‘Intelligence that will win this war’: Investigating Artificial Intelligence for Conservation

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Abstract

Artificial Intelligence is a novel technology being utilized to combat wildlife poaching in Africa. Poaching in Africa is not only part of a highly illegal and lucrative industry, but it correspondingly is effecting the ecosystems in depleting and causing the endangerment of many species, including Rhino, Elephant, Pangolins and Wild Dog. A range of strategies are utilized to combat poaching, however, the prevalence of poaching is still apparent. Therefore, the research will address to what extent can/does AI mitigate the wildlife poaching problems in Africa. More specifically, the research investigates the various beliefs about poaching the biggest challenges and existing strategies in countering poaching and the current initiatives and devices utilized. Research communicating the priorities, engaging stakeholders and sharing best practice, in accordance to these various artificial intelligence technologies available is limited. This study utilizes a mixed method approach including the qualitative analysis of interviews of key stakeholders in the field of conservation including those in the field, NGOs and technology experts, as well as news articles considering the potential of artificial intelligence technology in conservation. The main findings of this study include, that neoliberalist conservation ideologies still hold merit, there needs to be a re-examining of what constitutes as 'information networks' and the question of funding and management determines how successful artificial intelligence is utilized when embedded into conservation areas.

Keywords

Artificial Intelligence, Anti-poaching, Conservation, Neoliberalism, Stakeholder Engagement

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Introduction

At USD$60,000 a kilogram, rhino horn costs more than a pound of gold or cocaine and according to the UN Environment Program and Interpol this illicit wildlife poaching industry has an estimated worth of USD$ 7-23 billion ("Poaching Facts", 2020; African Wildlife Foundation, 2015). Wildlife trafficking can be described around three phases; the poaching activity deriving from the source countries, the transit and transportation to the destination countries and finally the trade in the destination countries (Cusack, 2020). African countries have specifically have alarming rates of poaching leading to the endangering and/or possible extinction of many species (Life as a Wildlfe Ranger, 2020). For example, an elephant is killed every fifteen minutes and in 2016 a rhino was killed every 8 hours (African Wildlife Foundation, 2015). Unfortunately, poaching is not limited to rhinos and elephants; amongst other species, gorillas and pangolins are also increasingly threatened, whilst African wild dogs are endangered largely due to accidental poaching, viral diseases and habitat loss (African Wildlife Foundation, 2015; African Wild Dog Species WWF, 2020). Wildlife trafficking is widely regarded as a high profit-low risk business (Krishnasamy & Stoner, 2016). Demand for wildlife products is driven largely for the purposes of status, symbolic collectables, pets, traditional medicines and food (Krishnasamy & Zavagali, 2020). China and SE Asia are considered a "biodiversity hotspot" at the center of legal and illegal wildlife trade (Krishnasamy & Zavagali, 2020, p.viii). Hence, in order to combat wildlife crime, the WWF and TRAFFIC have identified four core pillars, "stop the poaching", "stop the trafficking", "stop the buying", and "international policy" (Wildlife Crime Initiative, 2020). This thesis focuses on the first of the four pillars, in striving to cease poaching in Africa.

Africa is also the world's number one safari destination, for the world's "most iconic" wildlife, drawing in millions of tourists every year (African Wildlife Foundation, 2015). The United Nations World Tourism Organization secretary-general Zurab Pololikashvili stated: "wildlife tourism has the potential to benefit both people and planet and so play a key role in the 2030 Sustainable development agenda" (UNTWO, 2018). The global luxury safari tourism market in 2018 was valued at US$1184.6 million, a large percentage of this revenue stemming from the African tourism industry (Marketwatch, 2019). Nevertheless, it is estimated that in the event of extinction, the economic loss for tourism indirect and direct income of Rhino's could amount to as high as US$36 billion for South Africa, Kenya, Namibia and Zimbabwe, and US$74 billion for Elephants across Africa (Porsche & Smith, 2015). Hence, one denotes that due to the lucrativeness of such an industry, it is additionally

in the African nations best interests to conserve the wildlife and the overall ecosystems in Africa, due to the lucrativeness of such an industry (Marketwatch, 2019).

Presently, the COVID-19 pandemic has had many added effects on conservation. African conservation efforts are struggling to stay afloat as in many cases the COVID-19 lockdown has forced the conservation areas to shut down or international travel restrictions has reduced tourism (Bhalla & Jacques, 2020). As an example, in Tanzania, safari operator Elia Richard from 'Into Africa' explains that 99% of their clients were international tourists, and so their source market, and subsequent funding, has been devastatingly effected (Pieterson et al., 2020). Another prevalent issue is with the National Parks, because with the already limited funding that is afforded by the governments, these parks to a large extent depend on tourism revenue to run their operations. Therefore, the World Wildlife Fund (WWF) has put out a call of action as many protected and conserved areas are experiencing negative impacts from management capacity and budgets which impacts the livelihoods of communities living in and around these areas (Life as a wildlife ranger, 2020).

Additionally, the early stages of the COVID-19 pandemic was linked to a 'wet' market selling wild animals in Wuhun, China, causing the temporary ban of wildlife trade and consumption in China and a few other South East Asian countries (Standaert, 2020). Amongst the animals being sold at these markets were Pangolins, which are also trafficked from Africa, but as of June 2020, China has moved to remove pangolins from the traditional medicine treatments (Briggs, 2020). This news is a 'milestone' in wildlife protection, creating optimism for the potential first move towards the ultimate ban of using wildlife in traditional wildlife medicine, which include rhino horn and elephant tusk (Briggs, 2020).

Holden et al. (2019) stated that the success of increasing of enforcement strategies depends fundamentally on the social and economic uncertainties of a nation as well as its ecological uncertainties. In particular, wildlife poaching in Africa pays significant attention to 'high'-level intelligence anti-poaching operations in which the processed information about poachers can assist in crime prevention and criminal apprehension (Cowan, Burton & Moreto, 2019). It is argued that well-managed protected areas are one of the most important tools to assist in anti-poaching programs for the protection of the wildlife populations (Watson et al., 2014). Law enforcement in Africa is presently and primarily conducted by ranger forces who carry out patrols in protected areas on a daily basis (Fang et al., 2019). As these nations are developing, they tend to encounter resource constraints which consequently limits the implementation of conservation legislation (Rowcliffe et al., 2004). In Africa specifically, a large proportion of the protected areas budget contributes to

law enforcement activities due to the substantial employment of rangers who enforce the law (Fang et al., 2019). Agencies lack the manpower to have rangers effectively patrolling the vast, often arduous bush and terrain, quickly (Fang et al., 2019). Furthermore, many rangers lack proper training and equipment in comparison to some heavily armed professional poachers; in many cases lacking the simplest amenities of clean water and shelter, as well as community support (Neme, 2014). Rangers are daily putting themselves at risk wherein 2013 out of the 102 deaths of rangers, 69 were killed by poachers and the remainder by disease, wildlife and gruelling conditions (International Ranger Federation, 2014).

Whilst anti-poaching units (APUs) and law-enforcement is said to be crucial, it is argued that the increasing progression and sophistication of these poaching crimes means that conservation needs new tools to compete (Pimm et al., 2015). In order to assist the rangers in these protected and conserved areas, various technologies and equipment have also been tried and tested in order to prevent and detect poaching (Kamminga et al., 2018). According to Stokes (2020), preventing poaching in protected areas necessitates prompt data collection, analysis and reporting deriving from the field. Hence, existing anti-poaching systems are implemented which strive to support or enhance a further a range of anti-poaching tactics, to name a few; Global Positioning Systems (GPS), microchipping wildlife, drones, infrared cameras, sensors, acoustics, Cybertracker, Management Information System (MIST), and Spatial Monitoring and Reporting Tool (SMART) (Good, 2015; Pimm et al., 2015). These previously mentioned technologies enable the derivation of data for AI processing and this breakthrough of Artificial Intelligence (AI) for conservation therefore promises to be an advantageous tool for wildlife (Wearn, Freeman & Jacoby, 2019). Multiple technology companies, research institutes and non-profit organizations are utilizing machine learning, a subset of AI, and AI alogrithms to revolutionize efforts in conservation. They include the Elephant Listening Project, Rainforest Connection, Smart Parks, Air Shepherd, Protection Assistant for Wildlife Security (PAWS), and TrailGuard AI.

To name a few affiliations with these technologies where assistance is also derived ranging from funding to data science expertise include Microsoft AI for Earth, Google AI for Social Good, Leonardo DiCaprio Foundation, RESOLVE, Carnegie Mellon University, Cornell University, Harvard University, and University of Southern California. This variance of technologies utilizing AI begs the question of whether AI is the new anti-poaching system which can live up to the potential benefits in aligning with APUs strategies as well as improving the efficiency of prediction and prevention of wildlife poaching. Moreover, the quality of data which influences the quality and accuracy of these predictions that is most

important and relevant to the challenges in collecting quality data as well as the need to have 'low' intelligence which is equally important to 'high intelligence'.

In particular, AI can be defined as being "devoted to developing systems that can be taught, or systems that can learn to make decisions and/or predictions within specific contexts" (Smith & Neupane, 2018, p.25). As a result, typically the 'big data' mined in the conservation field is processed in the cloud and currently tests and development is also focusing on 'AI at the edge', which aids in alleviating data related issues such as too much traffic on local WiFi, or too much data being piped to the remote server (Sawhny, 2020). Thus, without requiring any connection, something that African protected areas often lack, AI at the edge can begin to run the less complex machine learning algorithms on a local server or even on the technology devices that are developing the data (Sawhny, 2020). Hence, it is stated that in the field of AI, "the potential benefits are huge; everything that civilization has to offer is a product of human intelligence; we cannot predict what we might achieve when this intelligence is magnified by the tools that AI may provide" (Hawking et al., 2014). Thus, AI in this case is utilized in assisting anti-poaching efforts for a social good initiative (Bughin et al., 2018).

James Hendler wrote "AI can be used for social good. But it can also be used for other types of social impact in which one man's good is another man's evil" (Smith & Neupane, 2018, p.21). It is noted that conservation faces many complexities, because besides the deep-rooted corruption in this industry, the policies about "green militarization" and nature commodification is heavily debated too and will be further discussed (Duffy, 2019). which causes much ethical debate about this concept of "green militarization" between scholars, conservationists and NGO's alike (Duffy et al., 2015; Duffy et al., 2019). Furthermore, in a bid to collaborate in international wildlife policy all African nations, with the exception of South Sudan, are party to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) treaty. Therefore, they are additionally pressured to follow the framework whose aim is to "ensure that international trade in specimens of wild animals and plants does not threaten their survival" ("what is CITES", 2020). Whilst this new policy doesn't align with the CITES treaty, it also argued to be relatively similar to poaching, the only difference being that hunters receive permission (Maron & Fobar, 2019). These distinctions align with scholar's assertion that conservation has transformed into a neoliberal framework in which natures can only be saved through their submission to capital (Buscher et al., 2012).

Many vulnerable protected areas do not have the funds nor infrastructures that facilitates this corresponding capacity of technology (Pimm et al., 2015). Furthermore, challenges of the implementation of AI technology include the political economies and digital exclusion of certain nations, the lessened attention provided to conservation innovation and the issues faced by conservationists who must apply the science in practice (Arts et al., 2015). This highlights the various debates which surround AI and the detriment that these conservational policies can have on the countries inclusion and finance of such technologies. Moreover, the debate also extends to the overall conservational framework that these AI applications align themselves with. Nevertheless, in the harnessing of this technology, "the challenge is to use technology more wisely, connect different technologies and get appropriate technologies into the hands of those who can use them more effectively" (Pimm, 2015).

Media reports that often describes AI for conservation as the "silver bullet" set to solve some of the serious bottlenecks in wildlife monitoring (Wearn, Freeman & Jacoby, 2019, p.73). Arts et. al (2015) discusses that "attention needs to be paid to who benefits (most) from digital conservation, and who does not (or who suffers from it); who is in control of information flows and processes; and how democratization may be promoted" (p.670). Hence, it can be examined how AI narratives can be helpful, or conversely how they can also generate false perceptions and expectations, especially for those not directly engaging with AI science or technology (Odell & McCarthy, 2017). Moreover, Art et al. (2015) argue that there is also a bias towards "good news narratives" of nature conservation and digital technology, thus calling for an in-depth analysis of these AI technologies. Such narratives could also have positive or negative consequences on the AI research, reception, funding and regulation. This statement holds true to the current technological advances of AI and to expand on the aforementioned research issues the following research question and sub-questions shall endeavor to gain more insight:

RQ: To what extent can/does AI mitigate the wildlife poaching problems in Africa?

Sub-question 1: What are the different beliefs about poaching and why?

Sub-question 2: What are the biggest challenges and existing strategies in countering poaching?

Sub-question 3: What are the current initiatives, devices and strategies for anti-poaching and how is AI being embedded here?

Theoretical Framework

2.1 Conservation

Global conservation practice stems from 'sustainable utilization' (Duffy, 1999) where wildlife laws are enforced and wildlife is utilized in such a way without jeopardizing the continued survival of the species, begging the question whether it is proven to work (Holden et al, 2018; Rowcliffe et al., 2004). Nature^{TM}Inc. describes the early twenty-first centuries' dominant discourse in the way of thinking about biodiversity conservation and environmental conservation, which entails using market force to curtail poaching (Arsel & Buscher, 2012). Currently, conservation governance widely follows the trend of neoliberalization which entails the promotion of market-based instruments for the management of the environment (Buscher, Dressler & Fletcher, 2014). The neoliberal logic alludes to the incentivisation of conservation for all affiliated parties through the extraction of natural resources (Fletcher et al., 2019). Neoliberal conservation has been examined extensively (Buscher et al, 2012; Buscher, Dressler & Fletcher, 2014; Holmes & Cavanagh, 2016).

It is argued that neoliberalization is a form of neoliberal biopower/ biopolitics, a term introduced by Foucault (2003) and adapted by Fletcher (2010). Foucault introduced the terms in order to explain the exercising of defence of human populations, and it has been extended into a form of environmental governance of nonhumans (Fletcher, 2010; Cavanagh, 2014). Thus, neoliberalization aligns with the obtaining of the ideology that the defence of life is demonstrated through its 'profitability' and therefore earns the right to exist (Fletcher et al., 2019).

Professional hunting is argued to be a form of 'neoliberal environmentality' as Koot (2019) asserts that it brings an array of economic incentives to the communities and can be utilized in conservation. However, professional hunting forms part of ethical and emotional arguments in conservation as it is questioned in how it functions differently in comparison to the illegal poaching of wildlife as well as how it can be done 'sustainably' (Kopnina, 2016; Hussain 2010).

2.1.1 Natural Capital Accounting

The further addition through the lens of biopolitics exhibits a productive new dimension through the claims of focusing on "how neoliberal interventions seek to optimize rural people's valuation and use of the resources in question" (Fletcher et al., 2019, p.1071). This form of support for environmental conservation is affiliated with the global movement to "harness the economic value of conserved nature to incentivise local resource

users to forgo the opportunity costs of extractive activities", a term referred to as 'natural capital accounting' (NCA) (Fletcher et al., 2019, p.1068). NCA is a component of the neoliberalization and biopolitical trends which are prevalent within conservation governance (Buscher, Dressler & Fletcher, 2014). Two case studies from the Philippines and Indonesian ecosystems provide insight into the usage of NCA initiatives being utilized to financially bring value to ecosystem services to the local people (Fletcher et al., 2019). Fletcher et al., (2019) asserts that despite the fact that substantial funding is still provided to the notion of 'natural capital' with the intention of aiding the rural livelihood of these affiliated communities, in actuality this strategy provides little finance to these communities. Furthermore, the two case studies in Southeast Asia exhibited that although the NCA initiatives initially are lucrative from the funding program design, in the long term essentially there is a misalignment between the local communities needs and the NCA interventions (Fletcher et al., 2019). As a result, Fletcher et al. (2019) study support the notion that resource extraction is practically always providing higher lucrative income than conservation itself. Hence, NCA for conservation is argued to in practice be the "antithesis of conservation" by encouraging the resource extraction that it is intended to combat (Fletcher et al., 2019, p.1090).

African nations such as South Africa are typically described as a 'neoliberalization from above' conservation structure (Dressler et al., 2010). Whilst Fletcher et al. (2019) currently debate that in response to these conservation pressures and state that an alternative form of conservation is required in which it takes into consideration the "economic system's structural pressures, violent socio-ecological realities, cascading extinctions and increasingly authoritarian politics"; a term named 'convivial conservation' (Buscher, 2019) which necessitates that NCA needs to be defended as it improves rural livelihoods, whom consequently are effected by conservation in either a positive or negative way. Yet, this study applies information from Asian nations and so there are limits to this promotion of economic valuation in Africa's conservation, hence this is a gap in the literature.

2.1.2 African context for conservation

Arsel and Buscher (2012) ask the question does the setting and context influence global discourses and policies that correspondingly link to capitalist change? Africa is a continent with the largest growing populations, parallel to this they also have some of the most endangered species in their conservation areas (IFAW annual report, 2019). Furthermore, Africa is home to the largest conservation areas in the world, and an increased

emphasis is put on these countries as in some countries the endangered species are extinct, or populations are dwindling (IFAW annual report, 2019).

3.1.4 Green Militarization Conservation

According to Lorimer (2015) biodiversity conservation is a biopolitical regime which can be explained as a type of governance in which the aim is "to secure the future of a valued life (both human and nonhuman) at the scale of the population (p. 12). Furthermore, Adams (2019) states that this power resides in its exercise "over both nature (keeping species and ecosystems within specific bounds in terms of state and location) and humans (determining who may take, kill or transform non-human lives and spaces)" (p.338). Buscher (2018) disputes that there has been a blurring of this discrepancy between the lives of humans and wildlife. Hence, Buscher (2018) states that the violent responses to wildlife crime, or green wars, is a move from biopower to a term referred to as 'ontopower' resulting in a focus on the "preemption and anticipatory action" of poaching in conservation (p. 157).

It is described that due to the increased levels of poaching, there is a shift from biodiversity conservation to security and counterinsurgency (Duffy, 2016). Further studies discuss the prevailing conservation strategies including 'green militarization' and 'green violence' (Duffy, 2014; Lunstrum, 2014; Buscher & Ramutsindela, 2016). These terms refer to where the conservation entails more force or the inclusion of rangers being armed (Masse and Lunstrum, 2016), the development and application of military style approaches is utilized (Buscher, 2018; Duffy et al., 2018); such as the creation of intelligence networks (Ball et al, 2019; Buscher, 2018); and the use and application of technologies which were originally developed by the military (Lunstrum, 2017). One of the strongest reasonings in favor of militarization of conservation is that it is the best, if not only, workable option in areas of intense armed conflict (Duffy et al., 2019). Therefore, militarized approaches to conservation are noted to be expanded, institutionalized and normalized in a growing number of protected areas and conservation NGOs and donors (Buscher & Fletcher, 2018; Duffy, 2016). Yet, it is also criticized to have negative implications to this form of conservation in relation to not addressing the underlying reasons for why people involve themselves in poaching, the negative lived experiences that rangers face in often facing dangerous situations of armed combat and so the question of the underlying political economy of the militarization of conservation is highlighted (Duffy et al., 2019).

