rewarding the conservation efforts by the locals through tokens of appreciation (Gandiwa, 2012).

However, the catch is that in terms of prices, a whole live pangolin costs USD 7000-9000 whilst killing the animal and selling its derivatives such as meat, bones, prepared scales or foetus actually fetches more money on the illegal market (Challender and Hywood, 2012). The opportunity cost and risk of fetching more money on the illegal pangolin market has actually attracted a number of local poachers resulting in an increase in poaching incidences of the pangolins. Nevertheless, Shepherd et al. (2017 specifically stated that "Informants in Zimbabwe have indicated that the fear of law enforcement activities and strong penalties are a deterrent." Often the conservation initiatives compete with more lucrative pangolin trafficking not only in Zimbabwe but in Africa (Ingram et al., 2018). The dilemma is how to incentivise pangolin conservation simultaneously stopping pangolin poaching and trafficking (Ingram et al., 2018; Pietersen et al., 2020). The opportunity cost of quick monetary returns over prison time has also shifted the cultural perceptions of locals towards pangolins from fear, reverence, and respect into disrespect, and they have adopted an attitude that the species has an economic value and is an escape route from poverty (Manwa and Ndamba, 2011).

What is noteworthy is that pangolins play a critical role in their ecosystems as they provide the earth with all-natural pest control and are fantastic tenders of soil, and they do these things simply through their everyday behaviours (Kingdon, 2015). A single pangolin consumes as many as 70 million insects per year, mainly ants and termites, reducing termite pests (Kingdon and Hoffman, 2013). Burrowing of anthills and woody debris helps recirculate nutrients and fertilises the topsoil, among others (Kingdon and Hoffman, 2013). On the other hand, the key issue is that humans persecute pangolins for selfish and mystical gains at best, however, the pangolins do not pose any direct threats to humans (Gaubert, 2012). What is clear is that human actions severely deplete pangolin populations, and not vice-versa. Thus, there is a need to balance the local perceptions, ecological needs of the pangolins and conservation paradigms to minimise persecution of the species in Zimbabwe and world over (Gandiwa, 2012).

**Feasible options for pangolin conservation in Zimbabwe**

Like most developing nations in sub-Saharan Africa, protected areas or national parks have offered a modicum of hope for the conservation of pangolins in Zimbabwe (Mahaka et al., 2021). However, Temminck's pangolins as secretive and predominantly nocturnal animals are exceptionally complex to monitor in the wild, thus, assessing the threats and impacts to the species is a challenge (Willcox et al., 2019).

An important conservation aspect to note is that there are clear laws and regulations and deterrent fines and prison sentences with regards to poaching and trafficking of pangolins and their derivatives (CITES, 2017; Pietersen et al., 2019). At most, the ZIMPARKS wildlife authorities have enforced to all intents and purposes strict bans on pangolin poaching and trade in the country and this appeared to be the main effective conservation option for the species (Challender et al., 2020). However, Challender and Hywood (2012) and Shepherd et al. (2017) indicated that trade in pangolins and its derivatives has not completely stopped. CITES (2017) indicated that the number of pangolin contraband seizures have increased over the years partly due to increased and strict monitoring and law enforcement. Introduction of zero export quotas for the country by CITES has not deterred pangolin poaching and its illegal export to lucrative Asian markets and this simply showed that bans on wildlife trade do not always decrease poaching and trafficking (ZPWMA, 2015; CITES, 2017; Shepherd et al., 2017). A similar case study exists for the conservation of the black rhinoceros *Diceros bicornis* (Leader-Williams, 2003). The challenge is to establish another range of effective additional interventions that could be adopted for pangolin conservation.

Contemporary global literature indicates several policy options for combating pangolin trade and trafficking including: additional national law enforcement measures, attempts to change consumer behaviour, substitution of specific pangolin products such as skins, scales and blood with, mostly synthetic alternatives, mimics or substitutes and other so-called 'supply-side interventions', including domestication and wildlife farming (Biggs et al., 2013; Challender and MacMillan, 2014). These conservation options indicated in Figure 2 are viable in general, however, there are limitations (Challender et al., 2019). For instance, the substitution of pangolin products such as skins with leather normally derived from other Vulnerable or Threatened game species

