

## LETTER

# Over 80% of Africa's savannah conservation land is failing or deteriorating according to lions as an indicator species

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## Abstract

Calls to increase the global area under protection for conservation assume existing conservation areas are effective but, without adequate investment, they may not be. We collected survey data from expert respondents on perceived budgets, management, and threats for 516 protected areas and community conservation areas in savannah Africa to create a Conservation Area Performance Index. Combining this index with an indicative biodiversity outcome—population status of African lion, *Panthera leo*—we found that 82% of the sampled area was in a state of failure or deterioration, with only 10% in a state of success or recovery. A large proportion of succeeding or recovering conservation areas received external support through collaborative management partnerships. That Africa's current conservation area network—the foundation of conservation efforts—is crumbling complicates proposed strategies to protect additional land. We contend that investing in the effective management of existing conservation areas—potentially through well-structured collaborative management partnerships—should be prioritized urgently.

## KEYWORDS

African lion, area-based conservation, collaborative management partnerships, funding, management, protected area expansion

## 1 | INTRODUCTION

We now live in the Anthropocene: the geological age of pervasive human impact on nature, including widespread environmental degradation and massive biodiversity loss (Barnosky et al., 2011; Dirzo et al., 2014; Johnson et al., 2017; Lewis & Maslin, 2015; Venter et al., 2016). As anthropogenic pressures have intensified, the amount of land

protected for biodiversity has increased substantially, with ~14.7% of the Earth's land area now under protection (Johnson et al., 2017; UNEP-WCMC et al., 2018). Protected areas (PAs) are the foundation upon which biodiversity conservation efforts depend (Dinerstein et al., 2019; Gray et al., 2016; Johnson et al., 2017).

Despite increased PA coverage, the current PA network is insufficient to safeguard global biodiversity

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(Wilson, 2016). Many conservationists argue for vastly increasing the geographical coverage of traditional PA networks and conservation initiatives on community land for the benefit of both people and biodiversity (Dinerstein et al., 2017, 2019; Waldron et al., 2020; Wilson, 2016). Conservation NGOs, donors, and scientists champion new targets for area-based conservation including 30% terrestrial protection by 2030 and 50% by 2050 (Dinerstein et al., 2019; Waldron et al., 2020). However, some question what counts as “protected,” arguing that “paper parks” (i.e., PAs with formal designation but inadequate management) add to area-based targets but fail to safeguard biodiversity (Visconti et al., 2019). PA designation without effective management will likely fail to achieve desired biodiversity outcomes (Visconti et al., 2019), and this disconnect has become especially apparent in parts of Africa.

Several African countries, especially in the south and east, are world-leaders in area-based conservation with extensive networks of both traditional PAs and/or community conservation areas—hereafter collectively called conservation areas—that eclipse the global average (Lindsey et al., 2017a; UNEP-WCMC et al., 2018). For example, Botswana (~29%), Mozambique (~29%), Namibia (~38%), Tanzania (~38%), Zambia (~41%), and Zimbabwe (~27%) all far exceed the Aichie target of 17% of terrestrial land area protected by 2020 (UNEP-WCMC et al., 2018; UNEP-WCMC & IUCN, 2019). Partly because of this extensive network of conservation areas, Africa is a refuge for the highest diversity and concentrations of the world’s megafauna (Lindsey et al., 2017a; Ripple et al., 2014, 2015) and contains large tracts of intact wilderness (Watson et al., 2016) and carbon sinks (Bebber & Butt, 2017). However, Africa’s human population is growing rapidly, the continent is developing quickly, and many conservation areas are struggling. Africa has shouldered the considerable responsibility of managing an extensive conservation area network that benefits the world while forgoing other economic opportunities, even as many African countries remain among the poorest in the world (Lindsey et al., 2017a). As such, most African conservation areas are chronically underresourced (Lindsey et al., 2018), and many are unable to sufficiently avert anthropogenic pressures (Jones et al., 2018; Lindsey et al., 2017b) to achieve their ecological (Craigie et al., 2010; Lindsey et al., 2017b; Robson et al., 2017) and socioeconomic potential (Lindsey et al., 2014). Prudent investment of resources into new conservation areas in Africa necessitates a more thorough accounting of the capacity of the current conservation area network to underpin area-based biodiversity conservation in the future.

Here, we create a unique index to understand the current ability of a sample of conservation areas (including PAs and community conservation areas) in savannah

Africa to manage threat burdens and deliver conservation results. We combine conservation area experts’ perceptions of budget adequacy, management effectiveness, and anthropogenic threats to calculate a Conservation Area Performance Index (CAPI). We then test the index’s ability to appropriately capture conservation outcomes by relating it to the population status of African lion (*Panthera leo*), a well-studied indicator species that plays a key functional role in savannah ecosystems and can therefore serve as a proxy for overall conservation efficacy (Lindsey et al., 2018; Ripple et al., 2014). Lastly, we classify conservation areas as failing, deteriorating, succeeding, and recovering based on their CAPI scores and lion population status and discuss our findings in the context of future investment in area-based conservation in Africa.