The 'shoot-to-kill' policy is an element to the militarization of conservation in which this policy is what Messer (2010) states is the only feasible solution to impoverished nations

in which economic gains are realized from the illegal poaching market demand. Laws usually only allow for rangers to shoot if shot at, but the "shoot-to-kill" poacher's policy negates this policy (Shoot to Kill, 2020). African nations who adopted this controversial strategy include Botswana and Zimbabwe wherein both countries verified the success with incremental increases in elephant and rhino populations (Anderson & Jooste, 2014). Conversely, moral obligations to preserving basic human rights under International Laws are raised as this policy doesn't correlate with the provisions for extrajudicial killings, except in self-defense (Mogomotsi & Madigele, 2017). Hence, the shoot-to-kill policy necessitates debate and controversy and can equally affect the support in financial provisions as well as resource and technological support for the protected wildlife areas.

Marijnen and Verweijen (2018) contends this argument of green militarization in stating that this militarization serves to further embed conflict dynamics, rather than resolve them. In many analyses it is asserted that poaching is a crucial funding strategy for militias, rebel groups and terrorist groups and so for this reason this narrative is consumed and utilized by NGOs, governments and media outlets to necessitate the justification of the shift towards more militarized forms of conservation and increase the urgency to save the species (Duffy et al., 2019). However, Duffy (2016) argues that these claims are poorly supported by evidence or are based on false assumptions. Thus, the gap in the research is the comprehensive understanding of how and why this violence is performed, resisted and/or negated, disseminated and furthermore how it will affect the different actors/ technologies in positively impacting the conservation of the endangered wildlife.

2.2 Wildlife Poaching Context

Sustainability in the context of conservation can be defined as the preservation and even proliferation of endangered species for a balanced ecosystem (Jackiw et al., 2015). The creation of game reserves, protected areas or national parks 'green zones' is set out in order to proliferate the populations of wildlife (Draulans & Van Krunkelsven, 2002, p.39). This technique, also termed as "fortress conservation", comparable to that of creating a demilitarized zone, as it is a militarized tactic in which the forcible or incentivized removal of civilians from a protected area is conducted (Duffy & St. John, 2013, p.493). As a result, it is argued that because of the debated success of militarized conservation efforts, the experience of the communities living in these areas concerned is overlooked which is noted to cause alienation and negative sentiment amongst the community towards the conservation efforts (Duffy et al., 2019). It is important to note that whilst international terrorist groups are a

threat to the security of the wildlife, Anderson (2014) maintains that additionally poaching is conducted by local hunters that are often linked to the international organized crime syndicates too. Hence, it is evident that there often an interconnection between bushmeat and crime poaching. Poaching is conducted by means of typically military grade rifles and wire contraptions, referred to as snares (Life as a Wildlfe Ranger, 2019). A study conducted in Namibia attributes the agency of local wildlife hunters to systematic issues of lack of transparency , economic mobility, and high unemployment and rates of alcoholism (Grobler, 2019).

2.3 Management strategies: Conservation on the reserve-level

Anti-poaching strategies on the reserve-level are diverse and formulate their own comparative analysis between various countries and reserves (Anderson, 2014). Bronkhorst and Matthys (2016) state that researchers should embed themselves within counter-poaching teams in order to further detail and comprehend the anti-poaching strategies. Moreover, it is worthy to note that there is a variance of management strategies due to the framework as well as the ways in which funding is established.

2.3.1 Community-led Conservation

Masse (2017) research aligns with various scholars' advocations to a dynamic systems-thinking approach and a dedication to community driven anti-poaching initiatives. The conferences of international Illegal Wildlife Trade (IWT) emphasize the importance of community-led conservation, these approaches include, but not limited to, including communities in the law enforcement effort, reducing the conflict between communities and wildlife and generating incentives for community-based conservation (Roe & Booker, 2019). Moreover, a recent study conducted by Holden et al. (2018) supports this notion in which the study details findings that exhibit that campaigns for reduction of campaigns combined with sustainable livelihood approaches are the more advantageous strategies for tackling poaching than enhanced policing and enforcement alone.

This community based approach is also referred to as a “bottom-up” solution, and Ajjaz (2017) asserts that in the future, researchers and policy makers must be encouraged to increase their focus on these socio-economic drivers of poaching. It is evident that recent literature is emphasizing that a combination of community driven anti-poaching initiatives is necessary to efforts of stopping syndicated poaching. Yet, Al-Ajjaz (2017) additionally reveals that the various African case studies demonstrate that anti-poaching strategies are multifaceted and complex with no one-fits-all solution, which in turn it is suggested that

poaching must be addressed at each level in order to maximize the efforts of each approach. Hence, given the opposing suggestions, the following research will strive to depict these strategies and note the prevailing and success and challenges in this capacity and so AI initiatives within these socio-economic mappings must be further addressed.

2.3.2 Anti-Poaching Units

It has been argued that ranger patrols, otherwise known as the 'boots on the ground' method, are considered to be one of the most effective 'on the ground' methods for poaching detection and deterrence (Kurland et al., 2017; Rayan & Linkie, 2015). However, it is asserted that these anti-poaching units (APUs) cannot be considered the only answer and resolution to the poaching issue (Barichievy et al., 2017). An analysis show that rangers make limited coverage as majority of their patrol activity take place within a 3km radius of the patrol posts, therefore the parks only receive 23% sufficiency in patrolling (Plumptre et al., 2014). This limited coverage is noted to be attributed to a varying of factors including lack of resources, difficulty with access to the terrain, and/or political/safety issues (Islam et al., 2019).

Ball et al. (2019) presents distinctive theory and principles as their findings emanate from their own practices of curtailing rhino poaching on the protected area named Malilangwe Trust. In contrast to the majority of the prevailing anti-poaching strategies, out of the seven pillars of management that is utilized and described on Malilangwe Trust, there is emphasis that the two most fundamental pillars are those of leadership and intelligence (Ball et al., 2019). It is noted that this strategy pillar of leadership is set apart from typical African conservation setting as it includes a particular focus on human resource management and adopting leadership styles geared to improving the satisfaction and loyalty of employees (Ball et al., 2019). Notably, this improvement of satisfaction and loyalty includes the fact that 98% of the employees derive from the neighboring communities, the high standard of infrastructure and increase in the value of salaries (Ball et al., 2019). The second pillar of intelligence is emphasized to be vital, and this intelligence refers to employing "considerable effort and resources with the aim of acquiring and managing informants, and following up on information" which increases the probability of successful arrests (Ball et al., 2019, p.103). Therefore, the variance in conservation strategies and the context of conservation in Africa is important to note as it could affect the success of the design of AI devices.

2.3.3 NGO Involvement

Bronkhorst and Matthys (2016) analysis of Green Militarization anti-poaching strategies in Sub-Saharan countries exhibited that NGOs involvement is more inclined towards ranger training and law enforcement. According to Buscher (2014) "selling success" is a vital aspect in the construction of conservation and its development within the neoliberal global political economy and it is noted that this success stems from knowledge bases as well as forms of capital. Assistance from foreign donors, NGO's and the private sector are argued to be crucial actors in the emanation and persistence of neoliberal conservation strategies (Dressler et al., 2010). Therefore, according to these studies, it suggests that this popular movement of neoliberal conservation is essentially the foundations of which prior and currently deployed twenty-first-century strategies and challenges emanate. Buscher and Dressler (2012) argue that these neoliberal strategies "need to build more effective connections between scholarly theorization, (local) social movements opposing neoliberal conservation, and the full diversity of human endeavours to animate socio-nature" (p.122).

The question of how AI, predominantly in the context of neoliberal capitalism with its emphasis on commodifying nature as a solution to the environmental crisis, needs to be further addressed. Moreover, military experience provide insight into the fact that technology should rather be tactics within the larger framework of, in this case, the conservation strategy (Crorin, 2013). These additional tactics include strengthened legislation, further effective judicial processes and demand for wildlife ultimately curtailed (Pimm et al., 2015). Hence, it is argued that whilst technologies can aid in conserving wildlife, "it is important that these tools themselves do not drive conservation efforts" (Pimm et al., 2015, p.693). Therefore, further research will locate this argument and consider its mediation within the AI conservation technology framework.

2.4 Responsible AI for conservation

Responsible innovation, a term utilized to describe the scientific research and technological processes which consider their effects and potential influence on society and the environment, is noted to have a significant gap in studies relating to the application in the context of the global south (Macnaghten et al., 2014). Wearn, Freeman, and Jacoby (2019) assert that misuse of AI could have severe consequences for people and wildlife. Firstly, the issue of machine learning algorithms misuse and misinterpretations are raised, including the difficulty of identifying the "implicit assumptions of an algorithm"; the uncertainty of algorithms making predictions beyond the reach of the training data and the difficulty to decipher the algorithms specific decisions (Wearn, Freeman, & Jacoby, 2019, p.72). Thus, it

is asserted that these issues could result in obstructive outcomes in which the implementation of machine learning in conservation creates a potential waste of resources, increase of cost and undermining the trust of science led approaches (Wearn, Freeman, & Jacoby, 2019

Improved metrics through improved collaborations between ML researchers and conservationists is said to be further enhanced, as it is stated that once algorithms are released and utilized in the wild, the accuracy metrics are likely to not provide a good indicator of success due to the input and transference to a new dataset in which retraining is then required (Wearn, Freeman, & Jacoby, 2019). Finally, there is also a call towards the formulation of ethical guidelines for the responsible utilization of AI in conservation (Wearn, Freeman & Jacoby, 2019). Issues are raised in which the guidelines should be designed to "steer algorithms development in the right direction for humanity and wildlife in ways that are collaborative, maximally beneficial, liberating and yet robust to misuse and corruption" (Wearn, Freeman & Jacoby, 2019, p.73).

Moreover, Smith and Neuprane (2018) note that there is a gap in literature in which little research exists guiding the design, development and deployment of AI in the global south. In particular, Smith and Neupane (2018) assert that the nature of the AI applications and the projections of the impacts of the AI applications are two elements which will investigate how the research agenda, according to AI's in the global south, should be designed. An 'AI divide' is noted to be an issue in which there is a gap between those who design, those who deploy the applications, and those who don't, thus highlighting the need to not studying the implications and not "continue blindly forward" (Smith & Neupane, 2018). Smith and Neupane (2018) argue that that this form of research can further inform the prevailing government policies and regulations of further alteration in the global south in order to ensure fair and appropriate use. Thus, the following research will focus on including further insights into the policies and regulations, inclusive and ethical applications, infrastructure and skills needed for the implementation of AI into conservation in Africa.

2.5 Security & AI Policy

Previous research asserts that AI can drive a project to success, in particular for the 'social good' of humanity (Castro & New, 2016; Hatley et al., 2019; Bughin et al., 2018). The social benefits, impacts and the capabilities that AI is delivering towards nonprofits and social service providers is a novel topic (Bughin et al., 2018). On one hand, there are hyper utopianism narratives of artificial intelligence exhibited by the public, policymakers and scientists (Odell & McCarthy, 2018). On the other hand, there are also a set of concerns, for

example, the dystopian prospect of the possible threats of using AI to make critical decisions and the corresponding safety of humans from the anticipated repercussions of the future of 'strong AI', more commonly understood in terms of robots, which could be in charge of making such critical decisions (Fang et al., 2019; Smith & Neupane, 2018). Furthermore, the prospect of the loss of jobs and the challenges in terms of moral, ethical and bias implications of AI applications are also of concern (Smith & Neupane, 2018). In the context of the Global South, a term referring to the low and middle income countries including those of African nations, Smith and Neupane (2018) note that both the digital and analogue foundations necessary for an equitable and ethical application of AI to these countries are substantially absent, and notable uneven power production is also prevalent.

Incorporating AI narratives research into ethics research is revealed to be an important future direction to take, as it is a component that will enhance research about the ethical impact of AI (Walsh et al., 2019; Benkert, 2019; Odell & McCarthy, 2018). In utilizing the AI models for law enforcement, an ethical dilemma, finds the expected outcome as one in which it will manipulate ranger behavior, decrease ranger bias and enable researchers to encompass a better understanding of what makes an effective deterrence from poaching (Feng et al., 2019). Ramifications of these controversies are presented by Bughin et al. (2018) who discuss that many potential AI solutions to security and justice may not have been employed or implemented due to the fear of detrimental repercussions. Hence, exploring the factors that form the use of these algorithms as well as the detrimental effects that they could have in reliance on such an algorithms is noted to be a gap in anti-poaching AI application studies

2.6 Non-AI Anti-Poaching Strategies

Previous research asserts that none of the current anti-poaching technologies completely satisfy the purpose of the protection of endangered species (Kamminga et al., 2018). Anti-poaching solutions can be divided into two subcategories; detection and prevention. Kamminga et al. (2018) situated the detection of (non-AI) technologies into five categories and they comprise of technologies that are perimeter-based, ground-based, aerial-based, sensor based and animal tagging based. Furthermore, Kamminga et al. (2018) study surveys of the (non-AI) technologies and practices of poaching prevention solutions, and it is further argued that these technologies comprise of the themes of diplomacy, negative reinforcement, law enforcement and demand reduction (Kamminga et al., 2018).

Within Kamminga et al. (2018) study, it notably doesn't include radio detection and ranging technology (RADAR), and in particular ground penetrating radar (GPR) which has been tested by Borrion et al. (2019) as a system and they argue that it can be useful to achieve semi-automated wire snare detection that is set by poachers. Yet, there are limitations to this novel study as the GPR was only tested in the United Kingdom therefore not allowing for first-hand experience with rangers and third parties, thus, it is noted that it is vital that in order to fulfill the testing of any novel technology, these principles need to be recognized and adjusted correspondingly (Barrion et al., 2019). Moreover, it is stated that Africa's different environmental conditions could affect the promise of such a technology (Borrion et al., 2019). Thus, this raised issue is further supported by studies which contend that a vast majority of these tools of drones, camera traps, law enforcement monitoring software and thermal imaging units often haven't been meticulously tested in the protected areas in Africa (Linchant et al., 2015; Pimm et al., 2015) In addition, their value could be lost in the hands of corrupt or incompetent security personnel (Ball et al., 2019). As a result, the research conducted will address these challenges accordingly in retrieving the possible benefits or challenges with the conservation technology that utilizes AI.

2.7 AI Technologies Designed for Conservation

According to Adams (2019), technology is a principal factor to conservation's employment of biopower and describes the current trend of digital data automation in conservation decisions as 'conservation by algorithm' (p.338). Ball et al. (2019) assert that whilst the increasingly sophisticated technology is being utilized to fight against poachers, it is noted that success is in the underlying philosophy of getting the basics in place before the addition of these technological frameworks and applications. Moreover, assessments are raised towards the media reporting that AI conservation studies are the 'silver bullet' in solving some of the prevailing conservation issues (Wearn, Freeman & Jacoby, 2019). Hence, the following research will take cognizance of these arguments in relation to the AI technology currently available and being tested in Africa.

2.7.1 AI Preventative and Detection Technologies

AI algorithms, machine learning and deep learning is utilized in a variance of ways with conservation. To date the following technologies that utilize AI for preventative and detective anti-poaching technologies are aerial based, patrol based, acoustic based, camera based and sensor based. Majority of the current AI advancements can be found on websties and in news reports, yet, there is a limited amount of research papers published in the

capacity that describe specifically how each of these technologies utilize AI, the current selection of market, as well as the challenges and the successes of implementation in the field.

2.7.2. Arial-based Technology

Arial-based technology is noted to be beneficial for either the aerial game counts (Eikelboorm et al., 2019; Haalck et al., 2019) or the aerial detection of illegal poachers (Bondi et al., 2018; Lopez & Mulero-Pazmany, 2019). Bondi et al. (2018) developed the AI program SPOT, which is piloted by the UAV/UAS/RPAS organization 'Air Shepherd'. Further studies noted the challenges with SPOT, firstly determining and deciding where conservation drones fly, followed by location of the human patrollers, and whether to signal when flying, thus the application of GUARDSS, an algorithm that supports future potential deployment, was thereafter implemented (Bondi, 2019). Nevertheless, on the website it is noted that the last news update was in 2018 explaining that the company had seen an organization change.

2.7.3 PAWS Technology

Secondly, the AI device named PAWS is an application that is subject to the law enforcement category as it attempts to enhance the effectiveness of patrols and the pursuing of the poachers through eliciting knowledge from experts (Fang et al., 2016; Feng et al., 2019). PAWS utilizes data from SMART which "enables rangers to collect and sort out data on their mobile devices about the locations of animals and humans, including illegal intruders, in order to deploy scarce staff as efficiently as possible" (Cookson, 2019). PAWS is based on the Stackelberg game theory and attempts to enhance the effectiveness of ranger patrols (Wang et al., 2019). Various improvements of the Steckelberg game theory have been implemented into the PAWS application and these include COSG (Zhao et al., 2019), CAPTURE (Nguyen et al., 2016) and INTERCEPT (Kar et al., 2017). PAWS has been tested in Malaysia and Uganda's National Parks, nevertheless, a recent partnership has been made with SMART which promises a?? (Fang et al., 2019).

2.7.4 Acoustic AI Technology

Acoustic monitoring and sound science is being utilized in order to monitor the rainforest environments (Burivalova, Game & Butler, 2019). Through the utilization of bioacoustics, the animal vocalizations and human-made sounds from the soundscapes can be detected through algorithms, deep learning and experts (Burivalova, Game & Butler, 2019). As a result, conservationists are then able to tackle forest loss, and in particular track

the forest elephants to protect them from poaching and other threats such as local animosity towards elephants (Burivalova, Game & Butler, 2019). The Elephant Listening Project and Rainforest Connection utilizes acoustic technology. The 'Elephant Listening Project' has an ongoing project being conducted in the Republic of Congo where the acoustic data processing is supported by the Microsoft's Azure cloud system and Conservation Metrics (Elephant Listening Program, 2020).

2.7.5 Camera AI Technology

The TrailGuard AI uses Intel's Modividius Myriad vision processing unit (VPU) in order to help park rangers identify poachers and prevent poaching using their smart infrared cameras ("Intel AI Projects", 2019). The TrailGuard AI was tested in the Sernegheti, and in 2020, there are promises that the TrailGuard AI will be implemented into 100 vulnerable sites worldwide ("Intel AI Projects", 2019).