such as zebras (*Equus* spp.), giraffe (*Giraffa camelopardalis*) and hippopotamuses *(Hippopotamus amphibius)* skins is rife and as equally destructive and at most serves to transmit or transfer the problem from one species to another (CITES, 2017; Utete, 2020). The use of keratin products from other non-synthetic substitutes suffers a similar fate as most of the products are illegally acquired from rhinoceroses (Leader-Williams, 2003; CITES, 2017). Currently, the impetus is to intervene on the 'supply side' of pangolins to curb its poaching and international trafficking (Challender et al., 2019). The first intervention option advocated for domestication or commercial breeding of pangolins in artificial habitats which mimic their preferred natural habitats (Tensen, 2016). This option, while theoretically feasible, in practice demands expensive resource input such as artificial habitat construction, supply of feeds mimicking ants and termites or diet with similar nutritional components, natural escape trails, and or minimised sunlight entrance to maximise nocturnal activity (Hua et al., 2015). Financial costs aside, some authors e.g., van Ee. (1978), Hua et al. (2015), and Tensen (2016) and Challender et al. (2019) indicated that the specialised diet requirements and the predominantly nocturnal, solitary, shy and cryptic nature of pangolins coupled with strict reproductive requirements limits their lifespan in captivity, induces diseases, inbreeding and makes their farming unsustainable moreso for impoverished African nations such as Zimbabwe grappling with basic needs e.g. shelter, water, and food. Commercial captive farming of wild species has been successful for Nile crocodiles (*Crocodylus niloticus*), fish mainly exotic ones e.g. Nile tilapia (*Oreochromis niloticus*), and a few plants and ornamental bird species in Zimbabwe (Utete, 2020). However, the practice is nascent and only a few frameworks exist for other species such as hippopotamuses, but early indications are that several key environmental factors require long-term careful study and consideration, and the impacts and success will differ across species and geographical and climatic regions (Utete, 2020). This review is rather sceptical on the feasibility of pangolin farming in Zimbabwe. Rather, it would be prudent to support and strengthen the current protected area zones system in place than to venture full-scale into pangolin farming which is too expensive for the country and has other non-financial limitations for the proliferation of the species (Challender et al., 2019).

Other viable conservation options for pangolins in Zimbabwe appear to be non-lethal and non-removal strategies such as understanding spatiotemporal changes in distribution and abundance, and their drivers and barriers alike that build up from previous studies e.g. Coulson (1989), Heath and Coulson (1997), and Richer et al. (1997) among others. These must basically target the ecology of the species i.e. its habitat requirements, diet and social behaviour. Analyses indicated that top level and elitist conservation measures such as total bans on trade in pangolins have not stopped poaching, and local and international trafficking (CITES, 2017). This reflected that addressing the 'natural wild supply side' comprising assessment of the ecological aspects, population trends, distribution of the species and the key drivers and barriers and disentangling the complex interplay of social, cultural, economic and political covariates in a geopolitical context may be the missing link in conserving Temminck's pangolins in Zimbabwe. Even more critical is the effective inclusion and active integration of local proximal and fringe communities in the conservation initiatives for the species (Gandiwa, 2012). The current CAMPFIRE model, which seeks to integrate the local community into the daily operational management of wildlife conservation initiatives and advocates for equitable sharing of accrued benefits, does not adequately address the interaction of humans and pangolins although it is buttressed by the Chiefs Act which has a provision for incentivising surrendering of pangolins to local political and wildlife authorities (ZPWMA, 2015).

Elsewhere, Fopa et al. (2020) indicated that local ecological knowledge (LEK) surveys are a vital tool for collecting data on small, solitary, rare and predominantly nocturnal species such as pangolins. Moreso, the use of robust ecological data to make evidence-based management decisions for highly threatened species is often limited by data availability, and thus, LEK is increasingly seen as an important source of information for conservation (Zanvo et al., 2020). Regardless, effective conservation actions for Temminck's pangolins are scarce due to limited information on the distribution of pangolins in many areas of Zimbabwe. There is a need for instigating and upscaling pangolin conservation awareness and education campaigns integrating locals in range states (Harrington et al., 2018; Fopa et al., 2020). What is needed for Zimbabwe in the absence of solid data are pangolin

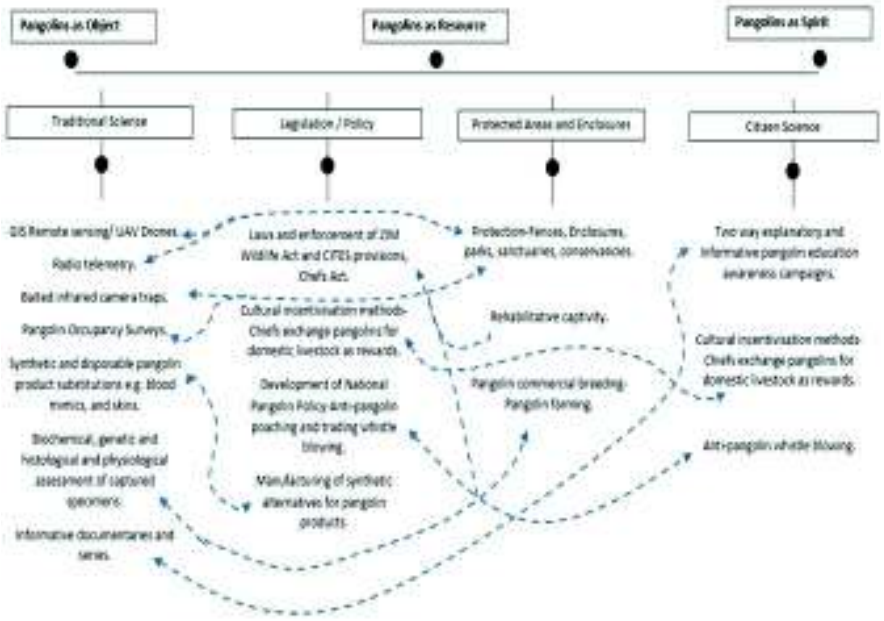
awareness campaigns and initiatives that are inclusive, educational and explanatory with a simultaneous or two-way flow of information mechanism not the contemporary informative, commanding and warning type of campaigns currently in place in the country (Gandiwa, 2012)

