



A Critical Review of Lion Research in South Africa: The Impact of Researcher Perspective, Research Mode, and Power Structures on Outcome Bias and Implementation Gaps

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Understanding the state of research, and its effectiveness, in a predominantly Life Sciences sphere, requires an assessment of knowledge growth dynamics, and the associated scientific and bibliometric impacts. We aim to create and evaluate, in a systematic review process, a macro-structure of the science generated in lion research in South Africa (SA) from 1990 to 2018. First, we classified the evidence architecture of lion research data extracted from the *Web of Science Core Collection*. Then, we identified prominent features that the datasets reveal in terms of authorship and ownership, as defined by first author affiliation and geographical location. Fifteen sub-disciplines were identified to characterize the topics. From 2000 onwards, multidisciplinary and interdisciplinary contributions started to emerge, catering for research problems defined at the interface of the academic-practitioner domains. These included social and economics components, and were aligned with conservation framings that seek to evaluate conservation within market-based vs. people-based approaches. Study areas were concentrated within SA (61.8%) and the remainder was either conducted in the rest of Africa (22.9%), or in various combinations of geographical focus. Author affiliation indicated that 63.1% of first authors had a South African affiliation. The rest of Africa was poorly represented at 2.4%. The majority (57.1%) of the first authors was male, but from 2014 to 2018, female researchers outnumbered males; however, male first authors continued to be cited more frequently. Furthermore, we provide a systemic analysis of the way in which research contributes to lion conservation. Overall, three voices dominate this area. Firstly, Mode 1 research has been driving research output in a “vicious circle,” motivated by researchers’ quest for accumulating academic rewards. Secondly, the citation impact shows a gender disparity against the recognition of female researchers. Lastly, a power imbalance against authors from the rest of Africa became apparent, whereby their role is mainly shaped toward being team contributors. This research shows

that effective conservation requires appropriate knowledge to be generated, and this to be effectively translated into practical applications, while considering all perspectives in order to provide the opportunity for balanced contributions and influences. Imbalances such as the ones revealed above are likely to prevail more broadly.

Keywords: lion research, South Africa, bibliometric analysis, research mode, citation analysis

INTRODUCTION

Conservation provides an interesting discipline space in which to consider how we go about doing research, because it has evolved both in terms of the methodologies as well as the socio-political dimensions, and in how its importance is defined by society (Fazey et al., 2005; Kareiva and Marvier, 2012). In general, the approach used to conceptualize an issue significantly impacts the ways in which it is perceived and framed, and, hence, defines the types of responses, and solutions that actors involved in the process create to address it (Nisbet and Scheufele, 2009; Newell et al., 2014). This means that conceptualizations reveal both how we “know,” and the future knowledge that can be shaped. Conservation has a history of plural views that continue to co-exist: starting with the seminal concept in which emphasis was placed on species/habitats/wildlife ecology (Nature for itself) which gradually shifted to ecosystems level through population biology/natural management (Nature despite itself) and, then, ecosystem functions/environmental economics (Nature for people) (Mace, 2014). These different framings guide the ways through which conservation is defined, and define the purposes it serves. Such long-held debates reverberate in the current “new vs. traditional conservation” debate (Holmes, 2015). For instance, questions have arisen as to whether poverty alleviation should form part of the undertaking of conservation (Roe, 2008) or whether true wilderness exists and its validity as a concept for conservation (Callicott and Nelson, 1998). At another level of debate, conservationists advocate for, and critique working with corporations and capitalism (Brockington and Duffy, 2010). In the new-conservation debate, the existence of two opposing positions on the motivations and means to approach conservation (Holmes, 2015) has resulted in the stifling of other relevant debates in conservation social science, such as those on biocultural diversity (Holmes et al., 2017). This indicates that there is a research-implementation gap in conservation assessment works. As far as three decades back, Soulé’s (1986) landmark paper cautioned against the mission-driven discipline approach (Meine et al., 2006) in the conservation sciences, as it curbs active engagement with “real world problems, circumstances, and experiences”. Consequently, even though scientific knowledge accumulates, the results are not translated into management actions. Recently, Toomey et al. (2017) reiterated that such issues have become pervasive over time. Even though the research-implementation gap approach has proposed a number of solutions to address pervasive problems in the form of evidence-based conservation, conservation evaluation, and science communication (Knight et al., 2008; Arlettaz et al., 2010; Matzek et al., 2014; Toomey

