Chapter 6
General discussion

1. Integrated discussion on the research findings

What is conservation? This question raised by Sandbrook (2015) deserves consideration before starting this discussion. As he notes:

> *"This is more than just an academic question, because so many of the choices that conservation entails about what to conserve, where and how, grow out from how it is defined, whether implicitly or explicitly".*

In fact, conservation is not a singular, fixed concept but a diverse and evolving field shaped by varying values, goals, and underlying philosophies. Conservation can be envisioned as a branching tree, with approaches ranging from strict protection of what is already there (often referred to as 'preservation') to more integrative models that promote sustainable use for the benefit of both people and the rest of nature. Restoration of what has been there is also an increasingly prominent field (IUCN, 2022). Acknowledging this diversity, Sandbrook suggests a broad definition of conservation: "actions that are intended to establish, improve or maintain good relations with nature". Notably, the term "nature" here accommodates multiple understandings, which for some may include people and even non-living geodiversity. Ultimately, conservation is both a practical endeavour and a philosophy. Although conservation is most commonly associated with the natural environment, it also extends to many domains such as cultural heritage, human-shaped landscape or the management of specific resources.

The history of western environmental conservation is often linked to the industrial age, emerging as a reaction to the large-scale, uncontrolled exploitation of Earth's resources. However, considered in its broader sense, conservation has been practiced since time immemorial (van Dalen & Roberts, 2020). The history of human interaction with its environment is not necessarily one of inevitable depletion and degradation. For instance, Hayashida (2005) highlights several archaeological cases in which human populations maintained woody resources through practices such as pruning, coppicing, and pollarding —some dating back thousands of years. Wild plant species were also transplanted, cultivated, tended, or encouraged, indicating a potentially sustainable approach to their use. Even today, some gatherer-hunter communities in the Kalahari apply conservative practices in bushveld harvesting —for example, prohibiting the cutting of the primary tuber of

certain harvested plants (Velempini & Perkins, 2008). Although wildlife exploitation for subsistence may have been driven more by self-interest than by explicit conservation principles (Jones, 2013), there is evidence of sustainable use of hunted species (Emery & Brown, 2011; Etnier, 2007; Frazier, 2007). While preindustrial societies might have transformed their environment to varying degrees, they did not necessarily exploit them unsustainably (van Dalen & Roberts, 2020). At the same time, what appears to be a harmonious relationship between humans and the rest of nature in some contexts may be attributed more to technological limitations and low population densities than to intentional behaviours, as Broughton (1999) argues. Evidence of both human resilience and environmental sustainability —as well as degradation and collapse— can be found throughout history, from small hunter-gatherer groups to larger urban societies (van Dalen & Roberts, 2020). As Etnier (2007) aptly summarises:

> "[…] *patterns of resource use are highly variable – different cultures have had varying levels of effects on […] species, and these effects have varied temporally, spatially, and taxonomically.*"

Although humans have influenced the environment for thousands of years, it was the expansion of European colonialism that marked a significant and widespread rupture with local ecodynamics on a global scale (van Dalen & Roberts, 2020). This disruption intensified with the onset of the industrial era, which also saw the emergence of 'modern' conservationism within the most developed economies of the moment, and the beginning of an enduring debate between sustainable resource management and the protection of untouched natural areas (see Mason (2018)). The contemporary conservation movement –focused on safeguarding the environment for future generations through extensive scientific evidence and supportive legislation— gained momentum in the 1960s, with Rachel Carson's Silent Spring (1962) widely credited as an important catalyst. Growing awareness of climate change, resource depletion, pollution, and species extinction drove global action. Just as there is no single, linear pathway of sustainability in human history (van Dalen & Roberts, 2020), conservation challenges today must be addressed in a way that balances biodiversity preservation with sustainable economic use, recognizing that effective solutions are highly context-dependent.

This thesis is closely tied to the notion of conservation –both environmental and of cultural heritage– born from its philosophy and aimed at informing its practice. At the intersection with ecology, it addresses the overarching question: **What is the current status of large wildlife species populations within the Western Kgalagadi Conservation Corridor (WKCC),**

and can track surveys serve as a reliable wildlife monitoring method while also promoting coexistence and conservation?

In response, Chapter 5 provides robust, spatially explicit insights into wildlife density, its spatial variation, and potential routes within the northern WKCC, largely consistent with previous and parallel research. The findings demonstrate that the area continues to function, wholly or partially, as a habitat and movement corridor for all targeted large wildlife species. At the same time, they highlight how current human activity —primarily tied to livestock farming— is impacting the environment in ways that are likely unsustainable in the long term. More broadly, beyond the Kalahari, this study offers a large-scale example at the wildlife community level of the versatility of animal track data for biodiversity assessment and monitoring. Because conservation often requires thinking at the landscape scale —and ideally beyond— due to the interconnectedness of biotic and abiotic processes, such spatially extensive approaches are essential (Lindenmayer et al., 2022; Perkins, 2019).

Regarding the reliability of track surveys as a wildlife monitoring method, Chapter 3 and 4 both contribute to improving the accuracy of wildlife population density estimates derived from track counts along transects, particularly through the use of the Formozov-Malyshev-Pereleshin (FMP) formula. Chapter 3 offers an estimate of track detection probability by observers ($\hat{p_2}$) for vehicle-based survey, allowing correction of density estimates ($\widehat{D}$). Chapter 4 enhances estimates of average daily travel distances ($\widehat{M}$) for Kalahari species, an essential parameter in the FMP approach. Both chapters also provide practical innovative methodologies for collecting such data that could be adapted to other ecosystems and different substrates worldwide. Together with past research (Jousimo & Ovaskainen, 2016; Keeping, 2020; Kondratenkov, 2019; Stephens et al., 2006), these findings strengthen the case for the FMP formula track survey approach as a reliable wildlife monitoring tool. Nonetheless, there remains room for further refinement to improve the accuracy and precision of absolute density estimates.

For clarity, I define **accuracy** as the absence of bias in the estimate, and **precision** as the level of uncertainty around it, represented here by confidence intervals. Summarising previous work by Stephens et al. (2006) and Keeping & Pelletier (2014), both the accuracy and precision of $\widehat{D}$ derived from the FMP formula are influenced by survey effort, transect design, and the accuracy and precision, respectively, of both $\frac{\hat{x}}{S}$ and $\widehat{M}$. I will review potential improvements

for each component below, noting that they are interrelated. The absence of bias in $\hat{D}$ is particularly important for management applications requiring estimates that closely approximate true animal abundance, such as setting hunting quotas. Then, in their critique of track-based index-calibration surveys, Drögue et al. (2020) also emphasised the importance of precision in detecting meaningful population changes over time. In this context, the half relative confidence interval width (HRCIW) is a useful metric: it indicates the minimum detectable population change (in %) with a given level of confidence (typically 95%). For large carnivore like lion, the IUCN recommends sufficient power to detect a 30% decline over 10 years, which corresponds to an HRCIW of 30%. Although not discussed in detail in this thesis, the survey-specific HRCIW averages approximately 88% at the 95% confidence level across all surveyed species when densities estimates are calculated for the entire study area – meaning only changes approaching near-total decrease (-88%) or doubling (+88%) have a 95% chance of being detected. The only species meeting the IUCN threshold is the brown hyena, with a HRCIW of 31%. Although Drögue et al. (2020) suggest relaxing this standard for field applications by using an 80% confidence level and shorter monitoring periods (e.g., 5 years or one generation), improving the precision of $\hat{D}$ under the FMP seems a critical goal.

