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Cross-scale and social-ecological changes constitute main threats to private land conservation in South Africa

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ABSTRACT

Conserving biodiversity in the long term will depend in part on the capacity of Protected Areas (PAs) to cope with cross-scale, social-ecological disturbances and changes, which are becoming more frequent in a highly connected world. Direct threats to biodiversity within PAs and their interactions with broader-scale threats are both likely to vary with PA spatial and management characteristics (e.g., location, dependence on ecotourism revenues, governmental support). Private Land Conservation Areas (PLCAs) are interesting case study systems for assessing cross-scale threats to PAs and their determinants. Despite the growing number of PLCAs around the world, there is considerable uncertainty regarding the long-term capacity of these privately owned areas to conserve biodiversity. Their potential impermanence is commonly raised as a key concern. To better understand the threats to which different types of PLCAs are likely to be vulnerable, we asked 112 PLCA landholders in South Africa what they perceived as the top threats to their PLCA. Landowners identified direct threats to the biodiversity within their PLCA as well as describing broader socio-economic threats (e.g., regional crime, national legislation and politics, global economic recessions), which were noted to interact across scales. We found support for the hypothesis that patterns in the perceived multi-scale threats to a PLCA correspond with its management and spatial characteristics, including its remoteness, dependence on ecotourism or hunting revenues, and richness of megafaunal species. Understanding the threats to which different PLCAs may be vulnerable is useful for developing more nuanced, targeted strategies to build PLCA resilience to these threats (for example, by strengthening the capacity of self-funded PLCAs to cope with the threat of economic downturns through more innovative financial instruments or diversified revenue streams). Our findings highlight the importance of considering interactions between broad-scale socio-economic changes and direct threats to biodiversity, which can influence the resilience of PAs in ways that are not anticipated by more traditional, discipline-specific consideration of direct threats to the biodiversity within their boundaries.

1. Introduction

It is increasingly recognized that protected areas (PAs) are social-ecological systems, interacting with biological, social, economic, cultural and political contexts from local to global scales (Cumming and Allen, 2017; Palomo et al., 2014; Pollnac et al., 2010). Fulfilling their key role of conserving biodiversity in the long term will depend on the capacity of PAs to cope with cross-scale, social-ecological disturbances and changes, which are becoming more frequent in a highly connected world (Biggs et al., 2011; Rocha et al., 2018). The social-ecological resilience of a PA is its capacity to conserve biodiversity amidst disturbance and change (Cumming et al., 2015; Folke et al., 2016). Building PA resilience requires careful consideration of (1) the direct threats to biodiversity and the broader-scale changes that cause, magnify or interact with those threats; and (2) the factors that influence a PA’s vulnerability to these threats and its ability to adapt and respond to them (Cumming et al., 2015; De Vos et al., 2016; Jones et al., 2013; Newton, 2011; Strickland-Munro et al., 2010).

A recent global assessment found that unsustainable hunting, natural system modifications from fire or its suppression, and disturbance from...
recreational activities were the most commonly reported direct threats to biodiversity within statutory PAs (Schulze et al., 2018). Patterns in the number and type of direct threats to biodiversity tend to correspond with PA spatial characteristics such as remoteness and size (e.g., more remote, hillier and larger PAs are exposed to fewer threats) and location (e.g., PAs in countries with lower human development scores may experience more threats; poaching is a greater threat in developing countries) (Bowker et al., 2017; Maiorano et al., 2008; Schulze et al., 2018; Tranquillii et al., 2014). Anthropogenic climate change, however, threatens even the most remote PAs. For example, atolls in the remote Chagos Islands Marine PA recently experienced coral bleaching due to high seawater temperatures (Head et al., 2019). Depending on the management strategy that has been adopted in a PA, its capacity to protect biodiversity from direct threats and persist as a land use may be undermined by a range of broader-scale disturbances, such as local or global economic downturns that influence income streams from tourism, governments, or private donors; political whims; or opposition from local communities (Cumming et al., 2015; Jones et al., 2013; Palomo et al., 2014). Understanding the relationship between the management of a PA and its vulnerability to multi-scale, social-ecological threats is therefore important for achieving the long-term goal of biodiversity conservation.