2.7.6 Sensor Technology

Smart Parks Further studies and tests are currently being conducted in alignment with Banzi (2014) theory that animals can be utilized as mobile biological sensors; thus far concrete findings have not been published. Overall, there is a scant of literature in which a comprehensive study of various AI anti-poaching technologies, with particular focus on the detection and prevention, is compared and contrasted in such a way in which Kamminga et al., (2018) established. As a result, the thesis will address the ways in which AI is being implemented into conservation, how it should be implemented in the future and how it should be fairly and appropriately used in this capacity of conservation.

2.8 Collaboration

It is noted that the difficulties with creating AI applications for anti-poaching are to a certain extent due to the different motivations driving nature conservation and technologies (Maffey et al. 2015). Adams (2019) notes that although the digital data collection may be distributed among a range of actors, the conservation planning and decisions based on these data streams tend to be operated further away from the people affected, and rather into the hands of the remotely situated decision-makers and technicians who devise the algorithms on which they rely. Two studies prompt the question of how to provide resource managers, which includes the managers of the conservation areas as well as the NGOs, with the information they need to evaluate which technology options will work best in their situation (De Vos et al., 2015; Pimm et al, 2015). Hence, this supports Feola (2015) discussion that

“communicating priorities, engaging stakeholders and sharing best practice” are further issues which deter the success of sustaining the various solutions (p.525).

Hence, a comparative narrative of the varying AI applications, in a structure that can align with Kamminga et al., (2018) comparison of (non-AI) technologies is a gap in the literature will be utilized in order to convey the variances of AI technologies. Moreover, the research will strive to gain varying stakeholders and testing fields insights in order to add value and complement the existing studies of non-AI technologies. As a result, these insights will provide further insight into the AI technologies varying practicalities and shortfalls.. Hence, the focus of this research is to create a holistic approach in deploying AI led strategies to combat poaching and illegal trade that spans digital and physical geographies due to the inherent global supply chain that enables this practice.

2.9 Societal Relevance

The study aims to provide societal relevance to various stakeholders and affiliated bystanders with AI anti-poaching applications. Due to the factors of AI and conservation being integrated into this research, it could supply more nuance to the relationship between the scientific case studies of the AI devices, the broadcast and internet media promotion of such devices and their responses from the various conservationist members in Africa. Hence, this will give a deeper understanding as to the role that AI will play in preventing poaching of wildlife. The findings from this research can also assist scientists with further design purposes, and show to the conservationists interested in the implementation of AI applications in their parks, the advantages and disadvantages of deployment. This research facilitates the identification of further policies and regulatory structures that the Global South regulatory bodies require. Furthermore, in light of the economic pressures of COVID -19 the aim is to also utilize these insights to futher enable cost-efficient and proficient conservancy.

Methodology

The following chapter provides an overview of the methodology implemented in this study that critically examines the use of AI and its stakeholders in illegal wildlife poaching. The goal is to provide a critical assessment of AI led tools in combating the illegal wildlife industry. This research will situate AI from the view point of ascertaining whether these supposed technological solutions address the problems proposed by the relative conservationists in the field. This study utilizes qualitative research methods to investigate subjective attitudes, opinions, or experiences of someone (Percy, Kostere & Kostere, 2015).

Research was conducted in the form of thematically analyzing both semi-structured interviews and media reports. Therefore, the essential points addressed in this collective case study ascertain how the current initiatives, devices and strategies of anti-poaching and illegal wildlife trafficking are embedded in AI. Additionally, the biggest challenges and existing strategies faced in countering the illegal wildlife industry with AI applications/ technology are recognized.

It is important to note that the analysis of these findings cannot be reproduced or generalized. Yet, the choices made, and steps taken during this research is described in detail in order to substantiate the interpretations and trustworthiness of the analysis conducted in this study (Brennen, 2012). Hence, the proceeding sections will elaborate on the research design, the sample and data collection, the operationalization, the analytical approach and finally the validity and credibility.

3.1 Research Design

This study used a combination of interview and textual analysis. The first method of interviews allowed for engagement and mapping of stakeholder interests and tensions with regards to conservation perspectives of AI technologies. The media reports covering these technologies reveals how AI is perceived and promoted via the media with regards to its utilization in the conservation industry. Therefore, the approach to this research is through mapping and critically analyzing 1) ranger experiences and perspectives in Africa; 2) AI based anti-poaching software design initiatives; and 3) news reports perspectives. Thematic analysis is used as the most appropriate method to interpret and understand the large quantity of data. Hence, with the nature of this study as a mixed method study, validity is acquired through the comparison of contrasting insights.

3.1.1 In-depth Interviews & News Reports

Interviews are utilized if a researcher needs insight about a phenomenon, the sample chosen are those in which the testimonies are of those who have experienced, or are experiencing the phenomenon (Collingridge & Gantt, 2008). In utilizing in-depth interviews, the aim was to help bridge the gaps between the conservationist stakeholders and the design processes of the AI anti-poaching models. Insight into the overall utility and requirement of such innovation for the developing nations of Africa will produce further insight into the politics and commodification of AI developments.

An in-depth interview is suitable in this study as it provided valuable personalized 'inside' information from those involved within conservation, specifically in the field of anti-poaching. An interview guide (see Appendix A) provided direction, while maintaining flexibility and space for participants to share new insights (Lindlof & Taylor, 2017). This research is interdisciplinary as interviews with NGOs, conservation experts and technology companies enable the intersection of social and technical factors. The aim of this data set is to accumulate knowledge from the seventeen (n=17) self-conducted interviews, focus on anti-poaching and the corresponding innovative techniques being used in their corresponding conservation areas.

As the nature of combatting poaching is multi-faceted, the way that the media describes the novel AI technology in this regard enables categorization of several slightly different passages (Schreier, 2014). Further supplementation of 8 online news articles were added to the data set. Hence, the goal is to show how the media provides insight into AI innovation for poaching in constructing the positive or negative consequences.

3.1.2 Textual analysis

Stakeholder analysis method is recognized as a vital process for environmental and natural resources management, making this method applicable to this study (Colvin, Wit & Lacey, 2015). It generates knowledge in order to comprehend the interviewees "behaviors, intentions, interrelations, agendas, interests and the influence of resources they have brought – or could bring – to bear on decision-making processes" (Brucha & Varvasovszky, 2000, p.239). Amongst the various rationales provided for conducting stakeholder analysis, the following research utilizes the method of semi-structured interviews in order to harness the typology of identifying the stakeholders (Reed et al., 2009). This typology can be explained to create in-depth insights of the stakeholders' relationships between each other and anti-poahing, and to further triangulate the data (Reed et al., 2009).

Qualitative thematic analysis was utilized to systematically extract insight from the large quantities of raw data (Marks & Yardley, 2011). This type of analysis was applicable as it harnesses the capacity to determine themes and behaviors (Aronson, 1995). The approach reduces the amount of media material, to focus on selected aspects of meaning (Hsieh and Shannon, 2005). Therefore, this research offers a perception of the different materials through the mapping of stakeholder interests and tensions. As these themes allow for the detection of stakeholder similarities and differences, this method allows for a detailed and changeable data analysis process (Clarke & Braun, 2013).

3.2 Sampling

The in-depth interviews and news articles used in this mixed method analysis allowed for a holistic approach to addressing the main question and sub-questions. This thematic analysis is a non-probability method based on an initial selection, therefore firstly purposive sampling was applied to this study, whereby non-randomly selected individuals were interviewed (Babbie, 2015). Purposeful sampling incorporates the need to make decisions based on specific characteristics for the content used (Elo et. al., 2014). Thereafter, snowball sampling was utilized mainly for the purpose of sourcing further applicable interviewees, as often the contacts of these interviewees are difficult to uncover due to security reasons (Babbie, 2015)

Flick (2007) asserts that the professional function of an individual, or their knowledge and skills in the field necessitates the reasoning behind sampling decisions. Thus, due to the fact that these interviews required the provision of expert knowledge in the field of interest, the selection of the interviewees was based on their position and expertise. Locally conducted research, in terms of the Global South guarantees significance and utility (Smith & Neupane, 2018, p.93). Thus, the interviews of various members of the conservation efforts in Africa increases local perspectives. Furthermore, to provide valid cross-comparison of answers, it is necessary that the individuals interviewed are working within the same overarching framework that endeavors to combat the poaching.

As previously mentioned, there are intertwined proposed categories, including those who work directly in the field with the APUs, NGOs, conservationists, technology researchers and technology companies. As these stakeholders all hold important positions in their field, analysing them contributes to the understanding of the social dimensions of challenging anti-poaching issues (Colvin et al., 2016). Additionally, conservation areas can vary in accordance to the type of management, such as government run National Parks or

privately run reserves or trusts. Countries also have differing conservation strategies and policies. Thus, a data set was sought out in which interview members stemmed from various countries and conservation areas in Africa.

To begin with the mapping of the stakeholders, firstly conservationist scholars were interviewed from the Global South to ascertain their views of conservation management and the current strategies being utilized in Africa. Secondly, stakeholders holding principal positions in the conservation areas constitute vital actors as the aim was to gather knowledge in the management strategies, challenges that the APUs face, and the current technologies they utilize. Thirdly, NGOs who work in the conservation areas were interviewed as they not only fill the knowledge gaps on funding, but also have an expert overview of the various prevailing challenges in combatting the illegal wildlife industry. Finally, the technology researchers and companies are able to provide insights into their own technology as well as the successes and challenges faced with the design and implementation of this technology into the conservation areas.

The sampling of news reports focused specifically on the themes of AI technology that was being utilized for conservation. The sample strived to grasp a further array of content published by various platforms, gain insight from the technology companies that weren't able to be reached for interviews, as well as gain insight into the narratives from third party sources.

3.3 Data collection

The following section discusses the data collected from the in-depth interviews and the news articles. With the intersection of the two data sets, the level of theoretical saturation was ascertained.

3.3.1 In-depth interviews

The interviews were conducted between the 28th of April to the 5th of May 2020 and oral consent during the interviews was given. As shown in Table 1, multiple stakeholders including those in control of the rangers, conservationists, NGOs, researchers and technology experts were interviewed on Zoom. As further explained in Table 1, these interviewees possess vital roles in conservation and technology. The mapping of these stakeholders are as follows.

The conservationist consultor, Sarah Savory, daughter of conservationist expert Allan Savory, was interviewed to gain insight into her theories about holistic conservation from the perspective of the Global South. In order to gain insight with those directly involved in anti-

poaching and conservation in the field of Africa where interviewed. Those directly involved in conservation efforts in the field included the Painted Dog Conservation, AndBeyond, Big Life Foundation and Panda Masuie Project. These individuals hold prominent positions whose responsibilities encompass various aspects of conservation, including anti-poaching. The NGOs that partner with the government run National Parks in Africa were also interviewed. These include Rhino 911, International Fund for Animal Welfare, African Wildlife Fund, and Zambezi Society. Members established as AI conservation technology entities that were interviewed included Microsoft, PAWS, Air Shepherd, Elephant Listening Project, Rainforest Connection and Smart Parks.

Connection and Smart Parks will be interviewed.

Company/ NGO/ Park/ Project	**Interviewees**	**Employment Position**	**Stakeholder**	**Country of Operations in Parks**	**Type of Park Management**	**Date & Program**
ACHM	Sarah Savory	Conservation Consultant & Author	Conservationist: scholar and consultant	Zimbabwe	Private Management & APU	28/04/2020 Zoom
AndBeyond,	Les Carlisle	Group Conservation Manager	Conservationist: operating in field (sepcializing in translocation)	South Africa	Private Management & APU	30/04/2020 Zoom
Big Life Foundation (BLF)	Richard Bonham	Co-Founder	APU: operating in field	Kenya	Private Management & APU	04/05/2020 Zoom
Painted Dog Conservation (PDC)	David Kuvawoga	Operations Manager	APU: operating in field	Zimbabwe	Government with NGO management support & private APU	05/05/2020 Zoom
Wild is Life & Panda Masuie Project (PMP)	Jos Danckwerts	Project Manager	APU: operating in field	Zimbabwe	Government APU with Private Management	06/05/2020 Zoom
The Malilangwe Trust	Mike Ball	Security Manager	APU: operating in field	Zimbabwe	Private Management & APU	06/05/2020 Zoom
Zambezi Society (ZamSoc)	Gary Layard	Volunteer Logistics Coordinator	NGO	Zimbabwe	Government with NGO management support	28/04/2020 Zoom
International Fund for Animal Welfare (IFAW)	Philip Kuvawoga	Director: Landscape Conservation Programs	NGO	African Countries	Government with NGO management support	05/05/2020 Zoom
African Wildlife	Olivia Mufute	Country Director	NGO	African Countries	Government with NGO management support	08/05/2020 Zoom

Foundation (AWF)						
Rhino 911	Nico Jacobs	Co-Founder and Pilot	NGO: operating in field	South Africa:	Private and Government management	30/04/2020 Zoom
Elephant Listening Project (ELP)	Peter Wrege	Senior Research Associate: Cornell University	AI technology & Ecology expert	Democratic Republic of Congo, Central African Republic	Government with NGO management support	29/04/2020 Zoom
PAWS & Air Shephard	Fei Fang	Assistant Professor: Carnegie Mellon University	AI technology expert	Test pilots in various African and Asian countries	Government Management & Conservation areas utilizing SMART technology	04/05/2020 Zoom
Microsoft	Patrick Flickinger	Senior Data Architect: AI for Good Research Lab	AI technology expert	Test pilots in various African and Asian countries	Conservation areas utilizing SMART technology	14/05/2020 Zoom
Microsoft	Shahrzad Gholami	Data and Applied Scientist	AI technology expert	Test pilots:	Conservation areas utilizing SMART technology	14/05/2020 Zoom
Microsoft	Remko De Lange	Cloud Solution Architect: Data & AI	AI technology expert	Test pilots:	Conservation areas utilizing SMART technology	14/05/2020 Zoom
Rainforest Connection	Topher White	CEO	AI technology expert	15 countries: 1 African country: Gabon	Government & Community Management/	09/05/2020 Zoom
Smart Parks B.V.	Tim van Dam	Co-Founder / Director	AI technology expert	'African Parks' Conservancies:	Private management & APU	14/05/2020 Zoom

Table 1. Overview of Stakeholder Analysis

3.3.2 News Articles

The collection of texts was purposively sampled. Lexis Nexis was utilized to locate the news articles in order to conduct a thorough scraping of current media, which includes online newswires and press releases, web-based publications, blogs, newspapers and magazines. The time frame chosen was between January the 1st, 2018 until May the 1st 2020, based on the recency of AI being supplemented in the field of conservation. For the sake of variety, two searches were conducted. The first search comprised of the main key search term being "artificial intelligence" and the search within this key word included the key words "wildlife", "conservation" and "poaching". Through this scraping 109 texts were available.

Thereafter, these reports were screened to isolate those with relevant and detailed data about AI and its effects on conservation in Africa specifically. Reports that were less than 300 words, were also excluded. The final process resulted in the inclusion of 8 news articles into the data set, as shown in Table 2.

News Article Title	**Author/ Source**	**Date**	**Words**
Wired and Free: the uneasy alliance of wildlife and technology	Matthew Field	January, 2019	774
Can finance help Africa keep its wildlife?	Helen Avery & Kanika Saigal	October, 2019	5115
'10 steps ahead': Kenya's tech war on wildlife poachers	Nick Perry	June, 2019	860
Inmarsat joins forces with RESOLVE to revolutionize fight to protect African wildlife	Inmarsat	August, 2019	839
Intel AI protects animals with National Geographic Society, Leonardo DiCaprio Foundation	ENP Newswire	January, 2019	1081
Using AI in Malawi to Save Elephants (transcript of report)	NPR News Anchor: Dina Temple-Raston Guests: Craig Reid, Various Donzani, Lawrence Munro, Paul Chidyera, Pawan Nrisimha	April, 2020	1562
Targeted action can stem the illegal wildlife trade: technology, economics and the law must be enlisted to stop poaching	Financial Times	November, 2019	589
Science v poachers: how tech is transforming wildlife conservation	Clive Cookson	November, 2019	2299

Table 2. Overview of News Articles

3.4 Operationalization

The seventeen interviews of this study were completed in an average time of 50 minutes. For the sake of efficient and prompt data collection of interviewees in different countries, computer mediated communication interviews via the platform Zoom was used. To obtain data relevant to the main and sub-questions, the interview topics were based on beliefs about poaching, the existing challenges and strategies in protecting the wildlife and what technologies are utilized in response to these strategies.

The development of a standardized list of topics assisted in this endeavor and each topic within the list contains a mixture of descriptive and narrative questions, with

accompanying probes, to help gather answers. For example, topics include descriptive questions regarding what anti-poaching strategies are currently utilized, as well as narrative questions regarding their opinions or challenges and the AI models solutions to these problems. As there are different types of groups being interviewed, from various standpoints on technology and its affiliations with conservation, the questions appointed to each theme varied. These topic lists were ultimately grouped into three loosely structured frameworks of conservationists in the field, NGOs and technology companies. Pilot interviews were also conducted, necessitating the revisal of the interview guide before engaging with the interviewees. Notably, the questioning throughout the conservation gradually narrowed down to the main subject of AI implementation (Brinkmann & Kvale, 2015).

The conversations were guided through 4 main themes. The first theme concerned poaching challenges, for example, inquiring about the current situation in the conservation areas they are working in, and whether there are any noticeable changes in poaching statistics. The second theme comprised of questions about needed collaborations, funding and market selection. The third theme's questions were field specific. Therefore, those working in the field were asked about what management processes are utilized in combatting poaching, NGOs were asked how they support APUs in the field and technology companies were asked what their design process, challenges and successes. The final theme comprised of contributing perspectives about COVID-19 and the effects it is having on poaching.

The in-depth interviews allowed for interviewees to include interesting anecdotes, and to focus on the successes and challenges of such strategies used in the protected areas. Probes specific to the interviewees area of expertise and conservation area were utilized to establish further trustworthiness and quality in the research. For example, the probe, “if I understand well…” acts as a member check (Guba & Lincoln, 1989). The three in-depth interviewee categories in combination with the news articles provided a broad contextual analysis.

3.5 Data Analysis and Coding Process

A cross-sectional analysis of the data looked at how AI technology is embedded in conservation and what other strategies and challenges are utilized in combatting the illegal poaching. This thematic analysis method processes the data by utilizing patterns and concepts originating from the theoretical framework. Overall, this process of creating several themes was fulfilled by Braun and Clarke’s (2006) instruction of searching and identification followed by the reporting and classifying of the established data. The resultant establishment

of these patterns in the interviews and articles enables a variety of insight and production of trustworthy material (Braun & Clarke, 2006).