Survey effort

For a given true population density, increasing survey effort improves both the accuracy and precision of $\hat{D}$ up to a point (Keeping & Pelletier, 2014), Additionally, better distribution of this effort —such as using shorter transects for broader spatial coverage— has also been shown to enhance precision (Stephens et al., 2006). However, the total effort required to reach desirable levels of accuracy and precision depends on characteristics intrinsic to the target wildlife population. As Keeping & Pelletier (2014) note:

> "*In particular, populations with lower density, clumped dispersion, larger group sizes, shorter daily movement distances, and greater tortuosity will require larger survey efforts to achieve the desired accuracy and precision*."

As a general rule, more survey effort is beneficial —within logistical limits—, especially when true density is unknown. Improving effort distribution, such as by using more numerous but shorter transects, may also help if feasible in the field.

Transect design

A key avenue for improving density estimates from FMP-based track surveys lies in optimizing the spatio-temporal transect design. On the spatial aspect, since the FMP formula operates as a random encounter model, transects' placement must proportionally represent the actual spatial distribution of the population to yield reliable estimates. In the absence of known density distributions, habitat type can serve as a useful proxy. For example, if pans cover one-third of the study area, then one-third of the transect length should be placed in pan habitat. The most straightforward way to ensure this proportional representation is through a randomised systematic design —overlaying the study area with a grid and randomly placing an equal number of transects within each grid cell. However, such designs are often logistically challenging, as they typically require off-road access, which can be difficult without specialised vehicles or animal transport (e.g. horse or donkey). Off-road surveys may also increase environmental disturbance. Aligning all transects along a common orientation (e.g., North–South) can simplify implementation somewhat. That said, such this "ideal" design may not be necessary if existing roads already provide adequate coverage and habitat representation. The main concern in such cases is the potential attraction or avoidance of roads by certain species. In this regard, D. Keeping (unpublished data) found no significant difference in density estimates for most large carnivores (lion, cheetah, leopard, and spotted hyena), which are often observed using roads (Abrahms et al., 2016; Hägerling & Ebersole, 2017). However, brown hyena showed notably higher densities in road-based surveys, suggesting a possible attraction to roads. In such cases, off-road transects should at least supplement the survey design to avoid overestimating $\widehat{D}$.

On the temporal dimension of survey design, the probability of an animal intersecting transects ($\widehat{p_1}$) likely varies from day to day due to fluctuations in daily travel distance (see Chapter 4) and movement characteristics relative to the transect layout. These variations are driven by intrinsic behavioural patterns, likely in response to both internal states and external environmental factors. To mitigate this inconsistency, repeating surveys over time appears to be appropriate.

Regarding the elements discussed above, an ongoing simulation-based study is evaluating the effectiveness of randomised systematic vs. road-based designs for estimating lion densities in the Kalahari, as well as the potential of temporal survey repetition to improve estimates of $\widehat{D}$ (Finerty, Gielen et al., in prep).

Track index ($\frac{\hat{x}}{S}$)

The accuracy of $\hat{D}$ partly depends on the accuracy of the number of track interceptions ($\hat{x}$) by the total transect length, which is influenced by $\hat{p_2}$ as well as the correct identification and ageing of tracks –both addressed in Chapter 3. However, another area for improvement lies in the practical execution of road-based surveys. Under the FMP formula approach, every track intersecting a transect is counted, assuming that animal movement is independent of transect placement (Keeping & Pelletier, 2014; Stephens et al., 2006). However, even if an animal neither seeks out nor avoids a road, it may choose to follow it upon encounter for ease of travel. In such cases, movement is no longer random relative to the transect, and the track should be counted only once, at the point where the animal first encountered the road (or exited it, depending on trail direction). From personal observation, animals sometimes temporarily leave the road —for example, to scent-mark a bush— before returning. These deviations should not be considered separate events, as the overall movement still reflects a road-following pattern. Recounting should only occur when the animal has left the road for a sufficient distance for its reappearance to be considered a new random encounter, or when it becomes unclear whether it is the same individual returning. As a general rule of thumb, I used a threshold around 500 meters in between re-countings, consistent with the figure used by Funston et al. (2010) to distinguish individuals. However, the appropriate distance may vary depending on a species' average daily travel distance range; more mobile species may require a higher threshold than more sedentary ones. While this issue likely had limited impact on the accuracy of $\hat{x}$ and the results presented in this thesis — being mostly restricted to large carnivores and ostriches, and not all individuals follow roads or make repeated returns— it nevertheless deserves further investigation. A more informed, species-specific recounting threshold could help improve accuracy of $\hat{D}$ in future surveys. It is worth noting that this issue does not apply to off-road transects, unless they follow existing linear landscape features —such as fossil valleys in the Kalahari.

In terms of precision, the uncertainty around $\frac{\hat{x}}{S}$ also contributes to the overall uncertainty of $\hat{D}$, and is driven by variation in $\hat{x}$ across transects. The greater the variation of local population density across the areas surveyed, the more variable $\hat{x}$ will be between transects, thereby reducing the precision of $\hat{D}$. One way to mitigate this is to design transects that each sample a gradient of habitat types, with the goal of producing more consistent values of $\hat{x}$. However, this may not be feasible in a random transect placement design. As

an alternative, post-stratification of survey data based on habitat type can help account for expected differences in density and improve precision.

Average daily travel distance estimate ($\widehat{M}$)

As with the track index, the accuracy of $\widehat{D}$ depends on the accuracy of $\widehat{M}$, which is partially addressed by Chapter 4. Beyond acquiring empirical data on daily travel distance for additional species, a key area of improvement lies in understanding temporal variation in this parameter. While this thesis' findings suggest that such variation is limited for most large species, it may be more pronounced in others (e.g. possibly duiker; see Chapter 4). Obtaining temporally explicit estimates of average daily travel distance, tied to the study period, can only enhance the accuracy of $\widehat{D}$.

Additionally, improving the precision of $\widehat{M}$ —and thus of $\widehat{D}$— would benefit from enlarging existing datasets. As demonstrated in Chapter 4, daily travel distances can vary substantially from day to day, often resulting in large uncertainty around $\widehat{M}$ when sample sizes are small, which is the case for several species.