et al., 2017), very little effort has been focused on whether these represent an accurate description, and actions, to address real world challenges. In the first article of this special series themed on “How Prides of Lion Researchers are Evolving to be Interdisciplinary,” the analysis performed by Montgomery et al. (2018) revealed that interdisciplinarity has been historically low even within the human-lion conflict research, which is inherently a multi-dimensional component, although efforts to incorporate more inclusivity are apparent. The most recent “People and Nature” conservation framing attributes a great significance to interdisciplinary, social, and ecological sciences (Mace, 2014), hence, paving the way for a more strategic research agenda with various configurations to create knowledge and understanding for both researchers and practitioners.

This paper is embedded within the context of lion, *Panthera leo*, research in South Africa, and provides a case study for understanding the many dimensions of how we go about doing science, and who is doing the work, and, therefore, shaping the interpretation, and the outcomes of science. Lions are a charismatic and flagship species (Courchamp et al., 2018; Montgomery et al., 2018), which is iconic to the public who has an interest in the species, as reflected in the large number of documentaries that have been made on lion biology, lion conservation, and lion-human interactions (Somerville, 2017; Albert et al., 2018). Importantly, the domain represents a large enough body of work to enable us to discern patterns, including over an extended period of three decades of lion research by South African-based authors. Even on the global scale, the African lions are among the most extensively studied and protected carnivores (e.g., Packer et al., 2013), but their population is declining, and they are listed as Vulnerable on the IUCN Red-list (Bauer et al., 2016). Factors causing lion population decline include: habitat loss which has resulted in the reduction of the lion’s range by 75% (Riggio et al., 2013), the intensification of human–lion conflicts because lions prey on livestock (Woodroffe and Frank, 2005; Kissui, 2008), and attack people (Packer et al., 2005a, 2011a), over-harvesting in inadequately regulated sport hunting (Packer et al., 2009, 2011b) which can extend into non-hunting National Parks (Loveridge et al., 2007; Caro, 2008; Kiffner et al., 2009), inbreeding in genetically isolated populations (Slotow and Hunter, 2009) leading to measurable reductions in reproductive rates and disease resistance in small populations (Kissui and Packer, 2004; Trinkel et al., 2008, 2011). Despite these trends, literature also shows a number of successful population restoration interventions, as seen in the Serengeti lions (Packer et al., 2005b), several large South African National Parks (Ferreira and Funston, 2010; Funston, 2011), and private reserves across

sub-Saharan Africa (Hunter et al., 2007; Lindsey et al., 2009a,b; Slotow and Hunter, 2009). However, contrasting approaches have emerged with regards to the economic and social feasibility of management practices, such as fencing or kraaling of livestock (Hunter et al., 2007; Hayward and Kerley, 2009; Slotow and Hunter, 2009; Creel et al., 2013; Packer et al., 2013). The lion being an apex predator, it can have profound effects on ecosystem functioning and structure (Tambling et al., 2013). Literature shows that research activities focus on scrutinizing the lion both in single species studies (Creel et al., 2016; Henschel et al., 2016; Lindsey et al., 2016), and in relation with other predators (Cozzi et al., 2012; Vanak et al., 2013; Swanson et al., 2014), herbivores (Valeix et al., 2009; Meena et al., 2014; Martin and Owen-Smith, 2016) and relevant conservation management practices (de Pinho et al., 2014; Winterbach et al., 2014; Snyman et al., 2015). Therefore, the African lion proves to be a rich academic, applied, and socially relevant species as a focus for a bibliometric assessment such as conducted here.