Private Land Conservation Areas (PLCAs) provide an under-researched case study for understanding the vulnerability of PAs to multi-scale, social-ecological threats. PLCAs are defined as areas that are managed for biodiversity conservation, and owned or otherwise secured by individuals, corporations or nongovernment organizations (Pasquini et al., 2010).

The past several decades have seen considerable growth in the number of PLCAs, with 25 countries now reporting PLCAs in the World Database on Protected Areas (Bingham et al., 2017; Stolton et al., 2014). PLCAs have been shown to complement statutory PAs in Australia, Brazil, Peru and South Africa by conserving threatened plant and vertebrate species, and improving landscape connectivity (Archibald et al., 2020; Clements et al., 2019; De Vos and Cumming, 2019; Pegas and Castley, 2016; Shancee et al., 2017). They can also contribute to regional and national economies through nature- and wildlife-based enterprises that create jobs, attract tourists to a region, and provide diverse ecosystem services (Clements and Cumming, 2017; Langholz and Lassoie, 2001; Pegas and Castley, 2014).

Despite growing recognition of their important role in biodiversity conservation, considerable uncertainty exists about the resilience of PLCAs to a changing world (Cortés Capano et al., 2019; Langholz and Lassoie, 2001). Uncertainty regarding permanence is a common cause of private land being omitted from international conservation reporting mechanisms and excluded from national conservation strategies (Stolton et al., 2014). PLCAs have been shown to be more at risk than statutory PAs to contract releases (Hardy et al., 2017), degazettation (De Vos et al., 2019) and human modification (Fouch et al., 2019). We currently lack a detailed answer to the ‘resilience to what?’ (Carpenter et al., 2001; Hellgott, 2018) question for PLCAs, and this limits our ability to understand and build their resilience. There is therefore a need to better understand the threats to PLCAs, and what influences their vulnerability to these threats.

Measurement of threats in social-ecological systems has several different but closely related dimensions: (1) possible threats; (2) actual threats; and (3) perceived threats. Addressing the first requires assembling an exhaustive list from which threats would need to be ranked; the second requires long-term data; and the third can be measured through interviews with people in the system. Perceived threats are likely to correspond to experienced threats, but not inevitably. In terms of understanding management actions, however, local perceptions of threats are possibly a more important driver of action than actual threats (De Vos et al., 2016), and there is a growing body of research highlighting the value of local knowledge for building PA resilience (Berkes, 2007; Jones et al., 2013; Palomo et al., 2014).

We focused on the third category of threat measurement: that of determining which threats landholders perceive as important for their PLCAs. We collected data in South Africa, where PLCAs are estimated to cover 14–17% of the land area and contribute significantly to the economy through ecotourism, trophy hunting, hunting for meat, and wildlife trade (Taylor et al., 2020). The increase in PLCAs in South Africa in recent decades has been driven by (a) legislation enabling the ownership of wildlife on private land; (b) the increasing viability of wildlife-based land-uses in the country’s more arid areas; and (c) the recent establishment of regional biodiversity stewardship programs (Child et al., 2012; Cumming and Daniels, 2014; De Vos et al., 2019).

South African PLCAs include private nature reserves, which are legally gazetted under the PA Act (Act 57, 2003); biodiversity agreements, which have legal status by virtue of a legally binding contract; and conservation areas, which are not legally recognized but receive some form of protection by the owners and are managed at least partly for biodiversity conservation (Cumming and Daniels, 2014). PLCAs in South Africa have diverse spatial characteristics (e.g., size, accessibility, topography) and management strategies (Child et al., 2013; Clements and Cumming, 2017; Taylor et al., 2020). Some PLCAs are funded by the owners while others are dependent on revenues generated by ecotourism or hunting operations that target local or international visitors. Some PLCAs have reintroduced charismatic megafauna and other antelope species (which were historically extirpated) in order to attract paying visitors. In addition to documenting the multi-scale threats that were perceived as important to 112 PLCA landholders in two of South Africa’s nine provinces, we tested the hypothesis that trends in the threats perceived by landholders would correspond with their PLCA’s spatial and management characteristics.