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Beyond the methodological reliability of track surveys, their socio-economic reliability is equally worth considering. One of the key advantages of track-based methods is their relatively low cost compared with other monitoring approaches. In this thesis, the cost of each c. 24-day survey was approximately BWP 18,000 (~USD 1,700 at an average exchange rate of 0.092 during the study period), translating to about USD 1.70 km^{-1}. Including the purchase of a 4x4 vehicle raises the cost of the initial survey to around USD 7.60 km^{-1} —comparable to the cost reported by Keeping et al. (2018). In contrast, the same authors report an average cost of USD 12.02 km^{-1} for aerial surveys. Direct comparisons with camera trapping are more complex; in addition to the costs involved in camera trap deployment, a single decent-quality camera (including SD card, lithium batteries, protective case, and padlock) already costs approximately USD 250, and significantly more for high-quality models (LEC, pers. comm.). While these different methods are not mutually exclusive, track surveys allow to accommodate smaller budgets. Finally, another key aspect of track-based methods is their potential to involve local community members with highly developed tracking skills, providing them with various direct benefits, an element that will be revisited later throughout this chapter.

The last part of this thesis' overarching question asks whether track surveys can also promote human-wildlife coexistence and conservation. Throughout the thesis, I have repeatedly emphasised the potential of track-based monitoring and local community involvement in research and conservation as beneficial for both environmental outcomes and community well-being —particularly in terms of economic, cultural, and resource management empowerment. This perspective is supported by a growing body of literature (Aswani et al., 2018; Esbach et al., 2024; Finerty et al., 2024; IPBES, 2019; Legge et al., 2024; Liebenberg et al., 2017; Lilleyman et al., 2022). However, these aspects were not the focus of in-depth socio-economic research at the study site and warrant further investigation. Nonetheless, preliminary insights from this work allow me to outline the specific contributions track surveys —and the broader efforts associated with this thesis— have made in these areas:

- **Periodic employment of nine local San trackers**, who received direct economic benefits (excluding food allowances) totalling BWP 86,506 (approximately USD 7,500, based on the average exchange rate of 0.085 between May 2019 and August 2023). For context, the minimum monthly wage during the study period for common jobs often held by members of San communities —such as cattle herding, domestic work, or Ipelegeng (government-supported public works)— was approximately BWP 1,000 (~USD 85). This is less than a third of what they earned while working as trackers.

- **Periodic employment of several village guides and two Motswana graduates**, amounting to BWP 2,655 (~USD 225) and BWP 46,197 (~USD 4,000), respectively.

- **Professional certification of six local San trackers** through CyberTracker Conservation's Tracker Certification System (Liebenberg et al., 2018).

- **Three-month training of two Master's students** (one Belgian and one Motswana) in animal trailing and associated data collection.

- **Tracking refresher sessions** were held before each track survey, having involved two guests from the Department of Wildlife and National Parks (DWNP), four from Cheetah Conservation Botswana (CCB) staff members, and one from a local community.

- **Findings from this thesis contributed to training materials** used during a Tracking Training Workshop for DWNP officers in Botswana's Central District and were later reused for training officers in the Chobe District.

- **Track data collected during surveys contributed to the Hyaena Distribution Mapping Project** in partnership with the IUCN SSC Hyaena Specialist Group. This project is producing new draft range maps for the Hyaenidae, supporting a new Red List assessment as well as updated data on the Red List website.

- **Track data also supported the African Lion Database**, an initiative by the IUCN Cat Specialist Group to consolidate lion population and distribution data across Africa.

- **Results on large wildlife densities and their spatial variation in the Ghanzi Wildlife Management Areas (WMAs)** were used to inform stakeholder discussions supporting the Ghanzi–Kgalagadi Integrated Land Use Management Plan (Tshukudu, 2024) aiming to balance wildlife connectivity and human development. They also supported stakeholder discussion pertaining to the development of Botswana's Leopard Management Plan.

- **Findings on large wildlife species abundance in Ghanzi WMAs supported successful funding applications** aimed at conserving large carnivores —especially lions— in the region.

- **Knowledge generated through this research and past ones has initiated collaboration** with the Botswana Carnivore Forum to develop a standardised national track survey protocol.

- **Enhancements to the FMP formula analysis framework (and accompanying R code)** enabled the analysis (or its refinement) of track datasets for various organizations, producing wildlife density estimates across several regions of Botswana, including Ngamiland, Ghanzi, Chobe Districts, and Khutse Game Reserve. The transect layout designed for this thesis will be reused again for continued monitoring. These efforts also fosters ongoing engagement with local trackers.

Whether track-based livelihoods can tangibly improve human-wildlife coexistence and shift attitudes toward wildlife at a larger scale within the region remains to be formally studied. However, during track surveys, I observed the trackers' excitement when encountering eland or lion trails,

sensed the deep connection with nature during storytelling around the fire, and noticed their disappointment —even boredom— when surveys yielded no wildlife tracks in areas heavily affected by human activity. This is thus and area open for future research.

To conclude this discussion, I believe the sustainable future of the WKCC, its wildlife and its people, depends on moving away from the dominant livestock farming economies rooted in the global North's growth-driven model. Instead, it calls for a reconnection with the many possible relationships between humans and non-humans, paving the way for a mixed economy (further explored in the next section of this Chapter). This aligns with the reflections of van Dalen & Robert (2020):

> *"[…] where severe environmental change became notable or evidence for sustainability began to falter, this often appears a direct consequence of the (sudden) introduction of external subsistence economies that neglect the nuances of the local environment. In contrast, the practice of mixed subsistence strategies which are closely integrated with local ecodynamics and built on substantial environmental knowledge appears to have been an important element in the sustainability of prehistoric societies and could sustain even large populations. […] this should serve as a further warning that western models might not be appropriate for achieving sustainability in these environments and instead Indigenous knowledge and practices […]might be the key to success."*

However, a transitional period that bridges with the current economic culture will likely be necessary.

2. Personal reflection over the story of the last wild lands of the Kalahari

Disclaimer: The following text is a personal reflection, shaped by a decade of living and working in the Kalahari alongside multiple stakeholders. While not intended as an exhaustive academic analysis, it aims to offer important perspectives on the conservation realities of the region.

> *"The Kalahari is not an easy place to know. It is still less easy to understand." (Wayland, 1953)*

For over a century, numerous authors have documented the Kalahari ecosystem and its history, with some of the most notable works being Passarge (1904), DHV (1980), Thomas & Shaw (1991), and CI (2010a). So today,

we cannot claim ignorance, at least for the most part. As discussed in Chapter 5, warnings about the uncontrolled expansion of cattle into the Kalahari have been repeatedly issued since at least 1970. Meanwhile, promoting economic development centred on arid-adapted wildlife has been also consistently advocated as a more sustainable long-term strategy for the region (Cooke, 1985). As Child (1970) stated:

> *"Most of the country consists of areas that, at their best, are marginal for conventional agriculture (including extensive livestock production) on a long-term basis. It is nevertheless important to raise the productivity of these areas so as to accommodate an increasing human population with higher standards of living. Wildlife utilization in its various forms appears to offer opportunities for diversifying land-use cheaply, without further endangering essential conservation values in these sensitive areas*."