The literature shows that over time, complex and real-world issues impacting lion conservation research had to be addressed in such a way to counteract problems such as: the “culture clash” between scientists and managers (Roux et al., 2006; Gibbons et al., 2008); weak interdisciplinarity capacity resulting in the inability of the scientific community to connect science with societal needs (McNie, 2007); insufficient expertise and/or literacy on the side of managers and practitioners (Sunderland et al., 2009); poor stakeholder or practitioner participation in the strategic enactment of conservation (Knight et al., 2008; Shaw et al., 2010); non-recognition of scientists’ participation in policy or practice by the academic reward system (Shanley and López, 2009; Arlettaz et al., 2010); and, mismatches in scale, budget, or approach between research experiments and management efforts (Hulme, 2003; Kuebbing et al., 2013). The emergence of integrated research with social and economic components in conservation management practices, hunting, human-wildlife, tourism, is in line with the surfacing trends of, on the one hand regulatory vs. capitalist-driven approaches regarding biodiversity management—managing nature to maximize the overall value of the human condition (Dressler and Roth, 2011; Jepson and Ladle, 2011; Hugé et al., 2017), and, on the other hand, the nature protectionist vs. the more development-oriented social conservationist approach (Miller et al., 2011). The utilitarian perspective emerged as it became increasingly clear that conservation has a cost (Hugé et al., 2017). The eclectic and multiple nature of disciplines in conservation has emerged because all components of human activity (economics, business management, economic viability forecasting, trade, human-wildlife conflict, conservation tourism etc.), are ultimately linked to the state or efficiency of conservation efforts (Hutton et al., 2005; Mace, 2014; Soulé, 2014), yet approaches used to define research questions differ. As a means to enhance the concepts articulated by the dichotomous conservation framings, Holmes et al. (2017) identified three main schemes: (i) conservation to benefit people but opposing links with monetization, capitalism and corporations; (ii) bio-centric approaches, labeled as traditional conservation 2.0, and (iii) a framing representing a more instrumental view of the importance of benefiting people

as a means to landscapes, also termed as the new conservation approach with an optimistic outlook on the use of market-based instruments. These are partly overlapping framings that can be used as entry points, depending on the decision-making context. These changes in research mode landscape represent attempts to respond to research-implementation challenges in the conservation sciences, including the lion as a species.

In addition to the discussion on the research mode within Nature conservation, we frame the power relations that shape lion conservation research from two different angles. In the first instance we assert that since the lion distribution range is limited to components of the global South, this makes it interesting for scrutiny from a North-South relations assessment point of view. This position on research collaboration has been under scientific scrutiny by a number of researchers in the higher education and international research partnership field (Jentsch and Pilley, 2003; Galvin and Haller, 2008; Confraria et al., 2017). The literature emphasizes the need for partnership, and its related principles, for researchers between developed countries and the rest of the world, whilst its critics highlight the problematical context of structural inequality and historical legacies which are antithetical for the development of mutually beneficial collaborations (Koch-Weser and Yankauer, 1993). More recently, Yarmoshuk et al. (2016) alluded that current systematic mappings of the basic, common characteristics of North-South research partnerships are scarce. This state of affairs, therefore, presents an open space for investigation within lion conservation research. The second aspect covers power in terms of gender representation in the research community (Bonnet et al., 2004), and, more specifically, in ecology and conservation (Martin, 2012; Pettorelli et al., 2013). Apart from enlightening the research community on the condition of the research carried out and knowledge produced, power relational issues are also of general interest to the public in order to understand the configuration of researchers who are at the forefront of lion research, and the resulting influence that their work may have. Besides the emergence of more complicated approaches, when considering application of the work to solve real-world problems posed by conservation needs, one also has to understand the foundational disciplines from which the evidence is derived for robust understanding. Not only have interest or capacity in certain disciplines changed over time (Di Marco et al., 2017), but the balance across disciplines may also be important for balanced decision-making (Martín-López et al., 2009). The “power” or “voice” of certain disciplines, or, rather, the scientists within those disciplines that may champion or influence thinking and understanding, may not be balanced.

In this paper, we use lion research based in South Africa as a case study to understand the following questions: (1) What is the approach that has been taken (alpha-science through to transdisciplinary), and how has that changed over time? (2) What are the sub-discipline areas that are researched? (3) Does the work focus on lions, or multiple species? (4) Who is leading the research (gender relations, SA based or from abroad), and in which sub-disciplines? (5) How can we assess the inclusion of social science methodologies to evaluate “people and conservation” issues, and economic approach to evaluate “capitalist conservation” issues? For each of these areas, we

evaluate how this has changed over the three decades from 1990. In addition, we analyze where the work has been published, and the citation of the work as a measure of impact.