## 2 | METHODS

### 2.1 | Sampled protected and community conservation areas

This study considered PAs and community conservation areas within or directly bordering the known African lion (*Panthera leo*) range (IUCN SSC Cat Specialist Group, 2018). We chose to sample conservation areas in the lion range because (i) the range is expansive, encompassing the majority of Africa’s savannah conservation land, including some of Africa’s largest, most iconic conservation areas; (ii) as top predators, lions are an indicator species; and (iii) lions are well studied, making accessing background data easier (Trimble & van Aarde, 2010). We sourced conservation area shapefiles from the World Database on Protected Areas (UNEP-WCMC & IUCN, 2019), local NGOs, and government agencies. In total, we considered 840 PAs and community conservation areas, combined, covering ~2.1 million km<sup>2</sup>. For a description of the categories of conservation areas included in the study, see Supporting Information Section 1.

### 2.2 | Determining budget adequacy, management effectiveness, and threat severity

We conducted structured questionnaire surveys with conservation experts from NGOs, conservation projects, research institutions, government departments, national wildlife authorities, safari companies, and consulting firms to collect data on perceived budget adequacy, management effectiveness, and threat severity in each conservation area (see Supporting Information Section 2 for more details).

**TABLE 1** Management categories that survey respondents rated while considering the associated management activities

Management categories	Associated management activities
Governance and asset management	<ul style="list-style-type: none"> <li>• Financial management</li> <li>• Control of corruption</li> <li>• Infrastructure development and maintenance</li> </ul>
Operational management	<ul style="list-style-type: none"> <li>• Antipoaching and law enforcement</li> <li>• Wildlife management (e.g., population management, veterinary services)</li> <li>• Habitat management (e.g., fire, rangeland* and natural resource management)</li> </ul>
Community engagement and beneficiation	<ul style="list-style-type: none"> <li>• Human–wildlife conflict mitigation</li> <li>• Awareness-raising and education</li> <li>• Community development</li> <li>• Benefit-sharing*</li> </ul>
Conservation-related revenue generation	<ul style="list-style-type: none"> <li>• Phototourism</li> <li>• Trophy hunting</li> <li>• Other (e.g., wildlife sales)</li> </ul>
Science and monitoring	<ul style="list-style-type: none"> <li>• Academic research</li> <li>• Wildlife, habitat, and/or community monitoring</li> </ul>

\*Management activities that were primarily considered for community conservation areas and not PAs.

### 2.2.1 | Budget adequacy

We asked respondents to rate perceived adequacy of annual management budgets (including all management-related expenditures, salaries, operational expenditures, infrastructure and capital investments, and community projects) to effectively manage conservation areas on a six-point scale ranging from 0 (no/negligible management budget) to 5 (very high/completely adequate). To test the appropriateness of budget adequacy ratings, we compared them to actual budget estimates gathered from a sample of respondents (see Supporting Information Section 3).

### 2.2.2 | Management effectiveness

We asked survey respondents to rate their perception of the effectiveness of 15 management activities across five categories (Table 1) on a six-point scale from 0 (the management activities are necessary but not implemented) to 5 (the management activities are implemented very effectively and require no improvement). We calculated the overall management category effectiveness score as the rounded mean of activity ratings within that category. For respondents that provided information for multiple conservation areas, we expedited the survey process by asking them to rate their perceived effectiveness of the five management categories—while considering the associated

management activities (Table 1)—on the same six-point scale. We defined management categories and activities based on previous assessments (Lham et al., 2019; Lindsey et al., 2017b, 2018; Stolton & Dudley, 2016) and consultation with experts. We calculated a Management Effectiveness Index for each conservation area—indicative of overall management effectiveness—as the arithmetic mean of the effectiveness ratings for all five management categories.

### 2.2.3 | Threat severity

To determine the severity of threats to governance, wildlife, and habitats, we asked respondents to rate each of eight threats—while considering threat descriptions (Table 2)—on a six-point scale from 0 (no threat: the threat could occur but is absent) to 5 (very severe: the threat is present and could be considered a crisis with the destruction of habitats and/or localized extinction of wildlife likely in the short term). The threats considered in this study—and the rating methodology—were based on procedures designed to rapidly assess threat status and were tailored to the context of African conservation areas and lions (Lham et al., 2019; Lindsey et al., 2017b, 2018; Salafsky et al., 2008; Stolton & Dudley, 2016). We calculated overall severity ratings for each category (i.e., governance, wildlife, and habitat) as the maximum severity rating of threats within that category. A Threat Severity Index for each conservation area—indicative of overall threat severity—was

**TABLE 2** Governance, wildlife, and habitat threats that survey respondents rated the severity of while considering the threat descriptions

Threat category	Threats	Threat description
Governance threats	War and civil instability	<ul style="list-style-type: none"> <li>War, militarization, and/or civil instability affecting the management of the conservation areas.</li> </ul>
Wildlife threats	Poaching of wildlife for nonmeat body parts	<ul style="list-style-type: none"> <li>Poaching of wildlife for horns, skin, teeth, bones tusks, etc. and associated reductions in population numbers.</li> </ul>
	Poaching of wildlife for bushmeat	<ul style="list-style-type: none"> <li>Poaching of wildlife for bushmeat and associated reductions in population numbers.</li> <li>Accidental mortality of nonbushmeat species in traps and associated reductions in population numbers.</li> </ul>
	Unsustainable legal utilization of wildlife	<ul style="list-style-type: none"> <li>Excessive trophy hunting quotas in or adjacent to the conservation area and associated reduction in population numbers.</li> <li>Excessive ration hunting / legal meat hunting and associated reductions in population numbers.</li> </ul>
	Human–wildlife conflict	<ul style="list-style-type: none"> <li>Human–wildlife conflict resulting in the retaliatory and/or killing of wildlife and associated reductions in population numbers.</li> <li>Cultural and/or ritual killings of wildlife and associated reductions in population numbers.</li> </ul>
Habitat threats	Development	<ul style="list-style-type: none"> <li>Major infrastructural development (including roads, dams, railways, towns, mines, forestry, etc.) within or adjacent to the conservation area affecting wildlife and habitats.</li> </ul>
	Human encroachment and/or expansion	<ul style="list-style-type: none"> <li>Encroachment of people into the conservation area and consequent issues (e.g., tree cutting for charcoal/firewood, agriculture, human settlements) associated with habitat loss and competition with wildlife.</li> </ul>
	Livestock encroachment and/or expansion	<ul style="list-style-type: none"> <li>Encroachment of livestock into the conservation area and consequent issues associated with habitat loss and competition with wildlife.</li> </ul>