To divulge further into the approach taken in thematic analysis the process indicated by Braun and Clarke (2006), their six-step guide was followed. Once the material is selected, the building of a coding frame was conducted. Thereafter, the codes were segmented and a trail coding proceeded, in which categories and subcategories were created and tested within the material. Following the test, the evaluation and modification of the coding frame was conducted from which the main analysis ensues.

In conducting this research, a selection of inductive and deductive approaches can be utilized to provide the opportunity to engage effectively in the data by comprehending the most important patterns and extract more discernment from these findings (Azungah, 2018). The codes and categories were firstly defined according to the gaps and further research, as described in the theoretical framework, as this keeps the results from diverging from the aims (Schrier, 2012). Moreover, the inductive approach allowed for the collection of direct information from the content as supposed to the preconceived categories (Kondracki, Wellman & Amundson, 2002).

Atlas.ti was employed as a reliable and consistent data gathering operation. Through the initial coding process, a total of 162 codes were created which related to the theoretical framework. Thereafter, the themes and connections between codes were constructed in which the codes were filtered and cross-coded (Creswell, 2009). In order to critically assess these codes into second-order themes, the creation of axial codes was proceeded as it created further intricate associations (Braun & Clarke, 2006). Ultimately, with cognizance of the theoretical framework the themes were filtered into six overarching themes (see Appendix B).

3.6 Reliability and Validity

Noor (2008) states that examining a various number of organizations will enhance the accuracy, validity and reliably of the results. In this study, source triangulation was utilized through the cultivation of various separate conservation entities. In particular, the research incorporated interviews with several sets of stakeholders which accounted for a research design that was valid. However, constraints of time, situational and security warranted the fact that some stakeholders were unable to be reached. Hence, the usage of news reports were employed in order to bridge these gaps.

The challenge with thematic analysis is drawing valuable themes from the data without reducing insights to an insignificant level for the basis of consistent discernment (Boyatzis, 1998). Hence, the Atlas.ti tool was employed in order to enhance the trustworthiness of the results as it allowed for thorough analysis, thus, minimizing any additional errors. Furthermore, in order to gather detailed transcripts of the interviews, the interpretations of visual and vocal behavior expressed by the interviewees were noted to enhance the validity. As a result, a transparent research design was accounted for (Baxter & Eyles, 1997).

Results

The following section will address the main themes derived from the data set. These themes include Neoliberal conservation, the foundations for anti-poaching strategies, Intelligence gathering, the AI market selection, AI implementation into the field and the effects of COVID-19 on conservation.

4.1. Neoliberal Conservation

The framework of neoliberal conservation was established to be an overarching theme in the data set. Thus, in the following section the debates the way that funding is obtained, and how the surrounding communities are sustained by conservation.

4.1.1 Finances

It is noteworthy that almost all interviewees, both within the fields of conservation and technology discussed the tensions with obtaining adequate funding, yet, the extent of deprivation differed. For instance, it is estimated that the investment of reinforcement per year in places like Kruger National Park in South Africa average US$2000 per square kilometers, whereas National Parks like in Zimbabwe are maybe investing less than US$10 per square kilometer (P. Kuvawoga, IFAW). The various conservation areas additionally have different finance models, and the data revealed that these models are typically divided into the categories of tourism, donations and professional hunting.

Hellen Newell, a finance manager at Conservation Capital argues that “the challenge lies in raising the up-front capital and operating expenditure required to support infrastructure growth and business development” (Avery & Saigal, 2019). In light of the current COVID-19 pandemic shutdown, all conservationists expressed their concern in further sustainability of these conservation areas due to their vast reliance on tourists, donations and professional hunting. Therefore, the following section will address the ways in which conservation is sustained.

4.1.1.1 Tourism

A large proportion of the interviewees working in the conservation field advocated for tourism as a funding model. Within this model the conservation areas “raise venture capital to fund conservation initiatives using luxury tourism as the engine that would repay and create the revenue” (Carlisle, And Beyond). However, in areas such as Eastern Africa “conservation doesn't make money” (Wrege, ELP). This is due to fact that the tourism infrastructure isn’t there due to various conflicts that have prevailed in these countries as well as environmentally the thick rainforests make the performing of photographic tourism a more

difficult task. Central Africa has similar issues, yet Wrege (ELP) does state that they do have tourism, but it is limited and at the very high end. As a result, it is noted that the tourism model cannot be utilized with every landscape. Hence, substantial differences to the type of funding that can be implemented into anti-poaching units through tourism funding is noted.

In comparison to Central and Eastern Africa countries such as Tanzania, Kenya and South Africa have a GDP production level of up to 10% due to the photographic wildlife tourism industry and so "because a lot of tourism revenue, wildlife had become a very, very important aspect of most countries tourism plans" (Carlisle, AndBeyond). Thus, it is evident that this revenue also effects the level of the governments interest in conservation which further supports that neoliberal politics is prevalent as defence of wildlife is further enhanced through its 'profitability' (Fletcher et al., 2019).

There is also criticism pointed towards tourism operators, specifically those that are established within National Parks as it is explained that although the tourism operators pay the concession fees, they could do more to further aid the conservation areas and surrounding communities (Danckwerts, PMP; Layard, ZamSoc; P. Kuvawoga, IFAW). As a result, this insight reinforces the concern about whether the tourism industry's capital isn't being equally redistributed to all involved parties (Fletcher et al., 2019). Hence, this notion limits tourism as a pathway to 'doing good' in this context of anti-poaching, as the data exhibits that the intersection of funding for both conservation and community contributes to the decrease of poaching.

4.1.1.2 Donations

Donations are another form of funding measures for these conservation areas. Data analysis exhibits that donations typically are given from NGOs, governments, private funders and technology companies. In many cases, financial model utilize a blend of donors and tourism, and Ball (Malilangwe Trust) states that this allows for "doing things for conservation rather than for tourism, although tourism is a big part of it". The NGOs stakeholders also explained that they also provide donations or partner with other donors/ NGOS in order to provide assistance to projects and conservation areas. A variance of donation models are prevalent, for instance besides typical donations the IFAW donation model is expressed to be sustainable, by providing grants but then also raising money back off the project (Danckwerts, PDM).

Data suggests that donations given to conservation areas as well as to NGOS are often given for a specific selection of markets or can be requested to be spent on specific projects. This suggests that Eurocentric values and

4.1.1.3 Professional Hunting

It is noted that there is a variance of opinions in reference to the legal hunting of wildlife, in general its asserted that "conservation has become very polarized, particularly in Southern Africa with hunters and non-hunters" (Danckwerts, PMP). Yet, it is noted that to a large extent the conservationists in the Southern countries of Africa recognized that there is a need for professional hunting fraternity to be maintained. A staggering statistic explains that "more than 75% of South Africa's wildlife protected by hunting, if we take hunting out of the South African context, we lose 75% of our biodiversity. That cannot be good" (Carlisle, AndBeyond). In order to further decipher the meaning behind this 'protection', in some cases conservation areas aren't suitable for photographic tourism, or the market for further tourist operations isn't available, therefore the alternative of professional hunting is then utilized for conservation purposes. Hence, without this type of funding being implemented into these conservation areas, the concern is that they will be replaced with the likes of mines and deforestation (Danckwerts, PMP). Hence, it is evident that value through hunting is garnered, as the data reveals that it can provide economic incentive for the conservation areas and surrounding communities, which supports theory that professional hunting is argued to be a form of 'neoliberal environmentality' as Koot (2019) asserts that it brings an array of economic incentives.

4.1.1.4 Legalize the trading market

A controversial and sensitive topic is one relating to the legalizing of the sale of rhino horn and elephant tusks in Africa. Overall this discussion aligns with the principles of the commodification of wildlife (Fletcher, 2010). It is noteworthy that whilst rhino horn grows back about four inches per year, other valuable (illegal) wildlife commodities from Africa include elephant tusk and pangolins scales, and so to obtain these products the animal has to be dead. Therefore, this argument doesn't apply to all the animals that need to be conserved. To illustrate the process of legally commodifying rhino horns, the current strategy of de-horn rhinos for anti-poaching purposes could thereafter include the horn being sold, as further described by Jacobs (Rhino 911):

"That is my personal belief. Why? We owe it to the animals to at least try to lift the ban, try the trade. Can you imagine if we start selling horns in South Africa. People will come out of bankruptcy and start breeding with the animals with a passion. Because at this stage it's a liability. It's not an asset

anymore. The rhino is worth $10,000 but it's horn? It is worth $180,000. That same rhino, the heart that's beating is worth $10,000 but the horn is worth $180,000." (Jacobs, Rhino 911)

Therefore, the proceeds could be reinvested into conservation and so this debate supports the neoliberalist biopower notion of the ideology that the preservation of the animals is ultimately due to their value (Fletcher, 2010). Nevertheless, in many of the Southern African countries they have large ivory stock piles and Mufute (AWF) explains that although there is debate that it could advocate for further poaching, as an opposing argument the selling of the stockpiles can be invested back into wildlife conservation.

Once again, it is expressed that this divergence in opinion is also attributed to the outlook from various countries, for example, it is explained that the southern African countries have a more positive view towards the legalization of the trade, whilst countries like Kenya aren't (Mufete, AWF). This notion is supported as CEO of Big Life Foundation in Kenya raises his concerns with flooding the market in stating that previous sale of ivory just caused the buildup of stocks in Asia and so it can be ascertained that this sale didn't substantially decrease the price of the ivory nor lower the market demand (Bonham, BLF) . Hence, there is a point to be made in the countries having their own autonomy when it comes to deciding their own decisions for legalizing the trade. This is another powerful ethical dilemma which clashes the history of colonialism and western paternalism vs.the reality of high levels of corruption/cronyism and the universal ethics on animal cruelty and the virtues of diversity/conservation. This is exhibited where the international community, in particular, CITES was often brought into the discussion, as in the analysis of the interviewees responses there was a number of them that question asking if the ban on trade for the past 30 years has actually saved the rhino and elephants.

Yet, in reference to the African government handling this type of syndication, the challenge of governmental corruption is questioned as "will it be done transparently? Will it be done according to the rules that they (the government) put in place?" (Layard, ZamSoc). Therefore, outlining the pros and cons, it is noted that this legalization has its variance of perspectives and that whilst neoliberalism has been so heavily critiqued but the marketization of horns/tusks and sustenance of animal life, the community life cannot be easily dismissed.

4.1.2 Natural Capital Accounting

It is noted that communities buffering the conservation areas experience conflict with the conservation areas and so a transcending theme from the conservationist and NGO stakeholders is there is a need for positive community relations. In order to improve these

relations AndBeyond integrated their development with the local chiefs and created community development committees (Carlisle, AndBeyond). This notion is supported by Avery and Saigal, (2019) who discuss success in treating the surrounding communities as partners. Nevertheless, wildlife conflict and poverty is typically described by the majority of the data to influence the prevalence of the communities poaching. Hence, it is noted that the communities must benefit and find other means of income from conservation, in other words natural capital accounting (NCA), and so it is noted that the boundary fences that are prevalent in many reserves must be "economically permeable" (Carlisle, AndBeyond). Thus, this challenges Adams (2019) theory that power resides in its exercise "over both nature (keeping species and ecosystems within specific bounds in terms of state and location) and humans (determining who may take, kill or transform non-human lives and spaces)"

Various NCA initiatives were mentioned such as tree planting and vegetable gardens (Carlisle, AndBeyond; Layard, ZamSoc). To illustrate another NCA initiative, in the Mbire district of Zimbabwe the buffering community farmers are encouraged to grow chilies. Mufute (AWF) explains that the chilies "are used to scare elephants, to chase away elephants, but at the same time, the farmers themselves make a reasonable income from growing chili." As a result, the communities can then generate their own income and so ultimately in the future there'll be no need for donors. Mufute (AWF) explains that these types of projects need the initial injection "but long-term sustainability would be guaranteed". Nevertheless, it is evident that as this is a recent project the remaining question is if this will be the case. Thus, these results establish further findings in the promotion of economic valuation in Africa's conservation proving that convivial conservation' is utilized (Buscher, 2019).

The reasoning behind IFAW focusing on aiding Africa and Asia, is that these continents will in the future see the largest increase in populations growth, contributing to pressure on the land (Kuvawoga, IFAW). Hence, due to these growing populations, Richard Bonham (BLF) states "we got to secure as much wildlife habitat as we can because in Kenya in 1962 we had, I think 3 million people and today we have 50 million". Proving that this conflict over land usage from the buffering communities as well as the contributing wildlife conflict is far from over and so solutions need to be found. A success anecdote that uses this type of partnership is discussed by Carlisle (AndBeyond) as he explains:

"We have amongst the highest density of communities neighboring a park anywhere in Africa and we have amongst the highest density of wildlife and we have amongst the lowest poaching and that's a direct result of care of the land, care of the wildlife, but most importantly care the people."

Hence, Carlisle (AndBeyond) attributed the success at AndBeyond, to their three pillars of care and names the care of the people as the cornerstone of this framework. Carlisle (AndBeyond) identifies that the aspects that their management techniques address the human-wildlife conflict that the buffering communities face as well as the fact that they must also derive economic benefits from the wildlife that they live with. Hence, this engages with long term sustainability as a discourse which Fletcher et al., (2019) asserts that in actuality this strategy provides little finance to the communities. Hence, although the conservationists describe NCA projects, they still further explain that other community projects in the conservation areas are funded. For example, the projects named in the data analysis range from clinics, fences, water supply, education, livestock husbandry, agricultural development and job creation. Hence, this supports the notion that substantial funding is still needed to be provided to the communities, raising the question if these communities can ever be sustainable (Fletcher et al., 2019).

4.2 Foundations for Anti-Poaching Strategies

The following chapter discusses the contributing factors which are described by the interviewees and textual analysis of the successes and challenges of countering wildlife poaching. These factors include quality infrastructures, means of transportation, proficient management techniques and disruption of trade. One of the prevalent arguments transcending the data set is one in which there have to be a series of foundations laid before any extra AI technologies are put into place. For example, Danckwerts (PMP) states that:

"where my skepticism lies is I think 90% of areas, and those areas are where the problems are, are not ready for it (AI technology) because they don't have the, the resources, the training, the manpower to actually physically react, you know?" (Danckwerts, PMP)

Hence, this skepticism exhibits the issues with implementing AI technologies in that majority of the current conservation areas aren't ready for the technology. Furthermore, the training and comprehension of such technologies is an issue as Mufute (AWF) explains:

"They can know big data and so forth. But like, it's all, it's all very abstract. They don't relate to it because … they have not reached that stage where they appreciate was it does, because even their own laptop, they don't fully utilize it, because they don't have the skills." (Mufute, AWF)

It is evident that even some of the simplest tools aren't implemented in these conservation areas and so a lot of training has to be conducted with even basic technology and so the uptake is slow. Therefore, this insight suggests that that usage of the technology is then redundant if the basics foundations aren't in place. Moreover, the cost of these technologies is raised, and this notion is explained by Ball (Malilangwe Trust):

"There's a... Quite a big tendency on a lot of places to, to mis-spend money, … if you haven't got your basics right, I'm not against technology, but if your basics aren't right, then you're wasting your time" (Ball, Malilangwe Trust)

Thus, it is evident that finances, once again, is the prevailing issue as it is additionally explained that even if the technology is available, the park might not have enough resources to manage the technology or enough rangers for a large increase in enforcement (Cookson, 2019). On the other hand, it is noted that if donations of this type of technology are provided,

the extra implementation of technology is still welcomed. For instance, all of the conservation stakeholders further stated that if the technology was sponsored or donated, they would still strive to implement it. As a result, it is argued that a holistic view of conservation practices must be harnessed as explained by Mufute (AWF):

There needs to be a lot more investment, but the investment should not look just at one side. It should look at it from a holistic side so that it's all complimentary. You improve this area, but also look at what the ultimate goal is, support the other areas to get that result, which you're looking for." (Mufete, AWF)

This notion is further supported by Savory (ACHM), who states that technology must be "tested within the context" as this form of management style "ensures that we test that every decision or actionable policy is leading us towards that context; socially, culturally, and environmentally".

4.2.1 Infrastructures & Transport

It is noted throughout the data analysis that there needs to be sufficient roads, fences, buildings and communication infrastructures in place in order to effectively carry out anti-poaching patrols. In some cases, interviewees express the success in their current infrastructures, in others cases interviewees express the challenges of lack of infrastructure and the future infrastructures that they therefore want to implement if funding permits.

Roads are one of the most important infrastructures emphasized when raising issues with patrolling effectiveness. The NGOS, emphasize the need for these improvements in the National Parks. For example, Kuvawoga (IFAW) gives an illustration of the prevailing issues facing Hwange National Park before IFAW took over infrastructure management in which they had to rehabilitate the road networks:

"In terms of road network the areas is, sits on deep Kalahari sands. So to drive from Main Camp to Makomo it was taking the rangers about four hours. I think 90 kilometers or so. So imagine you receive a phone call, or a radio they've been an incursion there are poachers in the area and you need to pull from Main Camp, it is going to take four hours before you get to Makomo. And I don't know how many more hours to get to where the actual problem is."(Kuvawoga, IFAW)

These statistics are staggering, and according to Philip Kuvawoga, the newly constructed roads thereafter decreased the travel time to one and a half hours. Amongst the interviewees, White (RC) who currently works for conservation areas in 15 countries, noted

that “the number one thing everyone wants is, is a vehicle”. Air support through the use of planes and helicopters on some reserves is also implemented into anti-poaching efforts (Bonham, BLF; Jacobs, Rhino911). For example, the NGO Rhino 911 provides the infrastructure of a small Robinson 44 helicopter in the Northwestern Province of South Africa in order to “give air support in terms of any game farm incursions of poaching incidents” in the form of detecting suspects and air lifting APUs to drop them off at the scene of the crime (Jacobs, Rhino911). Thus, it is evident that funding for infrastructures and transport is significant as it effects the execution of a patrol to a large extent.

The data exhibits that the quality of the building infrastructures if often lacking and if prevalent it consequently improves the rangers morale (Ball, Malilangwe Trust). Other building infrastructures include special operations/ ranger stations, these are points of where data gathering is conducted. Typically the private reserves had these stations, whilst government run National Parks are in the process of building or are hoping for future implementation. One of the infrastructures necessary for these operations rooms is a form of communication networks. These networks are described to provide “better communications between the teams and the command centers” (P. Kuvawoga, IFAW). However, often in these conservation areas in Africa, there is no cellular network. As a result, “poor network coverage and the huge cost of infrastructure has hamstrung the rollout of even basic telecommunication services in some remote habitats” (Perry, 2019). Overall, the technology companies interviewed noted the differences that these forms of infrastructures provide, as a form of communication is often the foundation of AI implementation.