2. Methods

2.1. PLA selection

A list of PLCAs in the Eastern and Western Cape Provinces of South Africa was compiled from the South African PA Database (Department of Environmental Affairs, 2016) and augmented by online searches with keywords such as private, game, nature, and reserve. Of the 412 PLCAs that were identified, contact details could be sourced for 151 (76 in the Eastern Cape and 75 in the Western Cape). Given time constraints on data collection, 112 randomly selected PLCAs from this list were included in the study.

2.2. Data collection approach

PLCAs were contacted by telephone, and interviews were arranged with either the managing owner or the manager (hereafter referred to collectively as ‘landholders’). Semi-structured in-person interviews were undertaken with participating landholders between October 2012 and February 2015, subsequent to approval by the Science Research Ethics Committee, University of Cape Town. Interview duration ranged from one to 3 h, and interviews included questions related to each PLCA’s ecological characteristics, management strategies, and key threats (Appendix 1). If a PLA was managed by multiple individuals, interviews were undertaken with the landholder who was available and willing to be interviewed. All interviews were recorded, and open-ended questions were later transcribed by the lead author.

2.3. Perceived threats to PLCAs

During the interview, the landholder was asked “What do you perceive to be the most disturbing impacts/threats to the park’s objectives?” (Appendix 1). Their answers to this question were recorded and later transcribed. Following the strategy of grounded theory, these transcriptions were analysed by way of thematic coding. Codes (phrases representing a single idea) were identified and then allocated into
broader threat themes, based on critical reading of all transcribed interviews and guided by the International Union for the Conservation of Nature-Conservation Measures Partnership (IUCN-CMP) classification scheme (Salafsky et al., 2008) and the broader literature on PAs. The IUCN-CMP scheme was used as a guide given its widespread use in identifying and categorizing biodiversity threats (e.g., Hausmann et al., 2019; Joppa, 2016; Schulze et al., 2018), thus promoting comparability with other studies. The IUCN-CMP scheme defines direct threats as “the proximate human activities or processes that have caused, are causing, or may cause the destruction, degradation, and/or impairment of biodiversity targets” (Salafsky et al., 2008, p 898), and classifies these threats into 11 broad categories (Table 1). If coded interview statements aligned with one of these threat categories, they were assigned to that category.

The remaining codes identified from interview transcriptions were not reflective of any of the IUCN-CMP categories of direct threats. These were allocated into four additional categories (see results) that were defined to be as mutually exclusive as possible, such that each threat mentioned by a landholder fitted within only one category. Threat categories were differentiated according to their scale of emergence, given the growing literature on the importance of cross-scale interactions in social-ecological systems in general (Reyers et al., 2018; Rocha et al., 2018; Scholes et al., 2013) and PAs in particular (Cumming et al., 2015; De Vos et al., 2017; Wade et al., 2011). Thus, each threat mentioned by PLCA landholders was allocated to one of 15 categories (11 direct threat categories – Table 1, and 4 broader-scale categories – see results).

We used transcriptions of landholders’ threat descriptions to identify any interactions that were mentioned between threats. These interactions were identified by statements including more than one threat category, where a threat in one category was stated to have an impact on a threat in another category.

2.4. PLCA spatial characteristics

PLCA spatial attributes were quantified (Table 2), following previous studies on PAs (Bowker et al., 2017; Schulze et al., 2018). PLCA boundaries were compiled from the South African cadastral data based on farm names provided during the interview (Appendix 1), and PLCA size (1) was calculated. Hilliness within each PLCA was measured as the standard deviation of the property’s elevation (2), using Shuttle Radar Topography Mission Digital Elevation Data Version 4. Remoteness was measured as the distance to the nearest town (3) (>50,000 residents; Bowker et al., 2017) and road (4), with road and town data obtained from the South African census. These analyses were performed in ArcGIS 10.