calculated as the arithmetic mean of the severity of governance, wildlife, and habitat threat categories.

### 2.3 | Calculating the Conservation Area Performance Index

We calculated a Conservation Area Performance Index (CAPI) to combine information on budget adequacy, management effectiveness, and threat severity for each conservation area. We reasoned that the primary role of management is to mitigate anthropogenic threats and that insufficient management to alleviate threats would negatively affect biodiversity. Although management budgets and effectiveness are generally correlated (Lindsey et al., 2017b, 2018), we separated these measures when calculating the CAPI to account for any relative discrepancies in perceptions (e.g., high management effectiveness rating with low

budget rating). We calculated the CAPI for each conservation area as follows:

$$((\text{Budget adequacy} + \text{Management Effectiveness Index}) \div 2) - \text{Threat Severity Index} = \text{CAPI}.$$

CAPI ranged from −5 to 5, and we hypothesized that a value could be identified where management balanced the severity of threats in the conservation area to maintain biodiversity. We chose our method because of its simplicity and intuitiveness, although there are many approaches that could have been used to combine the data.

To comply with requests for anonymity from some respondents and to ensure that underresourced conservation areas are not negatively affected by our findings (e.g., targeted by poachers because of inadequate management), we present and compare results at the country- and

regional-level following African Union designations, with Central and West Africa combined because of the relatively low number of surveyed conservation areas in West Africa. We also compared by management regime (i.e., conservation areas under state or community management; private management; or different forms of collaborative management partnerships). For a description of management regimes, see Supporting Information Section 4.

## 2.4 | Testing and interpreting the Conservation Area Performance Index

We tested the appropriateness of the CAPI in representing biodiversity outcomes in conservation areas by comparing CAPI to the population status of lions (based on population estimates and empirically calculated carrying capacities where available or experts' perceptions, see Supporting Information Section 5). We calculated logistic regressions between the CAPI (continuous;  $-5$  to  $5$ ) and lion population status (binary;  $\geq$  or  $<$  50% of carrying capacity) separately for PAs and community conservation areas and excluded overly influential data points (i.e., data points with a Cook's distance of  $> 4$  times the mean Cook's distance). We used the calculated logistic regressions to determine the CAPI cut-off values at which PAs and community conservation areas had  $\geq 50\%$  probability of lions being  $\geq 50\%$  of carrying capacity. We confirmed the appropriateness of lion population status as an indicator for the performance of other wildlife and habitat by (1) comparing lion population status and CAPI to expert-perceived prey population status, available for a subset of conservation areas ( $n = 150$ ) and (2) comparing lion population status to tree cover loss (see Supporting Information Section 8).

Using this CAPI cut-off, 95% confidence intervals (CI), and lion population status, we classified conservation areas into four performance categories: succeeding (CAPI  $>$  upper 95% CI of cut-off, lions  $\geq 50\%$  carrying capacity); recovering (CAPI  $>$  upper 95% CI of cut-off, lions  $< 50\%$  carrying capacity); deteriorating (CAPI  $<$  lower 95% CI of cut-off, lions  $\geq 50\%$  carrying capacity); and failing (CAPI  $<$  lower 95% CI of cut-off, lions  $< 50\%$  carrying capacity), with two additional intermediate categories (CAPI within 95% CI of cut-off value).

## 3 | RESULTS

We collected data to calculate, test, and interpret the CAPI for 347 PAs covering  $\sim 1.4$  million  $\text{km}^2$  and 169 community conservation areas covering  $\sim 186,000$   $\text{km}^2$  (Figure 1). This represents  $\sim 62\%$  of all conservation areas initially considered and  $\sim 75\%$  of their total combined area (Central-West

Africa =  $\sim 78\%$  of considered area; East Africa =  $\sim 76\%$ ; Southern Africa =  $\sim 70\%$ ). Due to likely differences in how budget adequacy, management effectiveness, and threat severity are perceived for different conservation area types, we present all results separately for PAs and community conservation areas.