However, there are challenges linked to this provision, for example in Zimbabwe often the batteries to the radio masts are stolen (Layard, ZamSoc). Although certain types of technology need specifically mobile coverage, issues can also come this type of coverage as explained by Layard (ZamSoc):

“*is actually a double edged sword because if there's mobile coverage in an area that there could be poachers they can definitely use that… I mean, I know for a fact that one of the contacts between our rangers and poachers, I know of a couple of years ago, they met in a particular area where there was a known spot for some mobile coverage and they bumped into each other.” (Layard, ZamSoc)*

Therefore, this anecdote illustrates the issues that the implementation of such infrastructures encompasses. Therefore, insights as described above need to be considered if the implementation of such communication infrastructures is needed.

4.2.3 Anti-Poaching Unit's Approaches

A gap in the research is the comprehensive understanding of how and why this violence is performed, resisted and/or negated, disseminated. Furthermore, investigation as to how this violent environment will impact the effectiveness of the different actors and technologies in combatting poaching is additionally essential.

4.2.3.1 Rangers Challenges

It is noted that in many cases the basic amenities is something that isn't often afforded for the rangers. For example, the NGOs explain that their donations includes uniforms, shoes, camping equipment and other basic equipment. It is evident that the rangers can often work under difficult circumstances and moreover, in particular under government management, the rangers hardly receive any pay. Whereas, the privately run and privately managed reserves express overall success rates in reference to their rangers working conditions and pay. In particular, Ball (Malilangwe Trust) states that two thirds of their budget is salaries as the "budgets for security is about $750,000 per annum, to eight hundred". Therefore, it is evident that this makes for a vast difference in comparison to government led National Parks.

It was highlighted also in the interviews that rangers work under difficult circumstances as during patrols they not only encounter dangerous wildlife but also poachers are noted to often be heavily armed. The poaching syndicates are described as "proper military operations" where "guys would be armed with military assault rifles would not hesitate to engage our rangers on the ground" and so most conservationist stakeholders, call this an anti-poaching 'war' (Layard, ZamSoc). It is noted that this shoot-to-kill topic was very sensitive as most interviewees weren't too comfortable to answer, nevertheless, the general consensus was that "people can criticize but the ranger has literally got seconds to make a decision and it's a potentially life threatening decision. Thereafter, the ranger still has to prove in that it was done lawfully. Hence, although the shoot-to-kill policy necessitates scholarly debate and controversy, it is evident that these situations, especially in the environments that the rangers are in is challenging. Thus, this violence justifies the policy which correspondingly reinforces militarized conservation (Messer, 2010).

4.2.3.3 Translocation

Translocating wild life is another strategy conducted and amongst various types of wildlife that have been translocated, rhinos and elephants have been translocated to new areas for anti-poaching strategies as it is argued that it spreads the level of risk (Carlisle, AndBeyond). On the other hand, Ball (Malilangwe Trust) also explained how they translocated have translocated rhinos into Botswana and other Zimbabwean conservancies

but some of them have been already poached. Ball's (Malilangwe Trust) response was the following:

"It's just, it's a tragic story, and in a way, it's irresponsible of us. It all looks good and it's a big story, but it's pointless sending rhinos to their death. We need to be more professional in the way that we handle those sorts of things. To go there, check the security and say, well no, we're not happy. And I mean, we, we gave them for nothing, we gave them to them to try and get another population going. They're actually talking now about moving the rhinos out of the area where they were. So it's an absolute disaster." (Ball, Malilangwe Trust)

As a result, this shows that translocation practices have to in the future take detailed cognizance of the conservation areas that they are going to translocate their wildlife to in order to assure that the wildlife is protected. Further translocation projects includes NGOs such as Rhino 911 who help facilitate the translocation of orphaned rhinos to a secure rhino orphanage, or the Panda Masuie Project which re-wilds orphaned elephants (Jacobs, Rhino 911; Danckwerts, PMP). As a result, all of these translocation projects are necessary to react to the prevailing poaching of wildlife and as a by-product venture to further protect these endangered species.

4.2.3.3 Conservation Management Techniques

As all interviewees work for, aid or provide technology for various types of reserves and parks there are decidedly different types of park management. The data reinforces this ideology, for instance Ball (Malilangwe Trust), supports this statement in stating:

"*You know, it's interesting, every way it's different. Even within Zim(babwe), everyone has a different way of doing things. Everyone has a different angle." (Ball, Malilangwe Trust)*

Ball's (Malilangwe Trust) recognition of these different angles is noteworthy to take stock of how they affect the anti-poaching strategies. This notions supports scholarly ideology that anti-poaching strategies are multifaceted and complex with no one-fits-all solution Ajjaz (2017). Ball (Malilangwe Trust) explains how "so many places in Africa tend to have that old colonial way of managing staff, and pay them very little and expect them to, to get shot at and, and I know they generally get treated not well." According to the analysis of the data, the interviewees working in a form of private park, or where the National Park has the capacity of a form of private control of management, or a private anti-poaching unit, there is a distinct reportage of less poaching issues. Furthermore, Van Dam (Smart Parks) whom

provides technical support for the ‘African Parks’, a company that signs public-private partnership agreements with National Parks, also explains that they are well protected and there are no reports of noticeable incidents.

On the other hand, other protected areas such as National Parks, run and managed by government institutions and have NGOs’ to aid and support are noted to a larger degree have currently have less of a control over poaching. Gary Layard explains the management technique in stating “We can make suggestion but there's a fine line between kind of telling parks what to do and making suggestion.” (Layard, Zambezi Society).

4.3 Means of Intelligence Gathering

Intelligence is noted to be a vital element to anti-poaching strategies. The fundamental challenge that persists is the internal politics of a conservation area wherein intelligence leakage begins within the conservation areas itself.

4.3.1 Anti-poaching patrolling techniques

Data gathered exhibited that in general patrols focus on similar techniques, and that the types of technologies implemented into the conservation areas effect the patrols to a large extent. Insights reveal that often there aren't enough rangers to cover the areas and lack of funding is often to blame as it the lack of rangers also effects the efficiency of preventing bushmeat poaching as "less ground covered and so that's more snares you're missing" (D.Kuvawoga, PDC). Therefore, this highlights the case if AI technology will supplement these shortfalls. It is described that "most intel on game reserves is gathered on foot by rangers in difficult and dangerous terrain" (Perry, 2019).

Strategies can be influenced by the following "the rangers don't randomly go to places, they choose where they go based on their understanding of the poaching pattern" (Fang, Carnegie Mellon). Being dynamic is also a factor as explained by Kuvawoga (PDC):

"We don't have a strict schedule. We mix it up a bit so that there's no routine to it that the poacher might now come to know that, they are in at eight and out at three, so we are doing day patrols, night patrols, double patrols per day. it's mixed up. A patrol member has his job is to go there, walk his distance, make sure there's no snares and get back." (D. Kuvawoga, PDC).

Hence, this notion of being dynamic is interesting, as it raises questions as to whether AI also be dynamic and can it function intelligently in terms of the kind of dynamism needed. Nevertheless, all of these patrols include rangers having to covering these expansive areas and so challenges is raised by Kuvawoga (IFAW) in saying "I think 20 years from now, 30 years from now, you to be very difficult to hire a ranger who walks 10 kilometers every day to check on the fence boundary." This is a valid argument, and so one has to question to what extent the implementation of technology can assist in this manner.

Dogs are additionally currently being utilized for anti-poaching strategies, including the conservation areas of the Kruger National Park, Painted Dog Conservancy, Gonarezhou National Park, and Ol Pejeta. David Kuvawoga (PDC) explains that the dogs are utilized to incite fear, aid in patrols, and currently they are being trained to detect copper snares. Malilangwe Trust is currently in the process of implementing dogs too, these dogs will be

used in the detection of poachers at the fence boundaries as well as tracking the poachers inside the conservancy (Ball, Malilangwe Trust). Although these dogs are described to be expensive to buy and train, success will be in "it just a lot faster than human tracking, although our guys are really good at tracking, it's a lot quicker" (Ball, Malilangwe Trust) All patrolling techniques described are purposeful and practical, yet it is noted that there are various features that need to be regarded within this capacity. Therefore, when technology comes in competition with funding communities, dogs, helicopters, roads, vans, higher salaries it makes it far more challenging in terms of it being a simple decision to fund or not in terms of "intelligence".

4.3.2 'High' – level Intelligence

Intelligence is noted to be a vital element to anti-poaching strategies. What constitutes as this form of 'intelligence' is that scholars call it 'high'-level intelligence in which the processed information about poachers can assist in crime prevention and criminal apprehension (Cowan, Burton & Moreto, 2019). The fundamental challenge that persists is the internal politics of a conservation area wherein intelligence leakage begins within the conservation areas itself. It is described that "90 to 95% of poaching comes from within your property" (Ball, Malilangwe Trust). Moreover, Ball states that in his case his rangers have been approached by poachers, but they reported back, and attributes this honesty "because they're well looked after" and this is where the success resides in keeping rangers from becoming informers themselves. Difficulties that the game rangers also face is that the areas that they cover are expansive and so "to have people, Scouts, walking around looking for poachers, there's no chance, you're one, a one in a million chance of bumping into poachers unless you have intelligence" (Ball, Malilangwe Trust). As a result, at Malilangwe Trust it is described that they have a 98% success rate of apprehending poachers and expresses that it is largely due to intelligence (Ball, Malilangwe Trust).

Philip Kuvawoga (IFAW) further emphasizes that "it's a very dark hole, but we know it's very important because, it provides for strategic, deployment of rangers, especially at checkpoints, road blocks, at ports of exits and entry". Furthermore, a general theme is in the capacity of further enforcement from the government, for instance in South Africa, Jacobs (Rhino911) describes a need for intelligence gathering to be accelerated by means of detailing the trends of people coming in and out of National Parks in order to ascertain further knowledge about the poachers.

Intelligence is largely attained from the bordering communities of the conservation areas. The process is as follows “those people would be undercover people who gather information, report information through a secure channel to us and if that information yields results, then they get paid their award” (Danckwerts, PMP). Thus, in order to manage and create these networks, rewards are needed to warrant the provision of such information, and many interviewees state that this is costly. Therefore, it is evident that the accumulation of intelligence will only go as far as the funding allows. Thus, NGOs describe that they often necessitate the provision of funds. Hence, it can be argued that AI is subservient to these informant networks that are to a certain extent more sustainable and more ‘on the ground;.

Nevertheless, working within the community to create intelligence networks also has its challenges, as David Kuvawoga describes in the villages around Hwange National Park they have challenges, especially in terms of bushmeat poaching. He explains:

“*We haven't had a lot of success with that because of the nature of these communities. The communities are, made up of people who are related. It's not, you know, your neighbor is from another area et cetera. Your neighbor is your brother, you neighbor is your child. So they tend to protect each other that way. It's just how it is.” (D. Kuvawoga, PDC)*

This is a counter argument which makes the case for AI as the challenges that prevail are also terms of socio-cultural aspects of the communities. Hence, it can be argued that in your information networks, its not individuals that make the notes but entire communities should be looked upon as a singular unit and reward systems should be designed with that in mind. In order to enhance these relations it is highlighted that rangers should be hired from the communities too, as it positively effects the communities view of the conservation area as it “gives one a strong informer network because they're all linked to their families” (Bonham, BLF). This notion is supported as Kuvawoga (PDC) stated that there is animosity towards the rangers as ZimParks didn’t choose the majority of the rangers from the surrounding communities.

Overall, it is highlighted by most interviewers that it is fundamental that through all of this intelligence gathering, there needs to be some form of cooperation, or an integration of intelligence systems transcending over the boundaries of various protected areas. Bonham explains the issues that prevails from this becoming a reality:

"Then sharing of data, um, I think could be taken a hell of a lot more seriously for everybody's advantage often very difficult to get data from other people working in the same landscape. Some are better than others, but there could be a great improvement on that level." (Bonham, BLF).

Thus, it is evident that the issues of collaborations and security of this sensitive information is a prevailing problem. In support of the gathering intelligence it is argued "for me, it always comes down to intelligence that will win this war" (Layard, Zambezi Society).

4.3.4 Basic Non-AI Technology

In general, the most basic non-AI technology that is currently being utilized by all conservation areas are analogue radios and GPS. In some cases, this technology wasn't even originally made readily available to rangers until NGOs donated them. For example, Mufute (AWF) explains how some rangers are still "using pens and paper, there was very little technology being used in terms of anti-poaching work." As a result, Mufute (AWF) explained that in these areas AWF donated basic technologies to be implemented, and these included radios, ICT equipment, cyber trackers and laptops.

Challenges utilizing his helicopter include that it isn't large enough to carry rhino orphans that are larger than two months old, and if it were bigger it would allow the capacity for more rangers to be deployed during urgent deployments. Further limitations include the technology capabilities of Jacob's (Rhino911) helicopter as it doesn't have night vision and thermal capacity to enable him to fly at night, which is a time when poachers usually mobilize. Therefore, it's not just any technology, but its about appropriate technology. Yet, Bonham (BLF) states that besides the fact that this technology is expensive, "the only problem that we've experienced with its normally very sensitive equipment and very delicate, just by nature what it is, so it tends to have quite a short life expectancy." Hence, it is evident that this supports the theory that technology suffers from 'pilotitis' where the selling of new technology is integral to testing new tech in communities and that is an end in itself, as a result there is a graveyard of applications and technologies as they are not built to be sustained and to be integrated (Arora, 2020).

If conservation areas in Africa have Special Ops Rooms, they are typically run by Earth Ranger. They utilize Kinetic Six, which is an organization that does radio networks and then the data is integrated onto the domain awareness system (DAS). It is argued that in Malawi at Liowande reserve Earth Ranger help deploy rangers more efficiently Using AI in Malawi, 2019). On the other hand, the method of log books is still widely utilized, as Ball (Malilangwe Trust) explains:

"As I say, we try and stay away from anything too fancy. Scouts have log books that they fill everything in. Very basic log books and it's very accurate. And you obviously have a record of it for years, we've got log books going right back 24 years. All that data is captured onto, we have two technicians, who are capturing it all onto the database." (Ball, Malilangwe Trust)

This is an important argument revealing that 'old technology' can be more sustainable than AI enabled tools in the sense that it has low skills barrier of entry, less breakdown and repairs are needed and in places where electricity is unreliable it is especially a useful tool. As this private trust has such a high anti-poaching success rate, this is evidence that one can be successful without technologies such as Earth Ranger. On the other hand it is argued that the updating of technology systems will improve antipoaching systems as Jacobs (Rhino 911) further explains:

"With a proper placing of radar, a helicopter with unlimited flying time, monitored fences... Better electrified fences, thermal cameras on the fences, radar systems and a four pilot team that works eight hour rotating shifts. I'll decrease it for you by 80% but... So I'm answering to say it's a financial issue…" (Jacobs, Rhino 911)

This anecdote reveals that what inhibits the proficiency of anti-poaching technologies is the funding of all other conservation systems. Overall, it is evident that AI alone cannot be worth the investment, as it has to come with an ecosystem of technologies that span the old to the new such as roads, and vehicles to log books. Furthermore, socio-cultural interventions like higher salaries and community trust building. Hence, the data set reveals that without these foundations, AI by itself is positioned to fail.

4.4 AI Technology Market Comparison

Feola (2015) discussion that "communicating priorities, engaging stakeholders and sharing best practice," in this case with new technology, is vital in order to share (p.525). However, it is argued best practices should come from real world institutional innovation and reform and not a test pilot project that is artificially designed to serve as a buy in for capturing markets (Arora, 2019). The following chapter provides an outline provided from the data set of the AI technology for conservation market, which are separated into the five themes of PAWS, Acoustics, Cameras, Drones and Sensors. Specifically within this outline the following factors are addressed, including the selection of markets and economic sustainability, AI design and capabilities, and in field successes and challenges. Therefore, this chapter addresses the following technologies.

4.4.1 PAWS

PAWS is described as a predictive tool which "can give us information about where in these vast Park areas there is highest or higher possibility of finding illegal poachers" (Gholami, Microsoft). Hence, the machine learning algorithm focuses largely on the past poaching efforts to predict future poaching hotspots. Additionally, "it can also help them to save their energy and time in planning the patrols and conducting the patrols." (Fang, Carnegie Mellon). As previously mentioned, PAWS principally utilizes the data from SMART, which gathers historical data "but it does not have any capability to analyze the data or try to provide insights to the Conservation Area managers" and so this is where PAWS bridges that gap (Gholami, Microsoft). Further data supplementation includes "geospatial features around that protected area, including the roads, rivers, elevation data, and even the location of the villages nearby" which is thereafter digitized by the PAWS organization (Fang, Carnegie Mellon). Van Dam (Smart Parks) raises the issue of gathering quality data which can therefore effect the patrols as the algorithms are "dependent on the quality of the input of the data".

4.4.1.1 Selection of Markets & Economic Sustainability

The stakeholders explain how PAWS has been successfully pilot tested in the National Parks of Uganda, Malaysia, Cambodia and China. Out of the interviews conducted, none of the conservation areas use the SMART system, although namely ZamSoc, AWF, PDC, IFAW and PMP are looking to implementing SMART in the future. The general consensus is that the uptake of the SMART technology is slow due to many different factors such as funding, training and ranger proficiency. Nevertheless, SMART is currently being

used “by more than 600 conservation sites worldwide” some of which are in Africa, and so this partnership with PAWS allows for ease of implementation of the PAWS algorithm (Fang, Carnegie Mellon). As of May 2019, the PAWS and SMART partnership is being tested in a production environment and then will be implemented at a large scale of all other SMART systems” (Flickinger, Microsoft). Hence, it is important to note that in this AI technology is now at the capacity and in the future will be scaled to the entire market of conservation.

4.4.1.2 AI Design & Capabilities

In order to utilize the data provided and to predict the poaching areas, machine learning and game theory integration is utilized and Fang further states that PAWS tries “to use more advanced techniques like using neural networks, to actually boost algorithms and others to improve our machine learning algorithm that does a prediction.” (Fang, Carnegie Mellon). Additionally, PAWS provides “heat maps so that the rangers can see which locations have higher risk, which locations have you know, lower risk of illegal poaching activities and so they can just, you know, direct their park rangers in a better way” (Gholami, Microsoft). Fang (Carnegie Mellon) explains that they also have previously send Rangers on “these planned patrol routes, and, sometimes we convert them into a format that can be directly imported to their handheld GPS.”