Following Botswana's independence, the government quickly recognised the need for long-term sustainable land development (Frimpong, 1995) and reaffirmed this commitment in later years:

> "*Concerning the environment, it is vital that our development be sustainable. Botswana has only a finite quantity of groundwater, grazing land, and forests. If we use up these resources faster than nature can replenish them, production that relies on them will be lower in future years, lowering the standard of living of our sons and daughters*." *1989 Budget Speech by Vice-President of Botswana, P.S. Mmusi relayed by Thomas & Shaw (1991).*

Well-intended policies and regulations have aimed to guide economic development sustainably, such as the Tribal Grazing Land Policy (TGLP) (Government of Botswana, 1975) or the Wildlife Conservation and National Parks Act (Government of Botswana, 1992). The former ultimately led to the creation of Wildlife Management Areas (WMAs) to integrate wildlife into Botswana's rural economy (Government of Botswana, 1986). Despite the available information, awareness, and efforts toward sustainable development, significant challenges persist. What stands in the way?

The TGLP ultimately failed to reduce livestock pressure mainly because several key assumptions proved incorrect (Frimpong, 1995; Makepe, 2006). One of them was that farmers would naturally implement proper rangeland management practices:

" […] cattle are inherently unsuited to the area, particularly when the traditional Tswana systems of herd and range management are practised. Under such systems there is little or no attempt to adjust stocking rates to range capacity as this varies from season to season, and with fixed water sources, the mobility practised of old is no longer followed. Maximisation of numbers is a principal aim of the cattlemen, many of whom are in case absentee dwellers in the towns where they carry on other occupations, leaving their herds in the care of poorly paid and untutored Basarwa and Bakgalagadi." (Cooke, 1985)

Plate 6-1 Example of overgrazed rangelands by livestock in the dry season around the edges of Kalahari WMAs.
Photo credit: Marie-Charlotte Gielen

Decades later, little has changed. Cattle are in fact rarely herded during the day, leading to a lack of rotational grazing around cattleposts and little control over encroachment into WMAs and Protected Areas (PAs) (M. Wallgren et al., 2009; pers. obs.) (**Plate 6-1**). Similarly, Commercial Farming Areas (CFAs) require fencing, yet maintenance is neglected, allowing livestock to roam into adjacent WMAs and PAs (pers. obs.). Beyond herd size, the sheer number of herds is problematic, driven by a growing human population and increasing land demands (Tshukudu, 2024). This is deeply rooted in culture. Across most ethnic groups in Botswana, cattle symbolise wealth and food security. They play a central role in marriage (*lobola* – bride price), serve as a marker of social cohesion during important events, and function as a form of self-reliance, much like a bank account (Chatibura, 2023; Huffman, 1998). Additionally, while efforts to promote a wildlife-based economy exist, government subsidies and incentives for agriculture remain overwhelmingly dominant (Government of Botswana, 2022b). As a result, alternative livelihoods to cattle farming remain scarce for WMA village inhabitants in the Kalahari. While most cattle are owned by the Bakgalagadi village minority or wealthier outsiders from nearby towns, the San majority often work as herders or

depend on government assistance, with limited formal employment or self-employment (CI, 2010b; Karunya Consulting et al., 2020; Twyman, 2000).

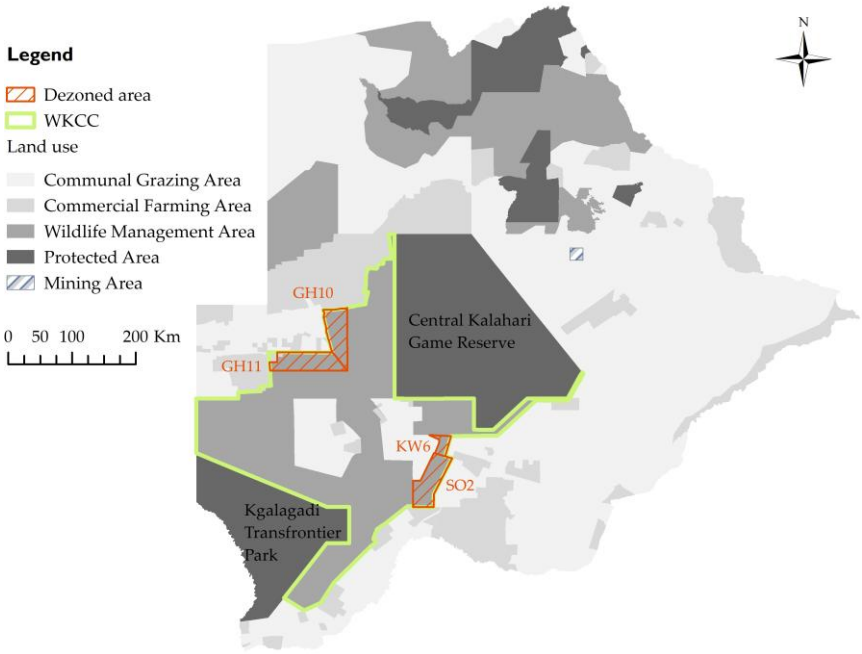

Figure 6-1 Portions of (GH10, GH11) or entire (KW6, SO2) Wildlife Management Areas dezoned for farming within the Western Kgalagadi Conservation Corridor (WKCC). Source: Figure adapted from Keeping et al. (2019).

In Botswana, every citizen aged 18 and above can apply for a free piece of tribal land anywhere in the country, i.e. within Communal Grazing Areas (CGAs) (Government of Botswana, 2022a). Land allocations within the 20 km development zone of WMA villages follow a separate process, as they are exclusively reserved for village inhabitants (Ministry of Local Government, 2009), but the underlying principles remain the same. Additionally, important subsidies are available for water access, including borehole drilling and potable water supply (Government of Botswana, 2022b). If people's appreciation for ecosystem functioning is limited, such low financial commitment is more prone to result in a diminished sense of responsibility, leading to poor land stewardship. As land degrades and populations grow in CGAs, some communities have called for a size reduction of WMAs, viewing them as underutilised and particularly attractive for further livestock

expansion (Department of Lands, 2009). This resulted in the official dezoning of 8,268 km² of Kalahari gazetted WMA in 2012 (**Figure 6-1**), despite remote area dwellers in the WMAs having developed (not yet implemented) land use management plans, such as for GH10 WMA (XNRCT, 2006).

The agricultural sector often regards livestock and wildlife as mutually exclusive rather than embracing a model of coexistence. Wildlife, as Government property, is frequently view as the Government's responsibility. As a result, many farmers expect authorities to handle predator conflicts rather than taking protective measures themselves (Karunya Consulting et al., 2020). The lack of direct benefits from wildlife —and limited involvement in its management— further reduces tolerance toward predators. In areas where cattle posts have been allocated questionably close to WMAs and PAs and face high predation, placing full blame on farmers seems unfair. While compensation schemes exist for livestock losses caused by certain carnivore species, limited Government resources prevent full coverage of predation incidents, and pay-outs fall short of replacement costs except in cases of lion predation (Karunya Consulting et al., 2020; LeFlore et al., 2019). More importantly, compensation is provided regardless of whether farmers practice good or poor rangeland management (Klein, 2013), which can unintentionally encourage negligence in livestock protection.