2.5. PLCA management characteristics

During the interview, landholders were asked about their PLCA management (Appendix 1). For this study we quantified six attributes that have been shown to reflect different PLCA management strategies (Clements and Cumming, 2017). Each interviewee was asked whether the landholder was dependent on revenues generated by the PLCA to cover its operational expenses (“financial dependence”; 1), what proportion of the PLCA’s revenue was generated from ecotourism (2) and hunting (trophy and meat hunting) (3), and to rate the importance of international tourists to the PLCA on a scale from one (not important) to five (very important) (4). Finally, we asked landholders to provide us with a species list (only mammal lists were consistently available), from which we determined the number of megafauna (5) (i.e., mega-herbivores such as elephant and rhinoceros, and large predators such as...
lion and antelope (6) (i.e., equid and bovid species) that the PLCAs supported. Most PLCAs in South Africa are former farmland on which large mammals were extirpated; megafauna and antelope therefore have to be actively reintroduced as part of the management strategy, with megafaunal introduction requiring adequate perimeter fencing and being particularly desired by ecotourists (Clements and Cumming, 2017). The richness of megafaunal and antelope species on a PLCA is thus considered to be part of its management strategy.

2.6. Correspondence between PLCA threats, and PLCA spatial and management characteristics

To test our hypothesis that patterns in perceived threats would correspond with PLCA spatial and management characteristics, we performed co-inertia analyses (CoIAs), excluding three PLCAs for which landholders identified no threats, as well as 26 PLCAs for which we did not have complete data (resulting in a sample size of 83 PLCAs). Given the low number of PLCAs mentioning the IUCN-CMP direct threat categories of residential and commercial development, energy production and mining, transportation and service corridors, human intrusions and disturbance, pollution, agriculture, and geological events (see Fig. 1), these categories were excluded from the CoIAs. Six direct threat categories were thus included, together with the four additional socio-economic threat categories. CoIA is a multivariate method that identifies co-variances between two data matrices (such as two principal component analyses; PCAs), based on Tucker’s inter-battery analysis (Tucker, 1958). It is used in a similar manner to canonical correlation analysis, but is more flexible and robust in situations where the number of variables is high relative to the number of samples, as is the case here (Borcard et al., 2011; Dray et al., 2003).

Three CoIAs were performed: comparing patterns in perceived threats (n = 10 categories) to (1) PLCA spatial characteristics (n = 4); (2) PLCA management characteristics (n = 6) and (3) both spatial and management characteristics (n = 10; Table 2). In each of the three analyses, a PCA of the standardized data (correlation matrix) was first performed on each of the two data tables (threats and PLCA characteristics), with the number of axes to be retained in each analysis specified as three based on the broken stick method (Borcard et al., 2011). The overall similarities between the two correlation matrices were then determined using a CoIA (Borcard et al., 2011). A multivariate generalization of the Pearson correlation coefficient (RV-coefficient) was used to assess the degree of similarity between matrices, calculated as the ratio of the total co-inertia to the square root of the product of the squared total inertias of the separate analyses (Dolédec and Chessel, 1994; Dray et al., 2003). A higher RV-coefficient (within the range of 0–1) indicates a higher degree of covariance, and a Monte-Carlo permutation test (permutated 1000 times) was used to assess its significance.

The significant CoIA with the largest RV score (see results) was then interpreted using a pair of biplots that represent the contribution of the variables in each data matrix to the canonical space. The percentage of total co-variation captured by the two axes of that biplot was determined. The more similar the directions of biplot arrows representing variables, the stronger the positive covariance between those variables. PCAs, CoIAs and RV-coefficients were performed and plotted with the ade4 R package (functions “dudi.pca”, “coincertia” and “RV.rtest”, respectively) (Dray and Dufour, 2007).

3. Results

3.1. Direct threats to PLCAs

Of the 112 interviewed landholders, 109 perceived at least one threat to their PLCA. Direct threats to biodiversity, as defined by the IUCN-CMP categories, were mentioned by 73% of landholders. Biological resource use was the most commonly mentioned direct threat (23% of landholders), almost entirely due to poaching concerns, with many landholders mentioning rhino poaching specifically (Fig. 1).