Microsoft has provided their data science expertise which has enabled the process of providing expertise to the different model modules scaling up PAWS so that it could be deployed into the real world. Flickinger (Microsoft) explains that his work of creating docker images, API platforms and stitching of the modules allows for a scale up of the PAWS research to several different locations with less prevalence of code breakage. As a result, this process is described as “extremely valuable” as it has allowed for the research labs that developed the models to then deploy the results to be integrated into the SMART platform (Gholami, Microsoft). Furthermore, it is noted that as there are differences across different sites difficulties prevail such as “it's very difficult to come up with a Machine learning model that it is a scalable for any possible size in the future, so it's highly possible that the codes will break right because we cannot fully automate everything easily”.

4.4.1.3 Success

PAWS pilot tests in the field were described to be successful. For example, in Uganda’s National Parks the machine learning algorithm successfully predicted the poaching hot-spots “the catch per unit effort, meaning the number of snares being found per kilometer walking in the high threat area, is 10 times higher than that in the most low threat area”

(Fang, Carnegie Mellon). Furthermore, PAWS additionally led the rangers to a poached elephant and countless snares that hadn't been deployed yet, exhibiting further success.

4.4.1.4 Challenges

As poor internet connections is prevalent in National Parks in Africa, in response to these kinds of factors, Flickinger (Microsoft) explains that they are taken into account where:

"The PAWS API's and the backing infrastructure is set so that when someone goes in and they can kick off an inference. Then they can return to it later on and retrieve results if needed. Additionally, it can stay into the end Azure Storage indefinitely and they can return to it when they can." (Flickinger, Microsoft)

Yet, internet capabilities still need to be implemented in order to utilize PAWS and so Flickinger (Microsoft) explains that "this will be the next phase of the project" in creating an application that can be utilized offline. Nevertheless, WCS is also handling this aspect of implementing communication networks in these conservation areas too. This seems perverse to provide internet connectivity to vast, almost uninhabited by humans national parks, while the cities in Africa for the most part have little internet connectivity (Jerimiah & Umeh, 2019).

Other challenges include that sometimes the rangers routes are not properly designed as of yet (Gholami, Microsoft). In the future, the PAWS team are looking towards making automated patrolling routes for the rangers as it is described that in addition to prediction strategies, prescription is also important (Gholami, Microsoft). Nevertheless, it is questioned if human capability still surpasses AI patrolled routes as Van Dam (Smart Parks) states "I think the human capability of good planning is still way exceeding the capability of AI at the moment, but then again, it will at some point be that AI is smarter".

4.4.2 ACOUSTICS

There are two organizations that utilize acoustics and AI are the Elephant Listening Project (ELP) and Rainforest Connection (RC) which utilize these systems in National Parks whose flora is typically Rainforests.

4.4.2.1 Acoustics: Selection of Markets & Economic Sustainability

The ELP's work is focused in Africa and has previously worked in rainforest conservation areas in Gabon, but due to political issues the project moved to Democratic Republic of Congo (DRC), Cameroon, Central African Republic (CAR) and Tanzania. It must be noted that the ELP doesn't work with APUs directly, therefore, Wrege (ELP) states

that the interface with the rangers is trying to measure their impact or help with where they could you be more efficient in patrols. The funding for this project mainly comes from US Fish and Wildlife Service of the US government and other private donations (Wrege, ELP).

The RC is currently in 15 countries around the world, at one point the RC was previously working on a project in the Cameroon and, in the future will hopefully be starting projects in the DRC, Gabon, Tanzania and Ghana (White, RC). The RC is a nonprofit organization, and the technology is quite economical as in order for the acoustic data to stream continuously for 24 hours a day costs about $10 a month using existing cell phone networks (White, RC).

4.4.2.2 Acoustics: AI Design & Capabilities

The ELP and RC both have differing acoustic systems. ELP works without cellphone networks and currently is working on technological advancements in reaching the capacity of real time, whereas the RC works in conservation areas that have cellphone networks and so offer real time data. For both ELP and RC the custom designed acoustic technology is erected in the trees, so it can monitor all variables applicable to poaching including animal noises, gun noises and chainsaws. This process as incredibly dangerous as not only do the trees need to be climbed but also to monitor or service the grid, the team is on 21 to 25 day long mission in the forest, as a result “when they're 10 or 12 days into the forest, if somebody got hurt, it would be almost impossible to get them out” (Wrege, ELP). This is an Important point, as when we speak about technological “maintenance” it seems rather benign and often framed as a sustainable issue in terms of planned obsolescence, but this adds another level which makes maintenance deadly.

The ELP and RC both utilize AI technology in order to process the acoustics by “going through the massive data and filtering and filtering out the stuff that we don't need people to pay attention to” and detect the certain sounds acquired (White, RC). Furthermore, the ELP collaborates with Amazon Web Services and Microsoft Azure for cloud capability and Conservation Metrics for the machine learning design, whilst the RC utilize their own cloud and machine learning algorithms (White, RC; Wrege, ELP).

On the other hand, due to the fact that the RC acoustic technology uses cell phone networks, the resultant effect is live streaming, the real time responses and the corresponding added benefit of software tools “allow people to review data systems for them to respond support” (White, RC). Additional capabilities with the RC acoustic technology include a ranger application that can be utilized on a smart phone. Therefore, when rangers gets an alert, they can pull up the sound and review the sound for themselves so it enables the rangers

to choose whether to respond or not (White, RC). Topher further explains the promise of this application in that:

"it may seem like it's just a feature, but it's actually critically, critically important, because, A), we need everyone out there to be telling us if the data is incorrect. And if it was -- the worst thing you can do is send somebody off to respond to something if you were not like exactly 100% sure that there's something there. Because you only get that you only get to do that like once or twice before they, before they find more excuses not to respond." (White, RC)

Important in building trust with technology as it effects how people adopt new interventions all depends on the initiation at the start. Interestingly, with the RC technology no data is stuck on 'the edge', which is typical of most AI technology processes, and so White (RC) explains that this is effective as "everything's available to us at all times for retraining, for other uses and for really pretty massive analysis". As a result, it is evident that human cognizance and social-cultural factors are included in the design of this technology.

4.4.2.3 Acoustics: Success

As an example of success, Wrege (ELP) stated that although he needed a bit more acoustic data to confirm his findings, he is able to discern that there has been a decrease in poaching in the DRC rainforests and so there is success in the APU's effort when carrying out effective patrolling routes. Furthermore, the successes of detection with the RC technology is evident, for example, at the beginning of his project in Sumatra ,they actually caught loggers on the second day where "they redacted the alert and they got out there and they stopped the loggers" (White, RC). This establishes that other anti-efforts like anti-logging can further benefit from these initiatives.

Moreover, both organizations explain the need and success in local implementation. For example, Wrege (ELP) employs 3 Congolese scientist from his project, and explains that:

"I think we need to build, we need to, to help create conservationists that are nationals of the countries where these things are happening… right now I have a fantastic group of, or a team of three Congolese guys who basically run that whole project now." (Wrege, ELP)

As a result, one can note that this type of project has been successful, and has also interlinked technology and conservation together in a format that has an impact on local livelihoods too.

4.4.2.4 Acoustics: Challenges

The main challenge noted is the lack of cell phone signal in many conservation areas in Africa, as White (RC) points out "there were assumptions about cell phone service, didn't work very well in Cameroon at all, learned a lot about how these things can, can operate there, learned a lot about the way in which we were building the API." In terms of success of using acoustics without cellphone service Wrege (ELP) states that it's frustrating of gaining the data, that isn't in real time, making it not applicable to current poaching circumstances. Nevertheless, Wrege (ELP) states that the success is coming, but it's not quite there. Therefore, it is evident that there is a lot of design and intended changes to be made in order for the acoustic technology to be utilized in real time in the African rainforests.

4.4.3 Cameras

There are multiple (non-AI) camera systems that are on the market and which are being utilized in protected areas. Specifically, a main challenge with these cameras are that only "until recently these had no wireless connection, so their operators had to physically visit each one to remove its film and later its electronic SD card, which was often full of useless images of moving branches or other wildlife that had triggered the trap" (Cookson, 2019). TrailGuard AI has sought to amend this challenge as it acts as an early warning system, in which APUs can be fully mobile and rapidly respond to poaching incursions in the protected areas (Immersat, 2019). The stakeholder for this technology was unavailable for an interview. Therefore, the following data was gleaned from news articles, raising concern that the "best practices" displayed span a spectrum of PR initiatives (Arora, 2020).

4.4.3.1 TrailGuard AI: Selection of Markets & Economic Sustainability

To date, the TrailGuard AI has only been pilot tested in National Parks, such as Tanzania (Avery & Saigal, 2019). One hundred National Parks have been identified as having the highest risk of poaching and so the technology will be deployed by the end of 2020 (Immersat, 2019). It is estimated that the equipment and infrastructure to protect these 100 parks could be installed for about $4 million (Targeted Action, 2019). To break it down even further it is explained:

"*Installation would cost a park an estimated $17,000 in the first year and slightly more in the second year, with future operating expenses for data transmission at about $200 a year — much less than alternative protection measures such as flying drones to spot poachers or employing additional rangers." (Cookson, 2019).*

Thus, this company seems like these are just start up and initiation costs which then eat up more of the budget with supplemental and supportive high tech costs from maintenance that will raise the bill even higher and come at the cost of paying for other factors in conservation.

4.4.3.3 TrailGuard AI: Design & Capabilities

TrailGuard AI is "a system of cameras, communications units and satellite modems placed at key points in a reserve to relay information to rangers' headquarters within two minutes of detection" (Avery & Saigal, 2019). The devices are explained to typically be placed at "ten 'chokepoints' - poacher intrusion hotspots - within each of these parks" (Immersat, 2019). Further capabilities include its discrete size so are easier to camouflage from humans and wildlife, can function for up to one and a half years, and so it decreases the foot-traffic around the hidden cameras (ENP NewsWire, 2019). Furthermore, it is noted that there are limited false-positives wherein "instead of alerting the rangers anytime there is motion in front of the camera, TrailGuard AI only sends images to the rangers when a person or vehicle is detected" (ENP NewsWire, 2019). Given the reality is the purpose to stop poaching or to go to the site to rescue orphan elephants/ rhinos the question is will the reaction speed be too late.

4.4.3.4 TrailGuard AI: Success

The overall success of the AI powered system is that it has a 97 per cent accuracy, and it can instantly transmit images to park rangers' facilities, therefore allowing for the process for them to identify the possible incursion and allow for response if needed (Inmarsat, 2019). The TrailGuard AI system has already been tested in the Grumeti Reserve where the results included the arrest of poachers from 20 different gangs and further seizures of bush meat (Avery & Saigal, 2019).

4.4.3.5 TrailGuard AI: Challenges

The reports didn't express any current challenges in the field. This is disturbing as it lacks in reflection, exhibiting how these news articles are set to promote this AI camera.

4.4.4 DRONES/ UAVS

Currently the Air Shephard drone is utilizing AI capabilities, in order to decrease effort and time spent watching the drone by utilizing similar AI algorithms that cameras use to identify poachers (Fang, Carnegie Mellon). However, conservationist stakeholders insights referred to only the usage of non-AI drones. In Zimbabwe it is described that ZimParks tried to deploy them, and whilst they brought new information and new images, the uptake was quite low (Mufete, AWF). The main challenge raised is that, for example in Kenya none of

the parks are using drones as it is thought that “the inhibiting factor is the high cost of actually operating something that's going to give you those returns” (Bonham, BLF). Other limitations include that it’s difficult to use some small drones in order to cover the large protected areas as some drones last around 30 minutes due to their lightweight batteries (Field, 2019). Besides implementing drones for anti-poaching purposes, they were utilized for photographing, and we've tried using drones to chase and find elephants on farms (Bonham, BLF).

Fang (Carnegie Mellon) was involved in the trial run in Ezemvelo KZN Wildlife, South Africa and notes that there were prevailing issues where there was a lack of data to integrate, in order to find out ways to improve it because in the dataset, “most of the video frames have nothing in it, so there's only a small fraction of the video frames has some poachers or has some wildlife.” Overall, it is evident that Air Shephard is still in the research and trail phase, and that it hasn’t been scaled up as of yet for anti-poaching purposes. During the pilot tests there was some success in identifying humans. Furthermore, an integration of patrols is currently being developed and tested which could have added benefits as Fang (Carnegie Mellon) explains:

“we have worked on this planning algorithm that plans the joint patrol of conservation, drones and human patrol, because we know that if you just put the machine learning based poacher detection algorithm there, it works, but it is not perfect.” (Fang, Carnegie Mellon)

As a result, it can be deducted that a lot more further research to be conducted in the way of drones and the integration of AI into its system.

4.4.5 SENSORS

There are a variance of sensors utilized by the company Smart Parks focused on protecting wildlife, many of which have machine learning software embedded in the technology (van Dam, Smart Parks). Smart Parks comprises of implementing and developing the internet of things (IOT), including animal open source/ collars and also standards for fecal tracking, vehicle tracking and water-tank monitoring (van Dam, Smart Parks). Other markets also utilize a variance of wildlife trackers are tested and utilized to track wildlife, yet it is described that there are a lot of prevailing issues with these types of sensors. For instance, the transmitters in the horns of rhinos only work well for the short term (Carlisle, AndBeyond). Furthermore, a major experiment, with a paper soon coming out, was conducted for “microtechnology and applying small transmitters to ear notches and ear tags”

(Carlisle, AndBeyond). Carlisle (&Beyond) explains “at Phinda where we've applied VHF and UHF technology to the ears of rhinos, but it has limited success because of challenges in finding viable battery implementations”. Therefore, a variance of techniques have been used, but at AndBeyond they haven’t come up with a perfect solution yet.

The prevalent issues in using VHF/ UCF technology is that these collars are very expensive, closed source and they use old technology which contributes to dangers as one can even catch that collars signal with $25 equipment (van Dam, Smart Parks). Moreover, Van Dam (Smart Parks) describes that he “also found out that even the tour guides were using these same signals to give wildlife guarantees”. Therefore, it is evident that this type of technology is a double edged sword. Hence, van Dam describes the following process that derived the introduction of Smart Parks ‘Open Collar’:

“There are some market leaders that make a lot of money and that's not bad because the development is very expensive, but then I think you have the obligation to continue, really develop it very well and make it very safe and also adapt to newer standards. And we found out that they were not doing it for whatever reasons, we offered our collaboration and they all said yes, but they never come through. So then we started Open Collar, which is an initiative to introduce new technology into these collars, but then fully open source.” (van Dam, Smart Parks)

This taps into a bigger discussion of technology for control and security and the gaming of that very tech in the name of democratization.

4.4.5.2 Smart Parks: Selection of Markets & Economic Sustainability

Smart Parks’ collaboration with ‘African Parks’ was described as an “obvious place to go” due to the fact that it is one of the biggest organization that does professional park management with the biggest private ranger force in Africa at the moment, and the relevant infrastructures and organization is also put in place. Therefore, due to this professional model, uh, which “is actually suitable for deploying such high, high end technology” as well as benefit from it as van Dam (Smart Parks) further explains that without the foundations in place “it's not a good time to introduce AI or sensors or even smartphones for that matter”.

4.4.5.3 Smart Parks: AI Design & Capabilities

LoRaWAN, is “one of the main drivers or key technologies in the internet of things” and it enables for the discrete connection to IOTs (van Dam, Smart Parks). In particular the vehicle sensors and capabilities of the Open Collar sensors are noted to be the most important in creating further interaction and awareness of the environment. The Open Collar is described by Van Dam (Smart Parks) as a:

"faster pace of innovation because we introduced the technology also into all the other collars, um, which essentially makes them the lowest GPS plus LoRa trackers in the world, a smaller size and yeah, we're only using them for conservation. And I can even tell you that they are more advanced than a lot of industrial applications in the world." (van Dam, Smart Parks)

Hence, it is evident that there are a variance of technologies being utilized and machine learning is just an aspect to the sensor systems

4.4.5.4 Smart Parks: Success

African Parks, that Smart Parks work with "haven't had any more noticeable incidents" since the implementation of the sensors, exhibiting that this form of sensors is very successful in anti-poaching strategies (van Dam, Smart Parks). Smart Parks can also now track rhinos real time based on GPS, so not even with, with the network anymore" (van Dam, Smart Parks). Thus far at a conservancy they have tracked rhinos for over two years with geo log every seven minutes. This surveillance of wildlife contributes to theory exhibiting how people construct anthropomorphic meanings around species in accordance to how they engage with species and attribute value to their characteristics (Root-Bernstien, Douglas, Smith & Verissimo, 2013).

4.4.5.25 Smart Parks: Challenges

There are two current developments that Smart Parks are working on. Firstly, van Dam (Smart Parks) "noticed that not all parks can allow this dense network of, of LoRa WAN stations because you always need reception on three towers". In reference to the open collar sensor tags, they're "continuously looking for ways to get the GPS also in that sensor, so we can get the location from GPS and send it over LoRa" (van Dam, Smart Parks). Smart Parks has also come into contact with AI models in the cloud and also on 'the edge', yet, in order to get to the level of AI, the difficulties include gathering that data to train up that artificial intelligence model to know what to predict, as well as integrating the sensor information to a higher quality level (Utilizing AI in Malawi, 2019; van Dam, Smart Parks). Hence, there is a need "to make very good models, as it's not integrated enough… but it's starting to get there" (van Dam, Smart Parks). As a result, Banzi's (2014) theory that animals can be utilized as mobile biological sensors is supported as currently Smart Parks is in the process of harnessing this capacity.

4.5 Implementation of AI into the Field

The following chapter will address the fair and appropriate usage of AI, the corresponding security and AI policies that need to be regarded and the future implementation and collaboration that is needed between scientists, researchers, NGOs and conservationists.

4.5.1 Fair and Appropriate Usage

Previous assessments include the potential misuse and misinterpretation of such machine learning algorithms, the need for better metrics and evaluating the responsible use of AI (Wearn, Freeman & Jacoby, 2019). However, as of yet this hasn't been conducted in the framework of AI utilized for anti-poaching purposes. Therefore, the following section explores the fair and appropriate usage of such AI technologies.

The first prevailing issue is the risk of the technology falling into the wrong hands, or of it being used by corrupt rangers. For example, Ball (Malilangwe Trust) draws an example of where the rangers can assist the poachers:

"Now listen, lot of that is down to the people you're working inside. And that's the way that's, we have so many people that have gone wrong. Like Kruger national parks, they brought in all this fancy equipment, um, tracking equipment. They've put in transmitters into rhino horns. Um, and the very people you look -- are looking after them, are using that to actually kill the rhinos. You know? They're getting on the, on the radio to their friend and saying, well, the phone and saying listen this rhino's at this point. So I mean it's pointless."(Ball, Malilangwe Trust)

Hence, Mike Ball (Malilangwe Trust) exhibits that there needs to be disciplined infrastructures in place before the utilization of such technologies. Philip Kuvawoga (IFAW) also suggests that the current techniques of training protocols, refresher training and evaluations could also be techniques utilized in the framework of AI implementation. Bonham (BLF) also asserts, "I suppose another potential downer is becoming too reliant on it"**.**

In order to safeguard AI, an example includes noting if the patrols have been followed correctly which is also a technique utilizing by the PAWS system (Fang, Carnegie Mellon). Yet, rangers could also show "reluctance to adopt it because it also creates a situation where normally you go on patrol, you can just sleep under the tree, but now you can be seen that they didn't really move much" (Mufete, AWF). This anecdote raises the prevalence of socio-cultural effects as well as it can be suggested that such responses are due to the lack of

discipline, pay, equipment and working conditions. Furthermore, it reveals that it's also about the rangers giving up their own privacy and becoming the targets of surveillance themselves.