Despite Government and Non-Governmental Organisation (NGO) recommendations for better livestock management, there is to date no legal framework enforcing sustainable practices, herd size limits, or penalties for mismanagement. Additionally, even an animal that "threatens to cause damage to any livestock, crops, water installation or fence on such land" may legally be lethally removed (Government of Botswana, 1992), despite the inherent subjectivity of such assessments. Policy mismatches between agricultural and wildlife departments add further complexity (Gupta, 2012). The list could go on, but the examples above illustrate the complex web of intertwined factors hindering progress toward sustainable development —a challenge not unique to this region but shared by many worldwide.

Yet, these are more symptoms than the root of the problem. In most societies, a still widely held belief —whether consciously embraced or unconsciously acted upon— is that Earth's resources exist primarily for human use, with little regard for humanity's interdependence with the rest of nature. This anthropocentric perspective is perhaps most starkly illustrated by Jensen (2016). Whether driven by ignorance, wilful blindness, survival needs, or an ingrained sense of dominance, most of humanity continues to uphold this view in daily life actions, often without considering long-term

consequences. This "culture" and inertia (and cultural inertia) remains one of the deepest drivers of our global ecological crisis —yet it may also hold the key to potential solutions (Plumwood, 2005). This is obviously not a new perspective, but I wish to explore it further through my own lens and within the specific context of the present work[i].

These notions of human supremacy and disconnection from the rest of nature has been linked to religion, political choices, socio-economic hierarchies, human-nature dichotomy ideas in Modern thinkers, the mathematization of the world, or the foundational principles of most economic models, to cite a few (Moore, 2017; Sadowski, 2024; White, 1967). These perspectives are certainly relevant, but they do not fully explain why these notions emerged in the first place. I believe that understanding their origins may benefit from a deeper look into the evolutionary mechanisms that shaped human behaviour. After all, *Homo sapiens* is part of the animal kingdom —an omnivorous mammal like many others, dependent on organic and inorganic elements to sustain its primary needs. Yet, why does this drive an ongoing attempt to dominate and reshape its environment? Laland & Ngai (2018) argue that what sets humans apart is their unparalleled ability to acquire and transmit knowledge from one another with high fidelity. This construction of a shared "cultural knowledge" exists in many species through social learning, imitation and innovation. However, the authors explain that humans developed an exceptional ability to pass on information through active teaching, in an unprecedentedly precise manner, achieving high-fidelity transmission. This enabled cultural knowledge to be retained and continuously innovated from across generations, leading to exponential accumulation. In fact, active teaching likely provided the conditions for language to appear, further accelerating this process. This cumulative culture allowed humans to exploit their environment (both physical and social) with increasing efficiency, actively shaping it through niche construction (Odling-Smee et al., 1996). These constructed niches, in turn, favoured traits that enhanced individuals' ability to navigate and thrive within them. This feedback loop (**Figure 6-2**) —where culture and biology co-evolve— has

[i] I fully acknowledge the existing diversity of human relationships with nature. Therefore, what follows is intended as a general reflection rather than a universal statement. I strive, where possible, to avoid grouping every individual or community together in the same way. Additionally, the use of the terms "Man/human" and "nature" is not intended to reinforce the dichotomy between them. Therefore, I preferred to use terms such as "the rest of nature".

driven humanity from gathering and hunting to early agriculture, industrial revolution, space exploration, and the digital age. The growing human control over energy and matter, reinforced by influential ideologies and political choices, has cultivated a sense —or at least a behaviour— of supremacy over the rest of nature, inevitably deepening humanity's disconnection from it (possibly deliberately, to escape its potential dangers). However, it is important to acknowledge that this process has not unfolded uniformly across all human cultures:

> *"Thus, there is no imperative to progress from hunter-gatherer trekking to manioc cultivation: co-existence between the two at different scales is possible. Eventual choices for "loss of agriculture" or its incorporation, resumption, alternation, and so on, result from political choices"(Aparício et al., 2024)*

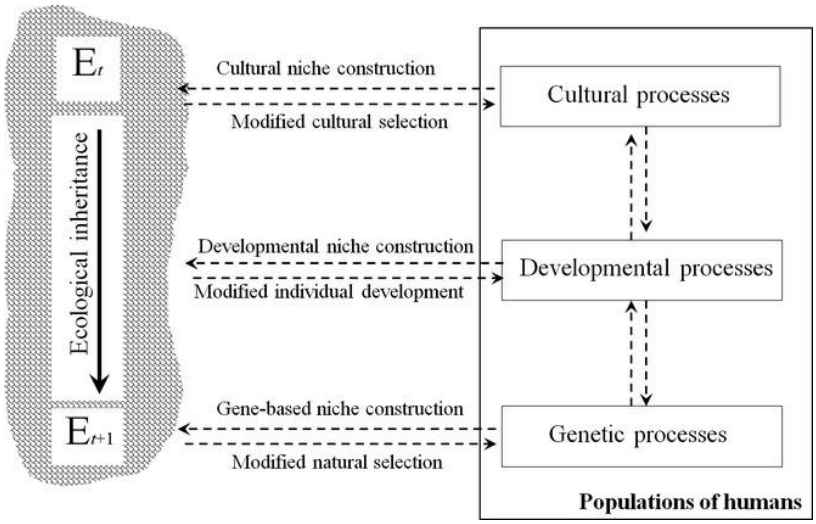

Figure 6-2 Diagram showing three domains of information acquisition — genetic, developmental (e.g. learning), and cultural— used by organisms, especially humans, to generate information that feeds back into niche construction. E_t = Environment at time t, E_{t+1} = Environment at t+1.
Source: Figure retrieved from Flynn et al. (2013).

Some parts of humanity have taken niche construction to such an extreme that the rest of nature has become remote or nearly invisible —literally, as seen in the structure of modern cities. Industrialised nations have built their own physical and social world within the natural world, yet in doing so, have often severed meaningful connections with it, both physically and relationally. The sense of control, along with the comfort, security, and

pleasure this artificial world provides, makes changing course rather difficult. Even when crises like the COVID-19 pandemic momentarily shake this bubble, it remains to be seen whether such disruptions truly shift attitudes toward the rest of nature on the long-term, or even further deepen the detachment.

In the face of the global ecological crisis, legal frameworks and policies currently serve as a major avenue for addressing the issue. While they can play an important role, their effectiveness seems limited in conception, enforcement, and long-term outcomes (UNEP, 2019). This is unsurprising if people do not relate with what they are trying to protect —if their own culture lacks a sense of interdependence with the rest of nature. How can humanity truly care for the rest of nature if it no longer feels for it? I believe most people enjoy natural places, and sociability beyond human beings persists in a limited form in modernity through relationships with domesticated animals. But how deeply do we truly engage in relational connections with the natural world? Do we understand the fragile balance we are part of and our role? I don't believe most of humanity does, certainly not industrialised nations. To hope adjust Man's niche and shift humanity trajectory, we first need to "repair" our cumulative culture and its transmission. Over time, it has increasingly focused on knowledge relevant to man-constructed niche while losing touch with the original knowledge of nature itself, which we need to reconnect with.