Severe weather (droughts and floods) was a concern to a fifth of landholders, while just less than a fifth were concerned about natural system modifications (inappropriate fire regimes) and problem species and disease (alien invasive plant species, predators that kill antelope, and diseases that affect antelope; Fig. 1). Residential, commercial and transport (road and railway) development and energy production (gas drilling, mining, wind farms) were of concern to less than 15% of landholders, while human intrusions (recreational activities and trespassing); pollution (pesticides and herbicides); and agriculture were of concern to a less than 5% of landholders (Fig. 1). Geological events were of no concern.

3.2. Multi-scale, socio-economic threats to PLCAs

The majority of landholders (72%) also mentioned threats that were not represented by any of the IUCN-CMP categories of direct threats to biodiversity. These threats were grouped into four categories (Table 3). A sixth of landholders were concerned about globally emergent socio-economic changes, including a volatile global economy, population growth, and growing anti-trophy hunting sentiments. Governance and national socio-economic policies, including the current government, South African political situation, political instability and/or South African legislation, were a concern for 41% of landholders.

Legislation commonly perceived to be a threat included policies regarding land reform (i.e., land redistribution to previously disadvantaged communities), tax and interest rates, minimum wages, and

![Fig. 1. Ranked frequency of direct threats mentioned by 112 landholders of Private Land Conservation Areas, according to the IUCN-CMP Threats Classification Scheme.](image-url)
were also noted by landholders to present other management challenges (depending partly on the feedbacks between governance, economic instability and economic downturns could cause increased poaching for this, to anyone that worse things get the more poaching happens)

3.3. Perceived interactions between threats to PLCAs

Landholders described how direct threats to biodiversity on their PLCAs (Fig. 1) were influenced by broader-scale, socio-economic threats (Table 3). For example, there were concerns that global change increased the frequency of extreme weather (e.g., “climate change is increasing the risk of flooding”), and that regional and national political instability and economic downturns could cause increased poaching (depending partly on the feedbacks between governance, economic growth, and rural-urban migration). One landholder stated that “political threats, safety and security is an issue I think in a remote place like this, to anyone that’s living on the farm and to the wildlife, because the worse things get the more poaching happens”.

Beyond their impact on biodiversity within PLCAs, direct threats were also noted by landholders to present other management challenges that threatened their PLCAs. One landholder stated that “if it doesn’t rain here we’re in big trouble here, we’ve got hippos in dams, if the rivers dry up. If we have to feed animals here, financially it won’t be sustainable for longer than 3 months”. The cost of managing (moving, feeding or culling) antelope if there was no rain can thus threaten PLCA financial viability. PLCA financial viability can similarly be threatened by the cost of managing alien vegetation (e.g., “managing alien invasion takes a lot of effort and money”) and the reduced live market value of wildlife (particularly rhino) caused by the rising costs of preventing poaching (“poaching drops the value of game”).

PLCA financial viability was also threatened by broader-scale socio-economic events, such as regional crime (e.g., “crime in the region, it erodes value of reserve which means less money for conservation”), national legislation (e.g., “labour has become too expensive through minimum wages with the labour act”) and global economic environments (e.g., “globally there are some financial pressures, I think people have less disposable income to visit far lying places like ours”). Global changes can also result in national changes that then threaten PLCAs. For example, there were concerns that global anti-hunting sentiments would result in national legislation that restricted or prevented trophy hunting in the country (e.g., “people make wrong hunting choices, which gives opponents [the global anti-trophy hunting community] ammunition, and puts pressure on governments to stop hunting”).

3.4. Correspondence of PLCA characteristics with perceived threats

Spatial characteristics of PLCAs alone did not correspond significantly with patterns in landholders’ perceived threats ($RV = 0.065, p = 0.4, n = 83$). By contrast, when considered collectively, PLCA spatial and management characteristics corresponded significantly with patterns in perceived threats ($RV = 0.117, p = 0.01, n = 83$; Fig. 2).