**Conclusion and recommendations for future research**

This review aimed to assess the population trends, socioeconomic complexities and conservation options for Temminck's pangolins in Zimbabwe. Due to paucity of data on Temminck's pangolins, the scoping review ended up readjusting the focus towards qualitative analysis of the underlying reasons for the lack of research on the species. However, where data were available, thematic clusters were assessed to cover the breadth of relevant issues. Data paucity is not peculiar to the pangolins in Zimbabwe, rather it is a common phenomenon in all range states (Pietersen et al., 2019; Challender et al., 2020). The few available records on the species in the country largely showed that there is a yawning data deficiency on the ecological aspects, population trends, distribution and the extent of the causal-effect relationship between socioeconomic, cultural and political factors and species population dynamics. Thus, future research should focus on the ecological aspects of the pangolin in Zimbabwe in relation to the prevailing environmental situation.

From the little research available only Heath and Coulson (1997) provided some data to enable estimates of population densities in selected protected areas i.e. Sengwa Wildlife Research Institute. Coulson (1985, 1989) instituted a nationwide survey to determine the distribution of Temminck's pangolin in Zimbabwe. The existing population survey gap, necessitates for concerted efforts in estimating the national pangolin population. Such an exercise may need innovativeness and dexterity, with use of modern equipment such as camera traps and unmanned aerial vehicles (drones) and a cocktail of other indirect methods of assessing the temporal and spatial variation of the population and distribution of the solitary species (Willcox et al., 2019). However, a raft of questions arise if this exercise is to be accomplished. For instance how to use drones ensuring adequate battery life to conduct these surveys? Moreso how do we solve the issue of visibility to detect pangolins at night and adequate sampling area coverage (Willcox et al., 2019). Furthermore, there is a need to determine detection rate errors for validity of any method

us




Zimbabwe has enforced a strict ban and deterrent punishments in the form of heavy fines and prison terms on pangolin poaching and trafficking of live specimens and its derivatives (ZPWMA, 2020). However, the economic meltdown and resultant social unrest has forced locals to risk venturing into the lucrative pangolin poaching and trafficking industry (Challender and Hywood, 2012). The cultural aspects related to the sacredness of the pangolins are being disregarded by locals who are in a survival mode. Consequently, there is an increase in pangolin poaching and trafficking of the species and its derivatives from Zimbabwe (ZPWMA, 2015; Shepherd et al., 2017). Hence there is a need to address the key economic, cultural, social and political fundamentals in order to dissuade society from venturing into pangolin poaching and trade in the country for survival, and to ensure sustainability of the species.

There are serious gaps imminent in conserving Temminck's pangolin in Zimbabwe. Figure 2 summarises a range of feasible, (both theoretical and practical) though not exhaustive, pangolin conservation options for the country. The proposed framework of pangolin conservation options interlinks the initiatives for instance the protected areas i.e national parks, conservancies, and sanctuaries are interlinked to pangolin protection, and the envisaged nascent pangolin commercial farming (Figure 2). The stringent enforcement of laws and regulations is closely related to the development of a stand-alone National Pangolin Policy (and not over relying on CITES documentation). The third cluster includes an instigation of two-way explanatory and informative pangolin awareness education campaigns and the use of cultural incentivisation methods which have local communities at the centre (Figure 2). Although clustered for convenience, the raft of feasible pangolin conservation options in practice and implementation must be interlinked for completeness. Therefore, any future discussions should be centred on a spectrum of interlinked and interdependent conservation options feasible for the country and their limitations as well with no clear allocation into rigid and meaningless categories such as deterrent, incentives, dis-incentives, and the wider nature of effective law enforcement which would rather contort the contextual interrelatedness of conservation options for the pangolins (Utete, 2020).

The most important component in all mooted feasible pangolin conservation options is involvement of local communities (Gandiwa, 2012). However, most often the CITES and IUCN options and background determinants for classifying the conservation status of pangolins exclude the local ecological knowledge (Fopa et al., 2020). For the future, the perceptions and this manuscript. I sincerely thank the anonymous reviewers for the painstaking and incisive and thorough eye opening comments and guidance and pangolin insights for this paper.

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