Practically, there are many ways to approach this as the concept of "Rewilding" rises (Video: Learning to rewild), especially as it should consider the diversity of possible human interactions with the rest of nature (Glentworth et al., 2024). However, since one of our species' greatest strengths lies in knowledge assimilation, why not first learn from those who still possess authentic natural knowledge —primarily Indigenous Peoples[ii]? They

[ii] An official definition of Indigenous Peoples has not yet been adopted by any United Nations body. However, Article 1 of the Indigenous and Tribal Peoples Convention of 1989 (Melander & Alfredsson, 1997), defines Indigenous Peoples as:
(a) tribal peoples in independent countries whose social, cultural and economic conditions distinguish them from other sections of the national community, and whose status is regulated wholly or partially by their own customs or traditions or by special laws or regulations;

probably represent best the precious thread that faintly links humanity to its roots and original relationship with the rest of nature. By this, I do not mean that we should all return to a pre-industrial way of life, but rather envisioning a pluralistic approach which embraces the integration of Indigenous knowledge with "modern" ones (see for instance Esbach et al. (2024)):

> *"The Kalahari San are modern people with modern aspirations. They have adopted western clothes. Their children go to school to prepare them for modern employment opportunities. They use smartphones and social media. What is invaluable is their intangible cultural heritage in the form of their Indigenous knowledge and expertise, such as the art of tracking, their knowledge of plants, how to hunt with bow-and-arrow, how to make fire, how to construct a grass hut... these are valuable aspects of their culture which they still practise within a mixed economy."(Liebenberg et al., 2021)*

As such, Indigenous Peoples can be invaluable teachers in restoring relational connections between humans and the natural world. It is no coincidence that in northern Australia, home to one of the world's oldest continuous cultures, successful contemporary land management by Indigenous groups is rooted in their "caring for country" ideology (NAILSMA, 2014).

In South America, Aparício et al. (2024) argue that the Amazon was not the pristine wilderness it is often imagined to be but instead has a deep history of human presence, with evidence dating back over 12,000 years. Around 1,000 years ago, large and complex villages existed, where Indigenous Peoples engaged in diverse activities, from resource extraction to small-scale agriculture involving a vast array of plant species. These areas still present a remarkable continuity of biodiversity with a notable presence of palm trees, fruit-bearing plants, and nut-producing species that have been utilised by humans for generations:

> *"The management of the landscape through the succession of forest / swidden / successional vegetation / forest acts as a dynamic to increase biodiversity. The apparent disorganization of indigenous crops from an agronomic point*

(b) peoples in independent countries who are regarded as indigenous on account of their descent from the populations which inhabited the country, or a geographical region to which the country belongs, at the time of conquest or colonisation or the establishment of present state boundaries and who, irrespective of their legal status, retain some or all of their own social, economic, cultural and political institutions.

> *of view is actually a complex system of co-evolution of humans, plants, birds, rodents, insects, fungi, etc […], a configuration according to which "Indigenous Peoples are more than selectors of varieties of the same species. They are, in fact, collectors""(Aparício et al., 2024)*

This challenges the view that sustainable resource use was primarily the result of low human population densities and limited technologies (Broughton, 1999), although this may have been true for some societies. Today, deforestation and land degradation rates across the tropics have been shown to be lower on Indigenous lands compared with non-Indigenous lands, performing comparably with Protected Areas (PAs) and even exceeding them in Africa. That is despite receiving a smaller fraction of official conservation funding (Sze et al., 2022).

Similarly, in the Kalahari, the San lived as gatherer-hunters —though not without some economic interactions with other cultural groups— in a sustainable relationship with the rest of nature for thousands of years:

> *They "… use the resources of the world to meet the needs of survival in reasonable comfort. Private ownership and control of the land and its unexploited resources are thus precluded. The doctrine also implies that none may be denied access to resources. […] Control [of competition] is facilitated by maintaining a surplus of resources in relation to the needs of the human population." (Silberbauer, 1981)*

Similar to several other Indigenous cultures worldwide (Honorato & Rocha, 2024; Kingston, 2015), this local ecodynamic was severely disrupted from the late 19th century as the San faced increasing restrictions on access to their natural resources, displacement from their ancestral lands, and resettlement in WMA villages (Twyman, 2000). Today, gathering and hunting function more as dietary supplements and a mean of maintaining cultural identity rather than a primary way of life (CI, 2010b; Karunya Consulting et al., 2020). Nevertheless, extensive knowledge persists, particularly among the older generation. Most importantly, participatory planning organised by Cheetah Conservation Botswana in 2017 revealed a clear desire among some community members to engage in nature and conservation-related activities.

Globally, Indigenous Peoples have already established protected and conserved areas both independently and through local- and broad-scale partnerships, leading to various successes across political, socio-cultural, and ecological dimensions. However, several challenges persist, particularly in governance, legislation, and relationships with partnering institutions (Tran

et al., 2020). Within the Ghanzi WMAs, community Trusts holding lease rights on the land face significant hurdles, including limited governance capacity, complex local power dynamics in multi-ethnic villages, and difficulties in securing partnerships. As a result, the development and implementation of land use development plans has been significantly delayed. Meanwhile, the dezoning of parts of the WMAs in 2012 for agriculture highlights an inadequate dialogue and lack of support for the Trusts' goals and rights. In recent years, NGOs, either independently or through internationally funded projects (e.g., UNDP Kgalagadi-Ghanzi Drylands Ecosystem Project), in collaboration with governmental institutions, have progressively supported and implemented community initiatives. These include the development of tourism campsites, cultural and craft centres (still at their infancy in Ghanzi WMAs), or resource mapping. Additionally, some community members with tracking skills are participating in research activities (Gielen et al., 2024; Keeping et al., 2019; Keeping et al., 2022a) (**Plate 6-2**).