Landholders of PLCAs that were far from roads and generated revenues through hunting were most concerned about national socio-economic changes, problem species and extreme weather. By contrast,
landholders that generated revenues through ecotourism were most concerned about regional socio-economic changes and, to a lesser extent, PLCA management challenges. Landholders of PLCAs that supported megafauna and attracted international tourists tended to be most concerned with poaching and regional socio-economic change, and to a lesser extent global socio-economic change. Global socio-economic concerns also corresponded with landholders of large PLCAs that supported many antelope species and were financially dependent on revenues generated from their PLCAs. Landholders of PLCAs that were remote, hilly and small with few megafauna and antelope species were consistently concerned about inappropriate fire regimes and tended to not be concerned about global or regional socio-economic change or poaching.

4. Discussion

By documenting the perceived multi-scale threats to over 100 PLCAs in South Africa, our findings contribute to addressing uncertainty around the likely permanence of private land conservation. We demonstrate that the threats to this permanence are determined not only by the spatial characteristics of PLCAs, but also by how they are managed and the socio-economic environments in which they are embedded. The potential for interactions between direct threats to biodiversity, PLCA management challenges, and broader-scale socio-economic threats highlights the complex, multi-scale arena in which private land conservation functions.

Illegal hunting (i.e., poaching) was the most commonly mentioned concern for PLCAs in this study, mirroring the recent finding that unsustainable hunting was the most widespread threat to statutory PAs in developing countries (Schulze et al., 2018). Private landholders are custodians of around half of South Africa’s rhinos, with poaching on private land therefore a direct threat to this species (Clements et al., 2020). The risk of rhino poaching presents management challenges, since anti-poaching activities are extremely costly to private landholders (Clements et al., 2020). Given that South African PLCAs typically receive no funding support, and perceive financial viability to be a key threat, an inability to cover the increased running costs arising from threat mitigation activities could cause many to change land use or sell. A direct threat to one species can thus threaten biodiversity more broadly through its impact on PLCA financial viability.

Direct threats to biodiversity on South African PLCAs (Fig. 1) were found to be influenced by broad-scale socio-economic factors (e.g., international and national politics and economics influence the threat of poaching). Broader-scale socio-economic changes can, however, also directly threaten PLCAs as a land use. International and national politics (e.g., growing anti-trophy hunting sentiments) and economics (e.g., recessions) were perceived by landholders to have a negative effect on ecotourism and hunting industries. Many PLCAs depend on these industries to remain financially viable, and have stated that they would adopt an alternative land use like farming if their PLCA became unviable (Parker et al., 2020; Taylor et al., 2020). Biodiversity on these PLCAs is therefore not just at risk from direct threats, but also ultimately from the loss of capacity to persist as a conservation land use in the long term, which depends on PLCA resilience to broader socio-economic change and its consequences for management. This finding for PLCAs supports a growing body of research on statutory PAs highlighting the influence of multi-scale, social-ecological contexts on PA resilience (Cumming et al., 2015; Palomo et al., 2014).

As has been observed for statutory PAs (Bowker et al., 2017; Schulze et al., 2018), South African PLCAs that were further from towns and hillier tended to be exposed to fewer direct threats to biodiversity (with inappropriate fire regimes being the only consistent concern; Fig. 2). These PLCAs also tended to be smaller, however (Fig. 2), which is contrary to findings that smaller statutory PAs are more vulnerable to threats than larger PAs (Bowker et al., 2017; Tranquilli et al., 2014). Rather, patterns in many of the threats perceived by landholders were better explained by PLCA management characteristics than spatial ones. For example, landholders of ecotourism-focused PLCAs were consistently concerned with regional socio-economic change. Ecotourism enterprises typically employ more staff and require them to be more skilled than hunting enterprises, and accommodate more visitors per year (Sims-Castley et al., 2005; Taylor et al., 2020). This may make them more susceptible to challenges from labour unions, a regional shortage of skilled labour, and management challenges associated with staff and visitors.