### 3.1 | Conservation Area Performance Index (CAPI)

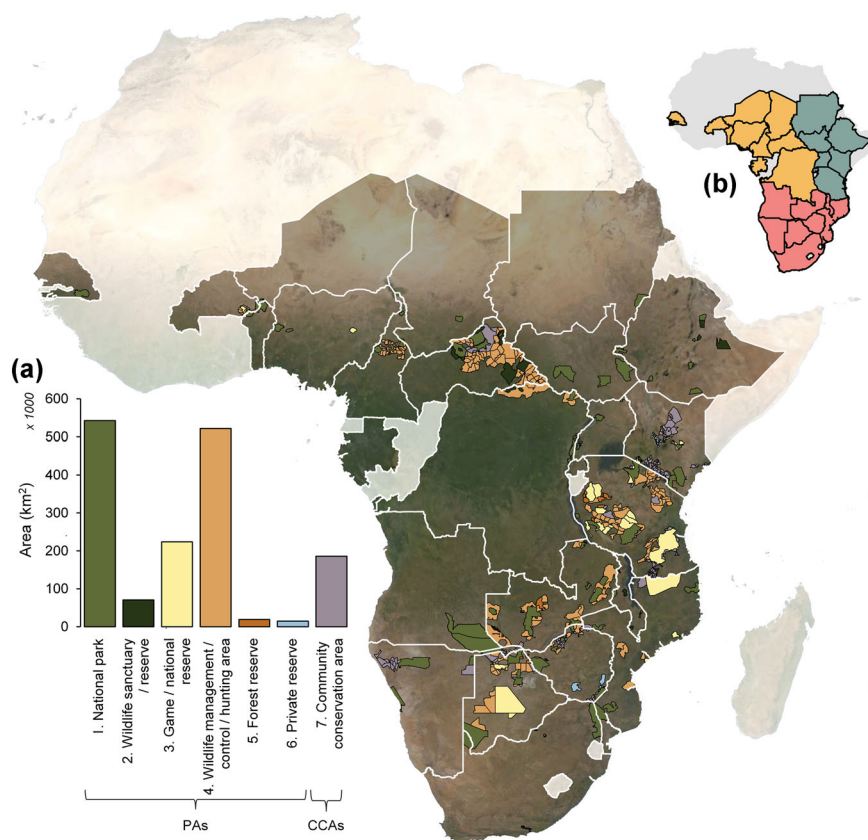
For PAs, CAPI values ranged from  $-5$  (worst) to  $4$  (best) and varied significantly by region (weighted Kruskal-Wallis  $p < 0.001$ ). Central-West Africa PAs achieved the worst CAPI scores (weighted [by area] median =  $-4.33$ ), followed by East Africa ( $-1.47$ ), and Southern Africa ( $-0.37$ ) (Figure 2). All interregional differences were significant (Table S3). CAPI values also differed significantly for community conservation areas among regions (weighted Kruskal-Wallis  $p < 0.001$ ), with Central-West Africa the lowest (weighted median =  $-4.67$ ), followed by Southern Africa ( $-0.10$ ), and East Africa ( $0.27$ ) (Figure 2). CAPI differences between Central-West Africa and other regions were significant; however, differences between East and Southern Africa were not (Table S3). No surveyed conservation area had a perfect CAPI of  $5$ ; however,  $51,500$   $\text{km}^2$  of PAs and  $2000$   $\text{km}^2$  of community conservation areas scored  $-5$  (all in Central-West Africa). In total,  $\sim 372,700$   $\text{km}^2$  ( $\sim 24\%$ ) of surveyed area had no budget, and  $\sim 260,000$   $\text{km}^2$  ( $\sim 16\%$ ) had no active management (for detailed budget adequacy, management effectiveness, and threat severity results, see Supporting Information Section 7).

CAPI values for conservation areas differed significantly by management regime (Kruskal-Wallis  $p < 0.001$  for both PAs and community conservation areas) (Figure 2). CAPI values of state-managed PAs (median =  $-3.00$ ) were significantly worse than those of all other PA management regimes (Figure 2; Table S4), and PAs under delegated ( $1.22$ ) and private management ( $1.47$ ) had the highest CAPI values (Figure 2; Table S4). Similarly, community conservation areas with varying levels of collaborative management partnership support had higher CAPI values than those without (Figure 2; Table S4).

### 3.2 | Relating CAPI to lion population status

CAPI was significantly and positively related to lion population status for both PAs and community conservation areas (Figure 3). The logistic regressions sufficiently distinguished conservation areas with lions





**FIGURE 1** Protected areas (PAs) and community conservation areas surveyed in this study. Insert (a) shows the surveyed area of different designations of PAs and community conservation areas (see Supporting Information Section 1 for more information) and insert (b) shows the three regions of Africa (Central-West Africa = orange; East Africa = turquoise; Southern Africa = pink) used to aggregate results. The regions follow African Union designations, and Central and West Africa were combined because of the relatively low number of surveyed conservation areas in West Africa

$\geq 50\%$  and  $< 50\%$  of carrying capacity (both receiver operating characteristics  $> 0.75$ ); however, the PA model provided greater distinguishing power than the community conservation area model (Figure 3). From the logistic regressions, we calculated CAPI cut-offs between conservation areas with lions  $\geq 50\%$  and  $< 50\%$  of carrying capacity as 0.3 (95% CI = 0–0.6) for PAs and 1.4 (95% CI = 1–2.2) for community conservation areas (Figure 3).