Plate 6-2 A group of trackers from the Ghanzi and Kgalagadi District communities, preparing to depart for large-scale track surveys in 2018, covering a significant portion of the Western Kgalagadi Conservation Corridor.
Photo credit: Marie-Charlotte Gielen

While these activities have the potential to strengthen individuals' relational connection with the rest of nature and foster its (re)development in younger generations, there are potentially more ways to expand this approach. Implementing Indigenous-led large-scale wildlife monitoring through track surveys, as demonstrated in previous chapters, holds great

promise for the Kalahari. A similar program has been in place for several years in Australian deserts (Legge et al., 2024). Such initiatives can supplement or even replace costly aerial surveys, which are becoming increasingly infrequent. Additionally, they can provide much-needed employment, reinforce cultural identity, be embedded in anti-poaching efforts, foster a sense of involvement in WMA management, and facilitate the rebuilding and transmission of natural knowledge and therefore care for nature. In this regard, the Kalahari Camelback Trackers Project is currently in development in the adjacent Kgalagadi District. A complementary initiative —the establishment of a tracking school— is also being explored (Keeping, pers. comm.), and the CyberTracker Junior Tracker certification (Liebenberg et al., 2018) is set to launch in 2025 at Kaudwane School in the Kweneng District, near Khutse Game Reserve (LEC, pers. comm.). On the tourism side, which remains underdeveloped, authentic immersive experiences rooted in nature and traditional knowledge —distinct from the Eurocentric "Living Museum" model— could be highly beneficial. If embraced by communities, activities such as wilderness "internships," survival trips, tracking and trailing workshops, or introductions to plant gathering and traditional uses could support conservation, strengthen cultural identity, and reconnect both visitors and locals with the rest of nature. See for instance The Old Way in United Kingdom or Tracking the Kalahari in Namibia. Why not even rethink part of the existing trophy hunting economy as a state-of-the-art practice using bow and arrow or persistence hunting —where the hunter truly connects with the animal, and its death carries far greater meaning? (Video: The Persistent Hunt). Visitor permits for WMAs, as seen in Northern Australia (NAILSMA, 2014), or conservation levies at campsites could also help fund village Trust management. Some of these fees, already implemented by two village Trusts in KD2 and KD12 WMAs in the Kgalagadi District, could be extended to other WMAs within the WKCC.

Naturally, the success of the village Trusts' nature conservation and reconnection projects depends on preserving or restoring the natural resources they rely on. This underscores the importance of sustainable land use planning and reconnecting the agricultural sector with the rest of nature. With regards to the former, the Integrated Land Use Management Plan (ILUMP) for the Kgalagadi-Ghanzi Districts (Tshukudu, 2024) offers a real compromise for balancing people diverse aspirations and relationships with the rest of nature. Its implementation and especially enforcement are crucial for the region's sustainable development. Such planning must also be considered on spatial and temporal scales that extend beyond individual lifespans and home regions (Lindenmayer et al., 2022; Perkins, 2019). In this context, the WKCC has the potential to link to a much larger entity: the

Kalahari-Rift Valley (KALARIVA) Transfrontier Conservation Landscape (TFCL) (**Figure 6-3**). This envisioned landscape, part of a larger drought corridor, would allow migratory or nomadic ungulates to access the relatively wetter climate of Eastern Africa (Kenya), as Southern Africa's interior is projected to become increasingly arid in the coming decades (Engelbrecht et al., 2015; Perkins, 2020b). Second, reconnecting the agricultural sector with the rest of nature, where it has been lost, is essential for fostering both a natural respect for the land and acceptance of future sustainable land management policies. Agri-culture, as the "culture of the field," can then reclaim its broader meaning, a culture of care.

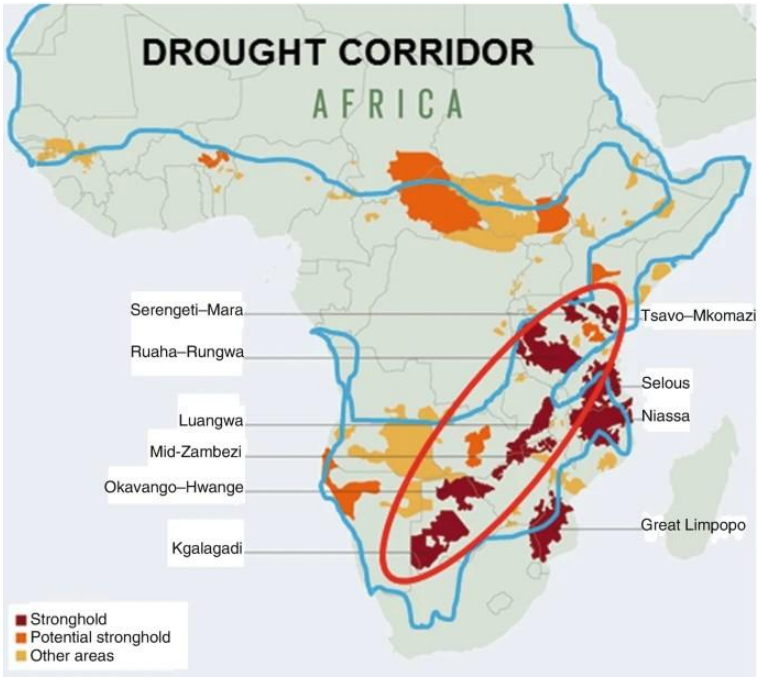

Figure 6-3 The 'drought corridor' (blue polygon) and the Kalahari-Rift Valley Transfrontier Conservation Landscape (KALARIVA - TFCL) (red ellipse) shown in relation to Lion conservation strongholds in Africa.

Source: Figure reproduced from Perkins (2020a) with permission, originally created using a background map from Watson (2013).

In 2024, six farmers from the Ghanzi WMAs were awarded a safari trip facilitated by Cheetah Conservation Botswana as a prize for their efforts in sustainability and coexistence with wildlife (see Farmers' competition winners go on safari!). For most, the highlight was seeing animals in their natural environment —something they rarely witness first-hand— and

experiencing them outside of a negative context, such as livestock loss. While scaling this up for all farmers may not be feasible, similar outings focused on shared knowledge, either among farmers or with San community members of the same villages, could help rekindle appreciation for nature and foster tolerance for occasional wildlife-related farm losses. Where possible and minimally disruptive for wildlife, inviting farmers on scientific research activities (e.g. animal collaring or camera trapping) could also be beneficial, as currently done with some tourists in ecotourism programs (see for instance Trimble (2019) in Zambia). Then, why not also envision regular outdoor cinema screenings related to wildlife, rangeland management success stories, or Indigenous knowledge? This could apply not only to farmers but also various subgroups within WMA communities. For instance, Dickman et al. (2025) report that camera-trap images from their community camera-trapping projects were shown at "film nights" in participating villages, sparking real interest in wildlife and its conservation on village land.

Before cattleposts became sedentary, pastoralists moved with wildlife based on rainfall and seasonal resource availability (Campbell, 1981; Cooke, 1985). This system allowed grazing periods to be followed by natural vegetation recovery, benefiting both livestock and wildlife. Reintroducing rotational grazing in Ghanzi WMAs, even on a smaller scale, holds promise for both rangeland preservation and reconnection with nature, as it requires constant herding. Initiatives like Meat Naturally and Herding for Health (H4H) which originated in South Africa, showcase the benefits of such practices and are now extending beyond the country's borders. In Botswana, H4H is implemented by CLAWS and Wild Entrust in the Ngamiland District for instance, though not yet within the WKCC. Herding can also reduce free-roaming livestock predation in the field. A 2024 pilot project, facilitated by CCB in collaboration with Birdlife Botswana and the DWNP, developed a horse patrol program in three cattle syndicates within GH3 WMA that faced higher levels of human-wildlife conflict (see A Lion's Share: Mitigating Human-Wildlife Conflict in New Xade) (**Plate 6-3**). Patrollers herded cattle back to kraals in the late afternoon, effectively preventing predation in the field throughout the entire three-month trial. The project's success generated enthusiasm among farmers for its continuation.