By contrast, national government and legislation were consistent concerns for South African PLCAs that generate revenues through hunting (Fig. 2). This industry is regulated by policies that influence the type and number of antelope that can be stocked, translocated and hunted (Cousins et al., 2010). Hunting PLCAs also tend to be less profitable than high-end ecotourism properties in the region (Clements et al., 2016), which may make them more susceptible to legislation that increases minimum wages and interest/tax rates. Landholders of hunting PLCAs are often distrustful of government and its regulation of the industry due to a perceived lack of consultation and inconsistent regulation (Brink et al., 2011; Pasquini et al., 2010). Landholders of hunting PLCAs were also consistently concerned about extreme weather, supporting previous findings that hunting PLCAs are vulnerable to low rainfall decline it reduces the number of antelope that can be sustainably hunted (Clements and Cumming, 2018).

It is important to reiterate that the threats described in this paper are landholders’ perceived threats. If a landholder does not mention a threat, it does not mean that their PLCA is not vulnerable to the threat. A good example is the threat of a global pandemic, which no landholders mentioned but which currently threatens the viability of many PLCAs due to the impact of COVID-19 on global travel and thus PLCA revenue streams (Stoddard, 2020). Conversely, landholders may be concerned

| Category | Threats included in this category | Scale of threat emergence | Landholders % |
|----------|----------------------------------|---------------------------|---------------|
| Global socio-economic change [global socio-economics] | World economy, climate change, population growth, anti-trophy hunting sentiments, aviation industry | Global | 16% |
| National socio-economics, including current government, politics and legislation [national socio-economics] | Land reform, tax rates, interest rates, animal movement and management policies, fencing policies, minimum wages | National | 41% |
| Regional socio-economics [regional socio-economics] | Crime, lack of education in the area, unemployment, labour unions, neighbour relations | Regional | 17% |
| Management challenges (PLCA management) | Staff issues, tourist issues, landholder succession, capacity to manage a lodge, housing capacity, maintenance capacity, marketing strategy, mammal overstocking, space limitations, covering large overheads, coping with uncertain incomes | Local (PLCA and surroundings) | 32% |
Given the largely self-funded and emergent nature of private land conservation in South Africa, much of the onus for building the resilience of PLCA to cope with revenue and/or running cost fluctuations, and a high niche for more innovative financial instruments that will help landholders cope better with risk. Diversifying the tourists that PLCA attract (e.g., not focusing solely on international tourists or those from a specific country) can buffer PLCA to socio-economic changes influencing certain markets (Biggs et al., 2012). Similarly, diversifying revenue-generating activities could build the capacity of PLCA to cope with growing anti-trophy hunting sentiments (Naidoo et al., 2016; Parker et al., 2020).

The historic transition of many landholders from livestock-to wildlife-based land uses reflects the capacity of landholders to own wildlife, emphasizing the influence that policy can have in promoting adaptations that benefit conservation (Child et al., 2012; De Vos et al., 2019). Given the largely self-funded and emergent nature of private land conservation in South Africa, much of the onus for building the resilience of PLCA to threats is likely to lie with the landholders themselves, through strategies such as those described in the previous paragraph. However, the notable influence of government on revenues (through the influence of politics on tourism), running costs (through tax, interest, labou and wildlife legislation) and other management challenges (through the need for skilled employees and fair labour unions) highlights the importance of context-relevant and co-produced policy interventions and governance systems for strengthening the resilience of the sector (Cocklin et al., 2007; Pasquini et al., 2010). The provincial biodiversity stewardship programs that have emerged over the past decade present an example of how the government is directly supporting landholders in mitigating threats such as fire and alien invasive species (Cumming and Daniels, 2014).

5. Conclusions

Notable threats to PLCA are not only those that impact biodiversity directly, but also the local to global socio-economic changes that interact to threaten PLCA viability as a land use. These interactions can influence the resilience of PAs in ways that are not anticipated through the consideration of direct threats that are assumed to act independently. While the complexity of the threat landscape may seem unmanageable, we have demonstrated that understanding the spatial and management-related factors that influence PLCA vulnerability to these threats can help identify targeted strategies to build the resilience of this important conservation mechanism.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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