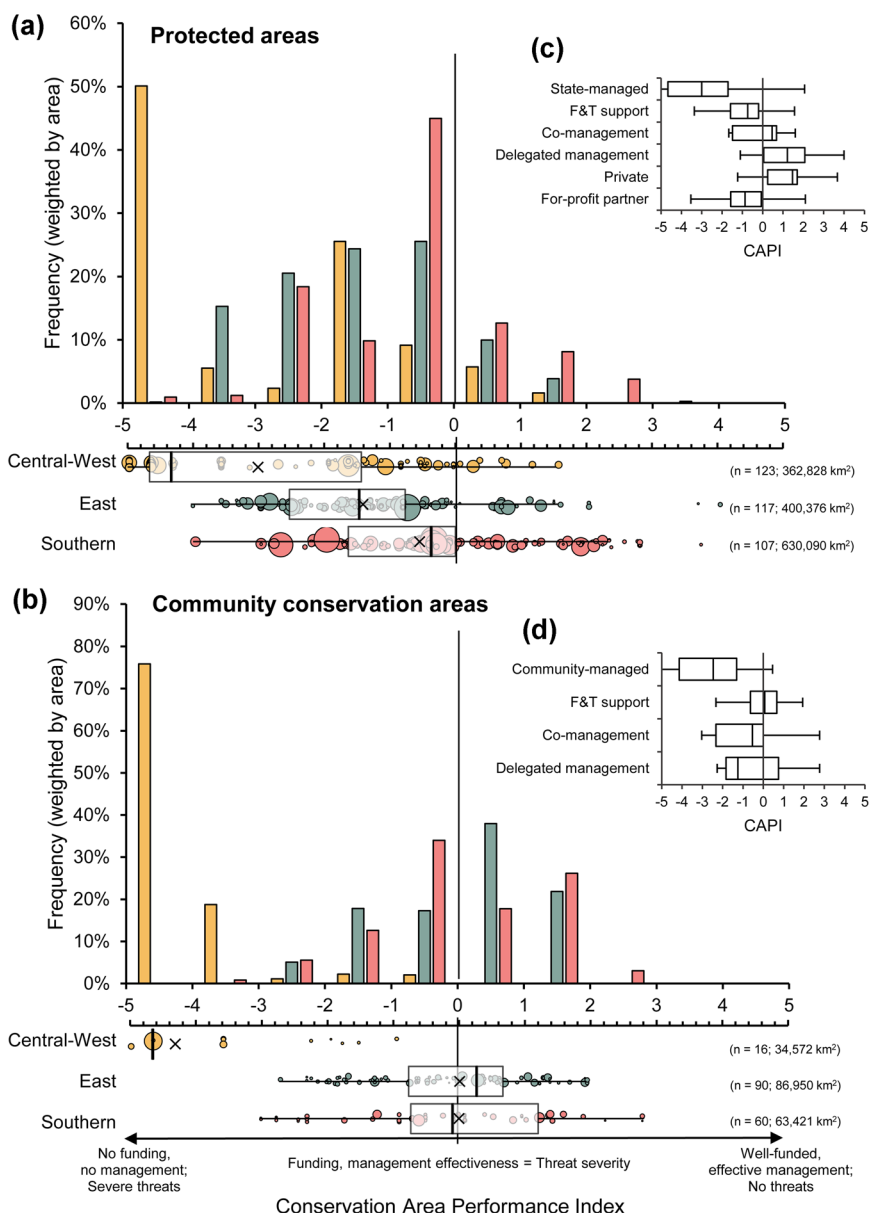
Using the CAPI cut-offs and lion population status, we calculated that 91% (~330,700 km<sup>2</sup>) of the area covered by Central-West African PAs was failing (CAPI  $<$  lower 95% CI of cut-off, lions  $< 50\%$  carrying capacity), as was 67% (~268,800 km<sup>2</sup>) of East and 58% (~365,000 km<sup>2</sup>) of Southern African PA area (Figures 3 and S7). Combined, that is 69% of the total PA area surveyed. Approximately 13% (~187,200 km<sup>2</sup>) of all PA area was deteriorating (CAPI  $<$  lower 95% CI of cut-off, lions  $\geq 50\%$  carrying capacity), and only 3% (~46,500 km<sup>2</sup>) and 8% (~110,500 km<sup>2</sup>) were recovering (CAPI  $>$  upper 95% CI of cut-off, lions  $< 50\%$  carrying capacity) and succeeding (CAPI  $>$  upper 95% CI of cut-off, lions  $\geq 50\%$  carrying

capacity), respectively (Figures 3 and S7). Only 6% of the PA area surveyed had CAPIs that overlapped the model uncertainty (Figures 3 and S7).

Community conservation areas showed similar patterns. All community conservation areas in Central-West Africa were failing (Figure 4), as was 71% (~61,700 km<sup>2</sup>) of community conservation area land in East Africa and 41% (~26,100 km<sup>2</sup>) in Southern Africa (Figures 3 and S7). Approximately 13% (~24,600 km<sup>2</sup>) of the surveyed community conservation area land was deteriorating, with very little succeeding or recovering (Figures 3 and S7). A high proportion (~20%) of the community conservation area land surveyed had CAPIs in intermediate categories (Figures 3 and S7).

In 8 of the 25 countries included in this assessment, all conservation areas were categorized as failing, and more than half were in an additional eight countries (Figure 4). Although countries in southern Africa tended to have the highest proportion of successful conservation areas, they also had large proportions of deteriorating conservation areas (Figure 4). Collaborative management partner-

**FIGURE 2** The Conservation Area Performance Index (CAPI) of protected and community conservation areas in different African regions (a and b) and under different management regimes (c and d). For (a) and (b), Central-West Africa = orange, East Africa = turquoise, and Southern Africa = pink. The top panels show the frequency (weighted by the area of PAs/community conservation areas) of the CAPI in five equally sized bins (i.e.,  $-5$  to  $-4$ ;  $-4$  to  $-3$ ; ...). The bottom panels are box-and-whisker plots (weighted by the area of PAs/community conservation areas) of the CAPI on a continuous scale from  $-5$  to  $5$ , showing minimum, lower quartile, median, upper quartile, maximum, and mean (xs) values. Individual data points (slightly jittered vertically for ease of presentation) are shown in the bottom panels, and their relative sizes correspond to their associated geographic areas. Insets c and d are box-and-whisker plots of the CAPI for PAs and community conservation areas under different management regimes. F&T support = financial and/or technical support