4.5.2 Security & AI Policy

Dimensions of the responsible innovation framework currently are being explored in relation to the AI technologies, yet, anti-poaching AI applications in the frame of Global South responsible innovation hasn't been contemplated as of yet (Hartley et al., 2019). Yet, the data reveals that this isn't completely true but rather there is a bias on using AI for good when it comes to the Global South. For example, van Dam (Smart Parks) suggested that the process of creating policy could be a faster process than expected and stated "I think the governments are pretty aware and they have initiatives going". Nevertheless, this research facilitates the identification of further policies and regulatory structures that the Global South regulatory bodies require.

The security and ethical implications of AI technology was a topic raised, as many of the stakeholders had opinions to share. Mufute's (AWF) response to these issues of security is one in which in African countries there is a lot of fear of the unknown due to a lack of adequate knowledge. To that end, in some cases the prevailing issues with security and social safe guard have caused the shutdown of projects, especially with reference to drones in African countries. For example, in "2014 effort to bring anti-poaching drones to Namibia by the WWF, sponsored for $5m by Google, was driven out by the government, citing security concerns" (Field, 2019). Another issue was also raised by Philip Kuvawoga (IFAW) who questioned that issues prevail in monitoring "how do you make sure that people are not putting camera traps on community members houses to monitor them without authority". As a solution to these security issues Mufute (AWF) suggested this alternative:

"you need to get the buy in of the security sectors. But that buy in, you only get it when they fully understand what the capabilities of the new technology. Yes. And if they [the respective government] feel they've got some control, but if they feel it's externally controlled [by the Western countries] they will not allow it."(Mufute, AWF)

Another insight included the certain ways that AI is pitched and reported to the government and evaluate implementations that has the success stories and the challenges in whatever adaptive management measures we can bring on board (P. Kuvawoga, IFAW). Danckwerts (Panda Masuie Release Project) also highlights that hackers could be a prevalent issue as there is always the risk in which they could glean information according to the data

made available in the conservation areas, he states “I'm a nervous of that part of it”. Microsoft has created effective safe guards for keeping the data safe for the PAWS application, yet, it is noted that other parks cannot access data from other parks. As a result, what constitutes as most secure design also makes it less user friendly by those who need to access it.

Carlisle (&Beyond) further suggests there should be intelligence integration into the rest of the crime protection in the country due to the fact that often wildlife crime is syndicated. Yet, as explained by Danckwerts this is the challenge of such a collaboration:

“When I discussed to our donors IFAW, their main rep in, in South Africa, the regional director, because I was talking about coming up with an intelligence database using Earth Ranger, and he just said, it's going to be very complicated with the government because who's going to have the data? Is it national parks? Is it forestry commission? Is it police? Is it CIO? You know, who's, who's going to manage it?

As a result, it is evident that due to the sensitivity of the data combined with corruption the issues of effectively sharing data could be a prevailing issue as it all depends on the possible allowance of the data falling in the wrong hands.

4.5.3 Future Implementation & Collaborations

Furthermore, collaboration from other researchers is something noted that is needed and in many cases in the future will be conducted. For example, Microsoft has provided an explanation in which one can “make your API's open to other conservation organizations or other researchers around the world, people can reuse the same API's inside of their own pipelines” (Flickinger, Microsoft). Moreover, with the cloud processing this information, at RC they are developing such a platform where part of the reason is due to collaboration as White (RC) explains, “We're never going to hire a dozen scientists, but if we build the right tools, they'll use the platform and build the capabilities that we need them to.”

4.6 Effects of COVID-19

In light that these interviews were conducted during the pandemic, perspectives from the interviewees about the effect that COVID-19 has had on the shut-down of the wet markets and corresponding effects on the sources of this trade is pinpointed. There were a variance of responses to this pandemic, and they were split up into their beliefs that due to COVID-19 there will either be less poaching, more poaching, or no change. The most frequent argument was that there will be a higher prevalence of poaching in Africa. The pressure on the economy is attributed to this decidedly increase in poaching, both for bushmeat and commercial purposes. In South Africa since COVID-19 shut down Jacobs (Rhino 911) describes the rescues of rhino orphans and incursions ensued during this time period and asks the questions:

"Is it normal to lose 10 rhino in six weeks? Yes. That's normal. Is it abnormal? I'd say no, it's kind of acceptable in terms of poaching acceptable but, is it humanly acceptable?" (Jacobs, Rhino 911)

Thus, it is evident that in South Africa there are ensuing challenges with rhino poaching, whether it will increase in the future is questionable. Wrege (Elephant Listening Project) draws an interconnection between the enforcement measures placed recently on the wet markets to the past measures placed on ivory trade:

" I think that the concerning issue there is that so far, that was what, two years ago or three years ago that trying to stop the, the legal trade of ivory in China. We've seen no change in Africa. So what is it? Is the, you know, the poaching syndicates, maybe they're saying, well, there is a black market. We'll figure out how to exploit it. Let's just stock pile the ivory." (Wrege, Elephant Listening Project)

Notably this data shows that there is still a prevalence of poaching and that poachers motives continue due to the black market demand, and therefore it is questioned if this in turn will be the case with the shutting down of the wet market, a transcendence of the demand to the black market.

Discussion

The research focused on how AI is embedded in conservation as part of the larger discourse on the role of new technology in mitigating chronic socio-economic barriers and designing pathways for a more sustainable future. The notion of 'doing good' with AI is entrenched in real world moral dilemmas in this thesis, revealing tensions on what constitutes as the moral approaches to poaching policies and practices and the trade-offs that ensue. This thesis argues that a) we need to build an empathetic understanding of the seeming paradoxes in the field – the sticky factor of neoliberalism in marginalized, weaker states, and resource scarce contexts, the rationale for commodification and privatization, and the militarization of conservation; in this effort, I argue that we need to acknowledge the Eurocentric values driving "doing good" policies; b) intelligence needs to be regarded in a more intersected fashion of "high" and "low" tech intelligence; c) we need to decenter anthropomorphic solutions and data for conservation; d) AI technology is a double edged sword and these dynamics need to be observant of the prevailing factors and e) the sustainability of AI technology needs to be considered in future implementations into conservation areas.

5.1. Complicating Neoliberalism

Neoliberalism is to a large extent critiqued by scholars, however, the results show that there is still an overarching rationale about why neoliberalism still largely appeals to conservationists in Africa. The notion of biopolitics wherein animals earn their right to exist through 'profitability' is a prevalent outlook explaining the success in economic incentives derived from tourism and professional hunting. Although both entities have their flaws in conducting and imparting of funding to the communities and wildlife conservation itself, if conducted properly there is merit to its sustainability both economically and ecologically. The polarization between these entities is also a prevalent issue and the research shows that their collaboration is more urgent than ever, for the sake of the common cause of protection.

Other protected areas such as National Parks, that are run and managed by government institutions and have NGOs' to support them are noted to have currently less control over poaching, in comparison to the privatized conservation areas. The marked difference is due to the ample funding allowing for such content including higher quality of infrastructure, budget in ranger salaries and usage of technology. Thus, privatization enables sufficient conservation management. Yet, privatization of conservation areas through the means of foreign organizations was deemed problematic once again, if it means loss of heritage and resource management controlled by foreigners. It can also be argued how that

can be correlated with Eurocentric ethics as these financials are often about survival mechanisms for both human and non-human entities as explained by the interviewees. Overall, there is this kind of anti-neoliberalism that can be a privileged position wherein there is a western righteousness from a distance without accounting for the realities on the ground. Therefore, it can be ascertained that scholarship tends not to synchronize with everyday realities of conservationists in the field, especially in their extraordinarily diverse and deprived contexts.

The marketization of horns/tusks, sustenance of animal life and the community life cannot be easily dismissed, because the market logic makes sense even though it is unfashionable to state that in today's academic circles. Therefore, it's not about the market being the bottom line, but noting how the market still plays a critical role in reordering justice and adding value to the animal itself. It is also evident that varying countries within Africa have different opinions in this light of marketization, as the Southern African countries are more in favor, whilst the likes of Kenyan conservationists are to a larger extent against this market. This aligns with the theory of Convivial Conservation, as the interviewees presented a vast array of "economic system's structural pressures, violent socio-ecological realities, cascading extinctions and increasingly authoritarian politics"; all of which this theory suggest should be utilized in order to structurally transform conservation, specifically in each African country where these structures differ (Buscher, 2019, p. 283).

Another important facet of neoliberalism is the sense of autonomy that countries struggle to encompass in deciding their own decisions for legalizing the trade. The results exhibit that this type of power manipulation is prevalent through committees such as CITES, and with the funding given to the conservation areas through means of western aid and NGOs. This intersection is prevalent as there is an overarching ethical dilemma which clashes the history of colonialism and western paternalism versus the reality of high levels of corruption/cronyism and the universal ethics on animal cruelty and the virtues of diversity/conservation.

It is asserted by Buscher et al (2019) that in actuality this strategy of NCA provides little finance to the communities, a theory which is to a certain extent proved in Africa. Nevertheless, it is evident from the research that when the communities are provided for through the economization of conservation, it has a positive impact on the anti-poaching initiatives. This highlights the fact that it's not about whether or not to financialize, but perhaps about more equality in the redistribution and involvement of parties, such as higher salaries for rangers and higher investment into communities through better roads, equipment

and jobs. Hence, there is a nuance as there is defense of neoliberalism in spite of today's unfashionability. Hence, light is shed on the fact that neoliberalism is still the realistic process, and each country should have their own individual policies according to their own circumstances.

5.2. Re-Examining What Constitutes as "Information Networks"

It can be ascertained from the research that there is a variance of means in collecting data for the management and performance of conservation strategies. Notably, this conservation data constitutes as "intelligence" which can be both socio-cultural just as much as it is technological (AI). The socio-cultural intelligence is typically gathered by means of informant networks, and is emphasized to be one of the most vital factors in ascertaining poachers strategies. However, success of these informant networks stem from the type of relationship that the conservation areas have with the bordering communities, as it is dependent on the effectiveness of the information networks. Thus, it is not just the individuals, but entire communities which should be looked upon as a singular unit of informant networks and reward systems should be designed with that in mind. Moreover, this notion of conservationists also sharing intelligence between themselves is a deliberated topic as many interviewees state that there is further need for these collaborations. What usually prevents this intel from being shared is stated to be the 'egos' as well as the issues with whom handles and can be trusted with this type of intel. Consequently, the research shows that AI can be subservient to these informant networks as this form of 'low' intelligence is regarded as more sustainable and more "on the ground". Nevertheless, it is worthy to note that where there are shortfalls with cultivating these informant networks, AI can then prove to aid in these predicaments.

Overall, in analyzing and connecting to the literature on old and new technology, the general consensus is not in favour of transition to completely AI technology, but hybridity as a solution. Data for AI algorithms is for the most part used for predictive analytics and this data can be derived from various means. For instance, infrastructures such as roads can be regarded as basic data to be processed for enabling the practice of utilizing AI effectively as both the technology and conservationist interviewees highlight that the roads, both national, dirt and wildlife created paths to which the poachers usually follow. Additionally, research also showed that the roads in the conservation areas also need to be considered with regards to the ease and realistic conduction of rapid response from the anti-poaching units. There is also an important argument of 'old technology', such as the rangers usage of log books,

which can be more sustainable than AI enabled tools in that sense of factors such as the low skills barrier of entry and less breakdown or repairs needed.

It is noted the better the model, the better the predictions or the outcomes, the better the AI. AI can utilize data that is processed with artificial intelligence solution or machine learning solutions which allows for real time monitoring in forms of generating automated detection and surveillance. This type of data derives predominantly from technology such as acoustics, sensors, camera and SMART which utilize machine learning algorithms to process this data, therefore it is also vital to be provided with "clean" training data from these sources. Thus, there are many described successes in the intersection of data enabling the detection of poaching activities. Yet, in some cases it is highlighted that AI can have faults or false negatives in its processing and there are still complications wherein the algorithms are dependent on the data inputted which has its shortfalls. Notably, these factors can be attributed to the areas of usage or implementation of the tools that utilize AI. Thus, it is evident that there is a stringent intersection of all forms of data in order for AI to be embedded.

The current research further explains that it is important in building the conservationists trust in the AI decisions, as there is often a difficulty to decipher the algorithms specific decisions (Wearn, Freeman, & Jacoby, 2019). In response to this issue it is noted that it's about how people adopt new interventions which all depends on the initiation and the comprehension of what the technology is doing as well as being able to crosscheck the decisions it has made in real time in the field too. As there is scarce academic groundwork of successes and challenges in the usage of AI, this research enables further comprehension in this regard.

5.3. Anthropomorphism

There is a larger focus on the human element for utilizing these technologies with very less knowledge on anthropomorphism such as animal migratory patterns. Due to climate change and the influx of communities bordering these conservation areas, it can be questioned how the migratory patterns can this be captured with AI in order to conceptualize where the animals habituate, migrate to and for anti-poaching purposes noting when the animal senses danger. Further studies and tests are currently being conducted in alignment with Banzi (2014) theory that animals can be utilized as mobile biological sensors, however, so far concrete findings have not been published. For example, non-AI technologies, such as the usage of APU dogs are part of anti-poaching strategy, however, it is significant how they

are underplayed in scholarly attention as a form of intelligence. Nevertheless, although it's in its elementary phases, AI is enabling the processing of these large amounts of data for ecological purposes too. For example, noting animal patterns in terms of the change in noises when humans walk through the areas. The technologists often stated that the data is not at the quality level that is needed to make very good AI models.

Additionally, there is often a disconnect between technology researchers who are trying to put their models or strategies to work, and their understanding of what's happening in the field. For example, noting where the animal sensory information is coming from or what is actually happening around that animal. Therefore, this insight calls for technology conservationists to situate themselves in the field which aligns with the corresponding literature. On the other hand, most technology companies express their process of creating platforms which allow access of conservation data in order to create means for further forms of this research. This is vital as exploring these large data sets will allow for researchers to create the context of the data which is needed to process and build an AI model for further usage of anthropomorphism. Hence, this research adds merit in exhibiting the need for further investigation in these anthropomorphism processes.

5.4. De-centering AI Technology: the doubled edged sword

The prevailing question is what is good AI, and it is evident that the implementation of AI technology into conservation areas is a contentious subject. Literature flags that there could be wider ramifications on how surveillance of care / AI for good can have unintended negative consequences. For example, it was noted how information gathered from the technology can be infiltrated and utilized by the poachers themselves. Additionally, open systems or platforms of intel similarly relate to these prescribed issues in enabling corruption and so closed systems are still perceived as the answer to this prevailing issue. Surveillance of rangers is brought up as it is noted that the uptake or preference of such technologies might be hindered due to their issues with privacy and being targets of surveillance themselves which marks their own proficiency in anti-poaching work. Nevertheless, these issues also emphasize the need for positive work conditions of the APUs, as the research shows that this increases their own proficiency and more importantly decrease information leakage. Hence, the notion of how AI can be used for good is noted to be an intricate manner, a dual edged sword.

The prevailing issue as even if the technology is available the park might not have enough resources to manage the technology or enough rangers for a larger increase and

response to enforcement. The foundational infrastructures for the implementation of some of this technology include the need for telecommunications, and interviewees also described the issues in this as it also provides the service for poachers. Additionally it is also the issue of as it seems perverse to provide internet connectivity to vast, almost uninhabited by humans, national parks while the cities in Africa still for the most part have little internet connectivity. Although there are efforts underway to address that there may be much resentment from communities who are desperately trying to get online in dense cities if they find out that money is being diverted to mobile connectivity in conservation areas where few people are. Therefore, this research sheds light on a distinct dynamic of which technology comes in competition with funding communities, dogs, helicopters, roads, vans, higher salaries, and so this makes it far more challenging in terms of it being a simple decision to fund or not in terms of intelligence.

5.5. Sustainability of AI Technology

The tools required for AI ranges in its cost, but in terms of its expense in comparison to some national parks that can barely afford to pay its rangers, even the sustainable technology is expensive. In many cases this technology is being afforded by funding into these conservation areas, yet, it is notable that there is a limitation to this funding. An important point is the additional upkeep and sensitivity of the equipment in which in some cases it can be viewed that in some cases conservation technology is not built to be sustained and to be integrated. Moreover, its fundamental that in the selling of this new technology it is integral to testing new technology in communities, which is an end in itself. The ‘best practices’ of this AI technology cannot be indiscriminate as it spans a spectrum of PR initiatives, technology testing on marginalized communities, entry point to an entire market and is impossible to replicate when scaled. In some cases of this AI technology, such as PAWS, Air Shephard and TrailGuard AI, it is still in the testing phase and so the sustainability of this technology cannot be known yet. Nevertheless, in some cases the best practices in actuality come from real world institutional innovation and reform and not a “test”/pilot project that is artificially designed to serve as a buy in for capturing markets, and there are noted successes in this regard.

Ball et al. (2019) assert that success in the innovative technology is the underlying philosophy of getting the basics in place before the addition of these technological frameworks and applications. Overall, this notion is supported by majority of the interviewees. AI alone cannot be worth the investment as it has to come with an ecosystem of

technologies spanning from the old to the new, as well as other socio-cultural interventions like higher salaries and community trust building. In many cases these fundamentals are still not prevalent in many national parks, therefore, in this scheme of things AI by itself is positioned to fail in its substantial effectiveness.

Another point is the engaging on long term sustainability. The discourse around that is described by Savory (ACHM) who remarks that this conventional reductionist management is one in which a decision is made, conducted and then it is checked later on. Therefore, it is argued that any new type of technology should be tested within the context, just as any biological, financial and social decisions should be tested too. It is evident that although there is, as will be further conflict over land usage which corresponds with further wildlife conflict, thus, the sustainability of all various forms of conservation management is questioned, and so in this way the context of these conservation areas in comparison to the community areas needs to be cognizant of. Moreover, this idea of caring for the people is marked as a necessity as in the end conservation cannot pit the human against animal as this overturns this classic dualism.