A deeper physical and relational connection to the land can foster care for it, with the hope to naturally encourage the development and respect of sustainable land management principles —grounded in its intrinsic, not just its economic value. While this reconnection takes time, policies are essential to guide the transition and prevent overexploitation by some —both approaches ideally reinforcing each other in a positive feedback loop.

Plate 6-3 Horse patrollers of New Xade cattleposts, Ghanzi District. Photo credit: Rethabile Setlalekgomo - Cheetah Conservation Botswana & Birdlife Botswana

Proposed measures include livestock herd size limits, herding compliance, temporally dynamic grazing zones, and a review of the problem animal compensation scheme —linking pay-outs to good land management practices and, where possible, ensuring they match replacement costs. Conservation Performance Payments, as a form of Payments for Ecosystem Services, and other Payments to Encourage Coexistence, could further support this transition (Dickman et al., 2025; Dickman et al., 2011; Hamm et al., 2025).

> *"The legal and governance structures must reflect human interdependency with land and ensure that 'ownership' involves understanding and care of the land; for land is not a mere object of wealth or backdrop to rights-claims, but a community of which we are an integral part. In this way, land —and the ecosystems it supports— is an important entity in any legal decision being made which affects it." (Howe, 2017)*

Last but certainly not least, further developing the concepts of natural interdependencies and reconnection with the rest of nature in children's education is crucial for anchoring the "repair" of our cumulative culture and steering bio-cultural co-evolution in a better direction. We have known for some times that childhood play in nature lays the foundation for a lifelong connection to and care for the natural world (Chawla, 2015). Likewise, empathy and sympathy for non-human elements is often rooted in early years (Chawla, 2009). In San culture, for instance, mimicry of a wide range of

animals —remarkably accurate, in fact— is a common feature of dances, plays, and games shared by both children and adults, all drawn from their direct experiences with wildlife (Guenther, 2020). As elaborated active teaching is another of humanity's greatest strengths —again, let's use it. This also applies to tertiary and informal education for adults as well, of course.

> *"That the Other is an independent being on whom one is dependent is the child's first and hardest lesson, even before the lesson that the nurturing Other must in turn be nurtured. It is a lesson that some children never properly learn, and neither do some cultures of denial." (Plumwood, 2005)*

Certainly, this is not a new call, and such notions are already integrated to varying degrees through nature outings, green retreats, and even the development of Forest Schools (O'Brien, 2020). In Africa, NGOs such as Children in the Wilderness host Eco-Club programs at local schools, and run camps at Wilderness and partner safari camps, for the children within the rural communities that live on the edges of the wild areas of Africa. In Botswana, the government supports the development of environmental clubs in schools. Various NGOs such as LEC or Wild Entrust also organise trips into protected areas for schoolchildren to encounter large wildlife —often for the first time and through a lens other than conflict narratives. In Ghanzi WMAs, CCB organises school activities and conducts educational bush camps where children and adult groups get immersed in experiential learning on Botswana's environment and carnivores (see Engagement and Awareness-Raising).

Such initiatives are certainly valuable but still remain supplementary, limiting both the number of children involved and the depth and duration of their connection with the rest of nature. In light of the ecological crisis, nature conservation and similar subjects should universally be embedded in school curricula at the same level as mathematics or language, across all grade levels. At the very least, biology classes should be systematically taught outdoors during favourable climate conditions. How we teach also matters, as Liebenberg (2021) eloquently discusses:

> *"For science to be humane and benefit humanity therefore requires a balance between subjective empathy and dispassionate objectivity."*

This seems like an obvious necessity —one that is only slowly gaining global attention (IUCN CEC & FLEDGE, 2020).

Since the end of the 20th century, "Reconnecting with nature" has become the mantra for addressing human socio-ecological crisis, so it is certainly not a new concept (Zylstra et al., 2014). However, as Fletcher (2017) points out, the human-nature dichotomy remains embedded in this approach, which simultaneously portrays nature as both separate from humans and something of which they are a part. A first step toward reconnection would be to shift linguistic framing —using terms like "the rest of nature" or "more-than-human"— and emphasizing interdependence rather than separation. Classical biodiversity conservation models, originally shaped through the lens of industrialised Western nations, have themselves sought to separate humans from nature confined to protected areas (PAs) (see White Man's Game by Stephanie Hanes). In contrast, existing Indigenous-managed lands and Kalahari WMAs may challenge this paradigm by offering a more integrated approach to conservation, with and for both people and the rest of nature. Finally, I align with Fletcher's view that while individual reconnection with nature is essential, it must go hand in hand with the transformation of broader socio-political and economic structures that contribute to environmental issues. Most solutions for sustainable development still prioritise economic growth, which drives both the ecological crisis and the exploitation of marginalised communities like the San. The state-led, international export of goods reflects a growth-driven logic that often draws on the cultural importance of such goods (e.g. beef in Botswana), creating a feedback loop. In the case of the Kalahari, one might ask: What alternative livelihoods, which might still include cattle, could avoid the endless accumulation of cattle that exploits and degrades the environment? What might a cattle and wildlife (and other nature-based elements) economy look like if it prioritised relational values over the pursuit of endless economic growth? These are open questions that challenge the extractive logic of economic growth, which treats Earth's life forms as mere resources, denying the relational connections that sustain both human and nonhuman life.

The web of interwoven factors cannot be fully unravelled in this limited discussion, particularly the cascading challenges posed by an ever-increasing human population. However, I hope my reflections underscore the critical importance of embedding reconnection at all levels, through a simultaneous effort where Indigenous Peoples, tracking, farming (and other forms of livelihoods), education and the WKCC collaborate to co-create ecosystems that can not only survive but, hopefully, thrive.

One day, I hope to witness again groups of wildebeest resting under a tree, gemsboks crossing the sand track in the distance, ostriches roaming the pan, and that one group of springboks in the Okwa Valley —all of which have

grown more elusive over my decade in the Kalahari WMAs. I also hope to be able to echo the words of Ribas (2023):

> *"Indigenous People […] today are no longer objects of observation —they have taken charge of their own […] using tools from different cultures"*

While discussing the restoration of the resilience of the Kalahari ecosystem, Perkins (2019) couldn't be more right relaying the famous words of Forster (1910) —originally about societal and personal relationships: "Only connect". I would add: Connect lands, connect the rest of nature with itself, connect it to people, and connect people with people.

To conclude this reflexion:

> *"What if the point is not to rule, but to participate? What if life less resembles the board games Risk or Monopoly, and more resembles a symphony? […] What if the point is for us to attempt to learn our proper role in this symphony, and then play that role?" (Jensen, 2016)*

Are you prepared to revise Darwin's Unfinished Symphony?

***

I have walked in your footsteps, you may have walked in mine,
Somewhere and sometime,
All our paths entwine.