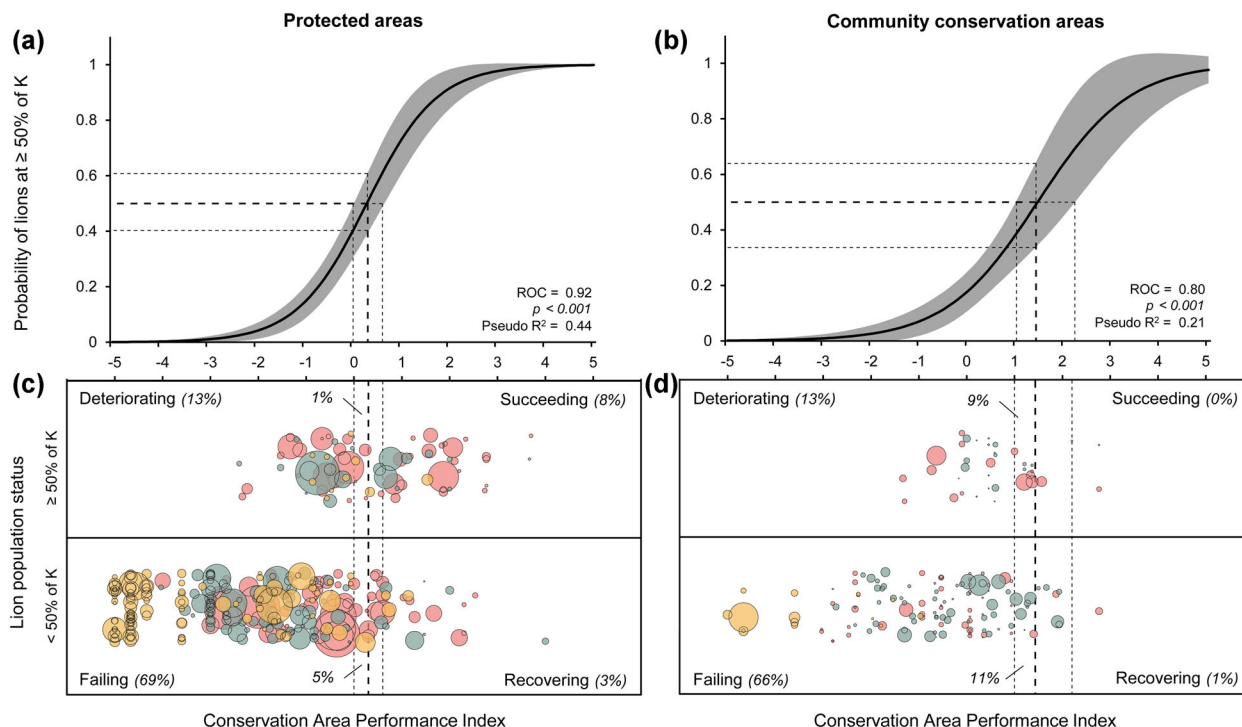
ships encompassed the largest land area of recovering PAs (Figure S8), whereas state management accounted for the largest area of both successful and deteriorating PAs. Community conservation areas that had financial and/or technical support, comanagement, or delegated management appeared to be doing better than those that did not receive external management support (Figure S8).

## 4 | DISCUSSION

The global conservation area network—including traditional protected areas (PAs) and community conservation areas—needs to expand dramatically and purposefully to safeguard biodiversity in the Anthropocene (Visconti et al., 2019; Wilson, 2016). However, the prevalence of “paper

parks”—inadequately managed conservation areas unable to mitigate threats—undermines area-based conservation efforts (Coad et al., 2019; Jones et al., 2018; Visconti et al., 2019). In our study of conservation area performance, we showed that this is especially true in Africa where more than 82% of the conserved area we surveyed was in a state of failure or deterioration with only 10% recovering or succeeding (Figures 3 and 4) as indicated by the Conservation Area Performance Index (CAPI) and the status of lion populations.

That such a large proportion of sampled conservation areas were failing to manage threats effectively to conserve lions is worrying. Lions, like other large carnivores, are an important component of ecosystems, maintaining ecosystem structure, resilience, and diversity through top-down trophic interactions with prey-species and meso-



**FIGURE 3** For protected areas (PAs) and community conservation areas, (a and b) logistic regressions showing the relationship between the Conservation Area Performance Index (CAPI) and lion population status and (c and d) the performance categories of conservation areas in Central-West Africa (orange), East Africa (turquoise), and Southern Africa (pink). For a and b, dark shaded areas are 95% confidence intervals. The thick dashed line shows the CAPI cut-off values where the probability of lions being at  $\geq 50\%$  of carrying capacity (K) is 50%. Thin dashed lines are 95% confidence around the cut-off CAPI values. ROC = Receiver Operating Characteristic. For c and d, PAs and community conservation areas are categorized according to their Conservation Area Performance Index (CAPI) (continuous horizontal axes) and current lion population status (binary vertical axes) relative to CAPI cut-offs (thick dashed vertical lines) calculated using logistic regressions. Cut-offs indicate the CAPI above which PAs/community conservation areas have  $\geq 50\%$  probability of lions being  $\geq 50\%$  of carrying capacity and vice versa. Thin dashed vertical lines are 95% confidence levels around the CAPI cut-offs and indicate CAPI ranges of model uncertainty. Individual datapoints are jittered vertically for ease of presentation (the vertical axes are binary), and the centre point indicates position on the horizontal axes. Datapoint size corresponds to the geographical area of each conservation area