Conclusion

The aim of this research is to provide various insights into the theoretical framework of how AI anti-poaching technology is being embedded into African Conservation. Accordingly, this research explored a diverse number of stakeholders' perceptions on conservation and its AI technologies, as well as regarding a various number of news articles and reports to supplement and gain a different outlook to the interviewees views. Specifically, the current academic studies haven't provided a cross section of these various AI technologies successes and challenges in the field, as well as the corresponding strategies that are currently being used in combatting poaching. The perceptions that people in the conservation field have in terms of views of this novel technology is also a gap in this research. Thus, with the use of an extensive in-depth interview method, news reports and NGO reports, the following research question was explored: To what extent can/does AI mitigate the wildlife poaching problems in Africa?

Through the qualitative analysis it is evident that the question of funding and management determines the prevailing narrative of how AI can successfully be embedded in the conservation areas. This form of neoliberalism is proven to still work and be favoured by conservationists; whether it will be sustainable in the long run is uncertain. There is an overarching argument that these countries need to have their own autonomy, and more importantly with cognizance of the perspectives from the conservationists who deal in the field themselves. This research also provides further insight into how to design policy and security measures for AI in conservation in the Global South.

This research explores the various forms of intelligence that are utilized in combatting poaching. Fundamentally, it is exhibited that 'low' intelligence is just as important as 'high intelligence', hence there is a need to create a holistic anti-poaching strategy in this regard. Additionally, there is a call for further collaboration between all stakeholders and intelligence sharing in order to sufficiently combat poaching. Intelligence gained for anthropomorphism is also an initiative that is currently being established. This research overall strives to bridge the knowledge gap that Smith and Neuprane (2018) note in which little research exists guiding the design, development and deployment of AI in the global south. As a result, this researcher provides deeper understanding as to the role that AI will play in preventing poaching of wildlife.

In light of the COVID-19 pandemic it is more apparent than ever that it is essential to collaborate and work towards a holistic response to repairing to the root causes of poaching

in Africa. As a result, this research showed that overall there will be a higher prevalence in poaching of both bushmeat and international trade.

6.1 Limitations of the Study

With the purpose of exploring how AI is embedded in conservation in Africa, this research addressed a variety of stakeholder perspectives. A primary limitation in this research was the limited sample size of the current data set. As there are various stakeholder categories within this research, as well as various countries represented, there is a need for further investigation from the perspectives of other technology entities, NGOs and people in the field of conservation areas from other African countries that were not represented. Therefore, whilst stakeholder representation within the data set was aspired, the maximum of fifteen interviews according to the set guidelines was obtained. Furthermore, due to the guidelines of word limit the data set of news reports and NGO reports was limited, as well as a further detailed assessment of the prevailing themes.

Factors such as the COVID-19 pandemic, as well as the situation of the interviewees residing in various countries created additional social restraints. Therefore, the interviews were conducted through the program Zoom, which as a consequence could affect the social connection of the interview that is typically harnessed more proficiently in a face-to-face setting. In addition, due to many of the interviewees residing in countries where WiFi connection is limited and problematic, technical problems on Zoom were common which potentially impacted the interview process. Despite the current limitations, this exploratory research generates valuable insights that can be utilized in further exploring how AI is mitigated in wildlife conservation.

6.2 Future Research

In order to extend beyond the current research on illegal wildlife trade, there are some recommendations for future research which are suggested. Firstly, as some of these AI technologies are still in their development and testing phases, further research at a later period would reveal the best practices and sustainability. Consequently, it is crucial that research continues to address the various technology and conservation strategies as well as management of these conservation areas.

As this research mainly focuses of the first WWF pillar of combatting poaching with AI, further research can address corresponding effects and utilizations that technologies such as blockchain and AI have in disrupting illegal wildlife trade and sales online. Anti-poaching AI initiatives utilized in Asia could also be further addressed. Moreover, a comparative study

can be conducted in which the context of the consumers could reveal further insights into the trade. Overall, due to the challenge of COVID-19 additionally enhancing the proliferating wildlife markets online, there is also a prevalent urgency to divulge further into what strategies can be utilized to counteract this illegal trade.

As this research mainly focuses of the first WWF pillar of combatting poaching with AI, further research can address corresponding effects and utilizations that technologies such as blockchain and AI have in disrupting illegal wildlife trade and sales online.

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Appendix

Appendix A: Interview Guide

Introduction Questions (All Stakeholders)
- Ask a bit more about personal profession/ story
- Ask for an introduction into responsibilities/ position/ role
- What were your motivations for getting involved in this field of conservation

Poaching Challenges (All Stakeholders)
- Do you think that the tackling of wildlife poaching is improving or getting worse and why? (political, economic, social situation)
- What are the most important things you need in order to reduce levels of poaching?

Existing Anti-poaching Strategies (All stakeholders)
- How are rangers supported in the field? (training and equipping)
- What is the importance of gathering intelligence?
- What is your opinion on these measures? (*ie shoot-to-kill*)]
- What is your opinion on legal rhino horn and elephant tusk trade?

Collaborations/ Partnerships (All stakeholders)
- What type of support do you get?
- Who are your partners?
- What kind of collaborations are amongst conservationists in your region?

Finance:
- How do you sustain your conservation/ NGO/ technology model? Cost effectiveness?

NGO Questions
- How do you tackle capacity building /sustainability due to short term funding measures?
- How do you tackle political changes/thereby support wavering and legitimacy at the local level?
- Can you please further explain what governance, utilization of frameworks and policies need to be further implemented in Africa?
- What kind of campaigns does AWF think is most effective?

Devices Technology (All Stakeholders)
- What technology needs to be present for rangers to efficiently be supported in their work?
- Have you utilized/ funded AI technologies?
- Any previous technology that failed to bring results?
- Which technology is more necessary in predictive or preventative design?

How is AI being embedded? (Technology Companies and Researchers)
- How does AI try to align with existing anti-poaching strategies?
- Design development of your technology?

- How do you decide on the country/ game reserve of partnership/ selection of markets?
- How cost effective are the tools?
- What are the most important policies that you follow?
- Can you provide examples of the successes?
- Any noteworthy future design implementation?
- Do they also train people on the ground on how to use their technologies?
- How do you ensure fair and appropriate usage after the implementation of certain technology into the field?

Final Questions (All Stakeholders)

- With the situation of COVID-19 effecting the wet markets being shut down in Asia have you noticed/ predict any changes?
- What are the short term/ long term goals
- Any final remarks/ questions?

Appendix B: Code Tree

Theme 1	Selective Codes	Axial Codes	Sub-codes	Example
Neoliberal Capitalism	*Finances*	Tourism	Positive	Wildlife had become a very, very important aspect of most countries tourism plans (Carlisle, AndBeyond)
			Negative	"Africans must be the ones to benefit from the tourism economy" (Avery & Saigal, 2019)
		Donations	Positive	We can stick with IFAW and they fund us, you know, a majority of our budget (Danckwerts, PMP)
			Negative	It's not a huge amount of money, but there aren't a lot of people asking for it (Wrege, ELP)
		Professional Hunting	Positive	I know quite a few hunters who I, who I respect (Danckwerts, PMP)
			Negative	Kenya who banned hunting in 1976 have lost 90% all the wildlife outside of the national parks (Layard, ZamSoc)
		Legalize trading Market	Positive	flooding of the market versus a steady supply, uh, I would say the steady supply would probably keep demand down more than than sudden flooding and then nothing (Savory, ACHM)
			Negative	We can't because the international community are not ready for that yet (Carlisle, AndBeyond)
		Holistic Management Framework	Everyone's on board with them yet they, they have the worst biodiversity loss of probably anywhere. So it's got to be our management. So that's what we're working on on a global scale. I'm working with, with some very interesting people on that globally including Prince Charles and the Pope. (Savory, ACHM)	
	Natural Capital Accounting	Education	We need to continue, like I said, with the Children's Bush camp, we need to continue the awareness (D. Kuvawoga,PDC)	
		Projects	support, community engagement, uh, programs, looking at livestock husbandry (P.Kuvawoga, IFAW)	
		NCA	Alternative livelihood projects, you know, uh, with the communities, this can really deter people from, from going out to poach or they can really come to your side (D.Kuvawoga, PDC)	

Theme 2	Selective Codes	Axial Codes	Sub-codes	Example
Foundations for Anti-poaching	*Conservation Management Techniques*	Private	this is happening throughout Africa with different parks. And the worry for me is that you, you, you loose your heritage. You know, for me what would be important is that Zimbabweans and a Zimbabwean entity with the well-- with the good of our country, it takes us over, as a private entity as opposed to a foreign city coming and telling us how to, how to use our resources. (Layard, ZamSoc)	
		National Park	But in the parks, they are working on very limited funds. They're working on very limited people, um, big areas to protect. So that's where we have our problems and, and lose animals (Jacobs, Rhino911)	
		Semi Private	African parks is, um, is one of the biggest organization that does professional park management. And they, um, are quite ambitious. And I guess they have like 20 parks under their management at the moment, uh, amongst that, uh, I believe the biggest ranger, uh, private ranger force, uh, in Africa at the moment. (van Dam, Smart Parks)	
	Anti-Poaching Unit Approaches	Rangers	Positive	In Mbire there is a private sector organization which is really a Safari operator who is assisting quite a lot, uh, uh, through funding of community Scouts, paying salaries, (Mufete, AWF)
			Negative	You find the boots on the ground, they lack the adequate training, they're not really motivated. Their salaries are so low, (Kuvawoga, IFAW)
			Shoot-to-kill policy	If you put yourself in the rangers shoes, you know, people can, can criticize or say you shouldn't have killed this person or you know, he's literally got seconds to make a decision (Layard, ZamSoc)
		Translocation	Positive	Then we increased, we doubled rhino population effectively with their rhino program. (Carlisle, AndBeyond)
			Negative	"Many poachers come heavily armed, and in South Africa rangers have to risk their lives for as little as £250 per month, meaning tech experiments rather than additional boots on the ground are not always welcomed" (Field, 2019)

	Infrastructures and Transport	Transport	They don't even have a vehicle up here. (Danckwerts, PMP)
		Infrastructures	We're trying to draw hard boundaries along the farming areas and, you know, try and curtail, you know, cultivation in other areas. Fence, but, yeah, I think that the only way to deal with that is through know electric fencing. (Bonham, BLF)

Theme 3	Selective Codes	Axial Codes	Sub Codes	Example
Means of Intelligence Gathering	*Non AI-Technology*	Types	We've bought a hardware, software, the laptops for community Scouts as well as for the Parks Rangers. (Mufete, AWF)	
		Future	Um, but it, yeah, so we, we've been in discussions with them. They sent us a proposal and a quote. It's very expensive, Mmm. To implement. And to manage. Um, but it's something, I mean, obviously if we can get the funding for it, we would love to do it. (Danckwerts, PMP)	
		Selection of markets	African Wildlife Tracking' in Pretoria is a specialist wildlife tracking company. All they do is produce transmitters for everything from birds and turtles and whales and um, rhinos and elephants. (Carlisle, AndBeyond)	
		Success	They've got all the, all the kits, little backpacks and um, um, like camelbacks and radios. We got a really good radio system, digital radio system. Um, which we, we rely on a lot, it's, it's got GPS tracking so we can track our Scouts throughout the day, um, and see exactly where they are. Um, so all of that's monitored. (Ball, Malilangwe Trust)	
		Challenges	Current	Um, the only problem that we've experienced with it's normally very sensitive equipment and very delicate, just by nature what it is, so it tends to have quite a short life expectancy. (Bonham, BLF)
			Future	But if you haven't got your basics right, um, I'm not against technology, but if your basics aren't right, then you're wasting your time (Ball, Malilangwe Trust)
	Anti- poaching patrolling techniques	Challenges	"Wildlife poaching in Africa is at epidemic levels, but despite the best efforts of dedicated rangers, the large park boundaries and rough terrain mean that they often only find out about poaching when it's too late." (Inmarsat, 2019)	
		Current	Mmm, well, we employ, just over 300 ranges across, but one and a half million acres, so they're the backbone of our security team, um, you know, they're spread out in outposts in obviously the key areas (Bonham, BLF).	

		Future	we are also going to have a, a rapid response unit, which will be a more private unit reporting to us with its own vehicle, and they will support the rangers. (Danckwerts, PMP)
		Success	Um, the people we, um, on Malilangwe itself, we don't have any for, for eight or nine years now, we've had no, no petty poaching as in people hunting with dogs and snares. And we don't have any of that at all. Um, which is largely caused by us doing, um, doing our job properly and also having to deal with rhino poachers who are all armed. (Ball, Malilangwe Trust)
	Anti-poaching strategy	Intelligence	Then sharing of data, um, I think could be taken a hell of a lot more seriously for everybody's advantage often very difficult to get data from other people working in the same landscape. Some are better than others, but there could be a great improvement on that level. (Bonham, BLF)

Theme 4	Selective Codes	Axial Codes	Sub Codes	Example
Artificial Intelligence for anti-poaching conservation	*Tools using AI* *AI Capabilities*	Acoustics	Design Process	We use, try to use infrastructure that already exists (White, RC)
			Challenge	There are no, there's no cell infrastructure where we work. Yeah. And that means that your communication, you know, infrastructure is there. So all these things become new problems to solve. (Wrege, ELP)
			Success	Acoustics, that's pretty advanced as well (van Dam, Smart Parks)
			Economic Sustainability	We've found that we can get these things to stream continuously 24 hours a day for about $10 a month (White, RC)
		Cameras	Design Process	"Small in size: Due to the miniscule size of the Intel Movidius VPU, TrailGuard AI is about the size of a pencil and easier to hide and camouflage from poachers and wild animals".(ENPNewswire, 2019)
			Challenge	"A handful of surveillance cameras may not seem very sophisticated for a sanctuary which is also home to the largest population of critically endangered black rhinos anywhere in East Africa" (Perry, 2019)
			Success	they may have small successes or sometimes a little bit bigger, (van Dam, Smart Parks)
			Economic Sustainability	"Resolve, a Washington-based conservation charity, estimates that the equipment and infrastructure to protect 100 of Africa's most important parks in this way could be installed for about $4m." (Cookson, 2019)
		Drones/ UAVS	Design Process	
			Challenge	We're facing a challenging problem of

				lack of lack of data. Like in our dataset, we, most of the video frames have no nothing in it, so there's only a small fraction of the video frames has some poachers or has some wildlife. (Fang, Carnegie Mellon)
			Success	"Despite their limitations, in some places drones are starting to win small victories" (Field, 2019)
			Economic Sustainability	You go up to the high level drone, you know talking about an investment of you know, 200 to $300,000 (Bonham. BLF)
		Sensors	Design Process	Designed the first rhino, um, tag based on LoRa, without GPS, because at that time GPS was consuming too much power. (van Dam, Smart Parks)
			Challenge	Of course we had also issues with early prototypes and stuff (van Dam, Smart Parks)
			Success	So then we started Open Collar, which is an initiative to, uh, well, introduce new technology into these collars, but then fully open source. (van Dam, Smart Parks)
			Economic Sustainability	There are a lot of reasons why you want to keep, uh, stay short and very effective. So, yeah, it's, um, it's about preparation. Um, so a lot of work has been done in preparation. (van Dam, Smart Parks)
		PAWS	Design Process	On the second part of this, we developed what's called our API platform. And this is a hosting infrastructure (Flickinger, Microsoft)
			Challenge	sometimes takes a lot of efforts for the set managers to collect more data. Something that they

				may not even realize. (Fang, Carnegie Mellon)
			Success	Benefit as we can see is kind of the, the increases, uh, the increased number of snares being found, the increased the number of poaching, uh, human activities and animal activities, uh, being found. (Fang, Carnegie Mellon)
			Economic Sustainability	in terms of the cost needed, clearly that's basically on time. The PhD students time, the research, the researchers time, the practitioner's time. (Fang, Carnegie Mellon)

Theme 5	*Selective Codes*	Axil Codes	Sub Codes	Example
AI Implementation	*Fair and Appropriate Usage*	Field	Success	And what the metrics that are being used are we're catching this many more poachers (Wrege, ELP)
			Challenge	There may be false negatives, meaning it says there's no poaching, but there is a poacher there just, it just didn't detect it. Then, uh, in those cases, um, what should the ranger do? (Fang, Carnegie Mellon)
		Fair and appropriate usage	Obviously really good vetting of the people who, are recipiants um confidential information. So that was obviously strictly vetted. (Bonham, BLF)	
		Government Successes	And we have, we've started to see some kind of hash penalties to these kinds of poachers. So, so yeah, that's what kind of my view of what this whole poaching and that international trade is concerned with. (D. Kuvawoga, PDC)	
		Government Corruption	We also want the people to hold all these leaders accountable. This is some of what's lacking in the current day governance mechanisms. Yes. Transparency and all this. That is the need for that new culture to develop, so that we get rid of all this corruption. (Mufete, AWF)	
	Security & AI policy	Security	In conservation tech, it's a little bit different cause most of the concerns in AI has to do with human privacy. No one cares quite as much about spying on nature. (White, RC)	
		AI Policy	but I do know that the use of drones, certainly within Zimbabwe you need a permit. And um, you know that there is a certain amount of sensitivity around the use of drones for whatever reason (Layard, ZamSoc)	
	Future Implementation	Next frontier	So that also is the part of the motivation to getting it done autonomously. You know, we need recording situation where the data can be broadcast with nobody needing to go there. (Wrege, ELP)	
		Future in field	So right now, as of this week we are testing it in a production environment	

			and then shortly after that... I won't stick the timetables, but shortly after that we are onboarding a handful of Parks and it's kind of a white glove treatment (Flickinger, Microsoft)
	Collaborations	there's a big open source group, called Wild.me. I think you may know them. Yeah. Which is very, very nice because they are fully open source and they have some really cool branches, mainly focused at Marine life. So shark detection and that kind of stuff. (van Dam, Smart Parks)	

Theme 6	Selective Codes	Axial Codes	Example
Effects of COVID 19	*Effects on poaching*	Less poaching	In terms of the poaching activities, so we do expect, or where we are hoping that with this new regulations there will be less poaching activity (Fang, Carnegie Mellon)
		More poaching	I'm hearing stories that it's, um, escalated as a result.(Bonham, BLF)
		No change in poaching	We were hoping they would be a direct link between rhino horn and COVID 19, but they haven't found that yet (Carlisle, AndBeyond)
	Effects on work	Tourism	Hunting has stopped. Photographic tourism has stopped. There's nobody coming anywhere in Africa. Everybody's under pressure. So the new model going forward, we're going to have to change the way we do things. (Carlisle, AndBeyond)
		Poaching strategies	The lockdown was introduced in Zimbabwe is we have, we are supporting anti-poaching in the Mbiri district. We requested that anti-poaching, uh, needed to continue so it was also identified as one of the key activities that was allowed to, uh, to continue during the lockdown. (Mufete, AWF)