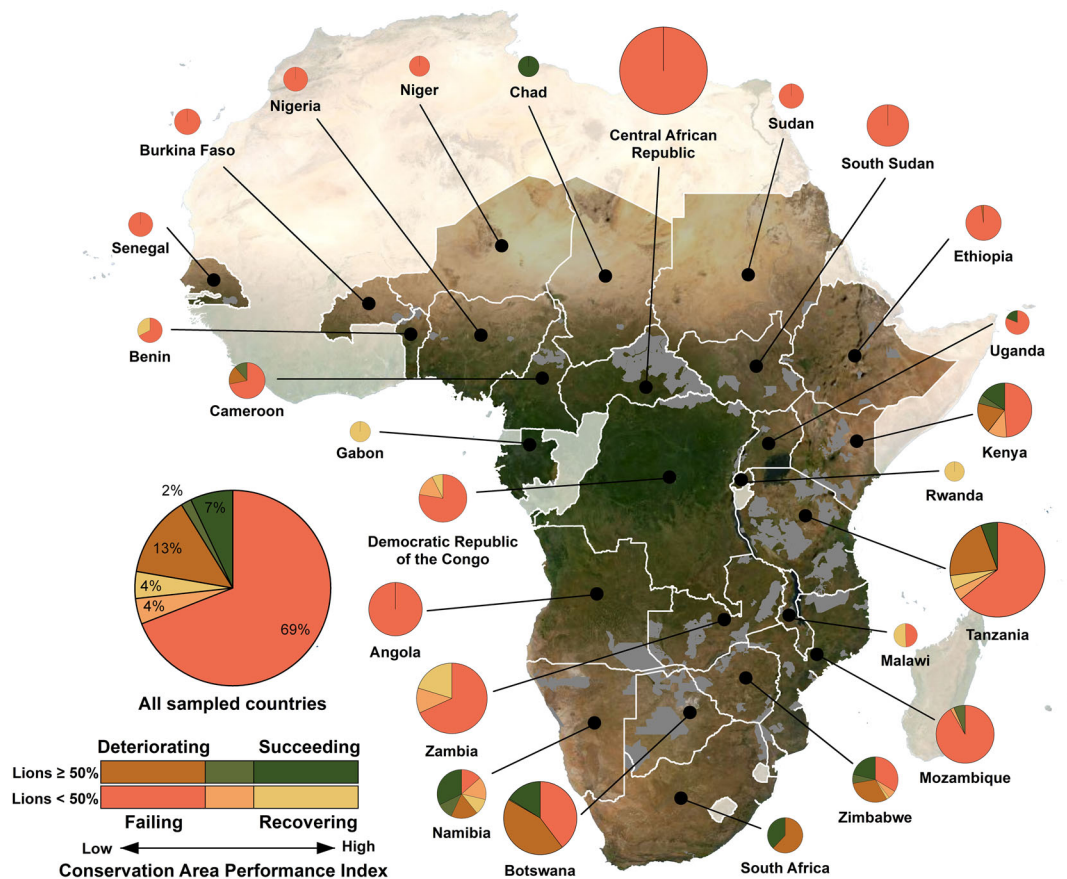
predators (Ripple et al., 2014). As charismatic top predators, lions are visible and useful indicators of ecosystem health because lions rely on intact habitat, an adequate prey base, and protection from anthropogenic threats (Lindsey et al., 2017b; Ripple et al., 2014). Additionally, lion landscapes support important ecosystem services, for example, water provisioning, carbon storage, and cultural and recreational benefits, that could be lost if not adequately protected (Stolton & Dudley, 2019).

Conservation areas unable to maintain lions at  $\geq 50\%$  of carrying capacity often have poor prey population status (Lindsey et al., 2017b) and are likely failing to adequately conserve intact ecosystems (see Supporting Information section 8). These areas may still provide some conservation benefits (Bruner et al., 2001); it is possible, for example, that habitat may remain intact and some species may thrive despite indiscriminate snaring or targeted poaching that collapses the prey-base and/or extirpates lions. However, where management is insufficient to protect lions, it

is likely insufficient to counter habitat threats including unsustainable tree cutting or land conversion. Underperforming conservation areas are unlikely to fulfill their full ecological and socioeconomic potential, and they may risk being downsized, downgraded, or degazetted (Qin et al., 2019; Watson et al., 2014). Our study relied on experts' perceptions, which may be subject to bias (see Supporting Information Section 8 for limitations). However, our designation of failing and deteriorating conservation areas is likely an underestimate for several reasons (see Supporting Information Section 8); for example, for most unsampled conservation areas, an appropriate survey respondent could not be identified, a likely indication of little or no management presence.

Only 7% of assessed conservation area land was in a state of success (Figures 3 and 4). Generally, strong government, donor, and/or community support are prerequisites for success in Africa (Figures 2 and S8) (Lindsey et al., 2017b, 2018). Our estimate of 7% success aligns





**FIGURE 4** A breakdown of country-specific conservation area performance categories. Pie charts show the percentage of the total assessed conservation area in each performance category and are scaled by the total assessed area in each country. Grey areas on the map are surveyed conservation areas

with the work of others (Lindsey et al., 2018). However, ours is the first study to explicitly combine measures of budget adequacy, management effectiveness, threat burdens, and conservation outcomes into a single performance metric—uniquely, for not only PAs but also community conservation areas, providing a more thorough accounting of the state of conservation areas.

Distressingly, our study categorized ~212,000 km<sup>2</sup> (13%) of the sampled area as deteriorating (Figure 3). These are conservation areas that likely owe a “conservation debt”—lion populations exceed 50% of carrying capacity but management capacities are insufficient to mitigate threats (Figure 3). Their success is probably a remnant of past circumstances (e.g., adequate management, lower threats), and without intervention, they will likely descend into a state of failure, especially given that human pressures on nature are likely to intensify in Africa in the future (Bradshaw & Di Minin, 2019). However, deteriorating conservation areas present an opportunity to enhance effective area-based conservation expediently and at a relatively low cost, both financially and socially. Instead of following the potentially long and uncertain path of ecologi-

cal recovery (Seddon et al., 2014), deteriorating conservation areas can shift quickly to a state of success by bolstering financial and/or technical capacity (Lindsey et al., 2021). Timely action could prevent failure, although active conservation measures (e.g., assisted colonization, habitat restoration) may be necessary to overcome the inertia of potential extinction debts (Kuussaari et al., 2009).

The compromised state of Africa’s conservation areas necessitates large-scale recovery efforts to enhance and then maintain conservation area performance. Conservationists and funders must collaborate to rescue deteriorating conservation areas and push those that are failing towards recovery. Although only 3% (~48,000 km<sup>2</sup>) of assessed land was in a state of recovery (Figure 3), recovery is possible. Best-practice examples are emerging from countries as diverse as Benin, Gabon, Malawi, Mozambique, and Rwanda (Figure 4). A large portion of recovering conservation area land is currently under private management or a collaborative management partnership, with external entities—either NGOs or for-profit companies (e.g., safari operators)—taking on management responsibility in collaboration with the state and/or local

people (Figure S8) (Baghai et al., 2018). Considering the high financial burden of conservation area management relative to national wealth in several countries (Lindsey et al., 2017a), external support through well-structured collaborative management partnerships may be an effective approach to move failing conservation areas into a state of recovery and, eventually, success (Baghai et al., 2018; Lindsey et al., 2021). For example, the innovative and long-term collaborative management partnership between the Mozambican government and the Carr Foundation (Pringle, 2017) has been highly effective in restoring lion dynamics (Bouley et al., 2018), large-mammal populations (Stalmans et al., 2019), and ecological processes (Guyton et al., 2020) to the once-failing Gorongosa National Park. Elsewhere, African Parks has engaged in collaborative management partnerships to spur recoveries, for example, Akagera National Park, Rwanda; Majete Wildlife Reserve, Malawi; and Zakouma National Park, Chad (Lindsey et al., 2021). These approaches allow the global community to share responsibility for managing Africa's vast conservation area network.

A uniform approach to investing in Africa's conservation areas is inappropriate as conservation area performance and the drivers thereof differ considerably across the continent (Figures 2–4; Supporting Information Section 7), as do political and cultural contexts. For instance, conservation areas in Central-West Africa are particularly underfunded, mismanaged, and primarily threatened by civil war/unrest, nonmeat and bushmeat poaching, and livestock encroachment (Lindsey et al., 2017b) (see Supporting Information Section 7). These areas require sustained and substantial financial and technical support with sufficient management delegation (Figures 2 and 3) (Craigie et al., 2010; Lindsey et al., 2018). Conversely, with comparatively less additional support, several conservation areas in East and Southern Africa, could shift from deteriorating to succeeding or failing to recovering with focus on mitigating human–wildlife conflict and infrastructural development threats (Figures 2–4, Supporting Information Section 7). Investment in Africa's conservation areas should take region-specific circumstances into account, although, we suggest that most would benefit from tailored collaborative management partnerships with strong NGO and/or private partners (Lindsey et al., 2021).

Using the existing conservation area network as a foundation to expand area-based conservation makes sense while the window of opportunity for such proclamations remains open. However, substantial investment into new areas may be illogical if the existing foundation is crumbling, as our results suggest for Africa. Ideally, adding resources would both recover and retain current conser-

vation areas while also growing the conservation estate in line with the 30% and 50% targets (Dinerstein et al., 2019). However, without drastic and rapid increases in resources and/or mitigation of threats (Lindsey et al., 2018), stakeholders face impossible decisions about how to avoid forfeiture of the hundreds of thousands of square kilometers identified here as failing or deteriorating in Africa, let alone how to fund additional effective conservation areas. While other conservation interventions (e.g., combating international wildlife trafficking; research; and awareness raising) are important, we contend that support for managing existing conservation areas—the foundation of conservation in Africa—is urgent and should be prioritized accordingly. Ensuring the protection of these areas is an existential issue for the biodiversity contained therein and is necessary to maintain the ecosystem services they provide.

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## AUTHOR CONTRIBUTIONS

AR, MT, PT, and PL designed the study. AR, MT, DB, AL, GW, and PL collected data, and AR analyzed the data. AR wrote the initial manuscript, which was revised iteratively with feedback from MT, DB, AL, PT, GW, and PL.

## DATA ACCESSIBILITY STATEMENT

Protected area-specific data used in this paper are of a sensitive nature. To comply with requests for anonymity from survey respondents and to avoid jeopardizing underfunded/poorly managed protected areas, data are not freely shared but will be made available by the authors upon reasonable request in line with confidentiality agreements.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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