MATERIALS AND METHODS

The study is comprised of a retrospective bibliometric analysis in the *Web of Science Core Collection* on lion research conducted with at least one author with a South African affiliation. In order to capture the overall contribution of the South African-led lion research, the total number of publications covering *Panthera leo* as a topic was determined as “TS = *Panthera leo*.” The search returned 1,087 publications. Following screening for relevance, 937 publications were retained.

For the second search where emphasis was laid on lion research carried out with at least one author bearing a South African affiliation, the main search topic, “TS” was “*Panthera leo*.” This was combined with the “AND” operator to link the search term with articles that has at least one author with “South Africa” as an address affiliation. This search allowed for the accrual of 262 research articles. Following screening, 249 articles ($n = 249$) were retained for scrutiny: 13 articles were omitted from the list (one commentary and 12 articles did not constitute research aspects related to lions).

A third bibliometric search was performed in order to assess whether there is any participation of African authors outside of South Africa, having conducted lion research in South African study sites, without the co-authorship of South African researchers. The search criteria for topic was defined as TS = “*Panthera leo* AND South Africa.” Additionally, the address criterion, AD, was robustly expressed as: “Ägypten OR Algeria OR Algerie OR Algerië OR Algérie OR Algerien OR Algeriet OR Algerije OR Algieria OR Angola OR Äquatorialguinea OR Argelia OR Argélia OR Äthiopien OR Benin OR Benín OR Bénin OR “Boerkina Fasso” OR “Botsuana OR Botswana” OR “Burkina Faso” OR “Burquina Faso” OR Burundi OR “Cabo Verde” OR Cameroon OR Cameroun OR Camerún OR “Cape Verde” OR “Cap-Vert” OR “Centraal-Afrikaanse Republiek” OR “Central African Republic” OR “Centralafrikanska republiken” OR Chad OR Chade OR Comoras OR Comore OR Comoren OR Comores OR Comoros OR Congo OR “Costa do Marfim” OR “Côte d’Ivoire” OR “Cote d’Ivoire” OR “Côte d’Ivoire” OR Czad OR Djiboeti OR Djibouti OR Djibuti OR Dschibuti OR Dzibuti OR Egipt OR Egipte OR Egipto OR Egito OR Egypt OR Egipte OR Égypte OR Egypten OR Ekvatorialguinea OR “Ekvatorial-Guinea” OR “Ekvatoriaal-Guinee” OR Elfenbenskusten OR Elfenbenskysten OR “Equatoriaal-Guinea” OR “Equatorial Guinea” OR Eritrea OR Eritreia OR Érythrée OR Erytrea OR Ethiopia OR Ethiopië OR Éthiopie OR Etiopia OR Etiopía OR Etiópia OR Etiopien OR Gabão OR Gaboen OR Gabon OR Gabón OR Gabun OR Gambia OR Gàmbia OR Gambie OR Gambië OR Gana OR Ghana OR Guiné OR “Guiné Bissau” OR “Guiné Equatorial” OR Guinea OR “Guinea Bissau” OR “Guinea Ecuatorial” OR “Guinea-Bissau” OR Guinee OR Guinée OR “Guinée équatoriale” OR “Guinee-Bissau” OR “Guinée-Bissau” OR Gwinea OR “Gwinea Bissau”

OR “Gwinea Równikowa” OR Ivoorkus OR Ivoorkust OR “Kaap Verde” OR Kaapverdië OR Kameroen OR Kamerun OR “Kap Verde” OR “Kapp Verde” OR Kenia OR Kenya OR Komoren OR Komorene OR Komorerna OR Komory OR Kongo OR Kongo OR Kongo OR Lesotho OR Lesoto OR Liberia OR Libéria OR Liberië OR Libia OR Líbia OR Libië OR Libya OR Libye OR Libyen OR Madagascar OR Madagaskar OR Majotta OR Malawi OR Maroko OR Marrocos OR Marruecos OR Mauretania OR Mauretanië OR Maurice OR Mauricio OR Maurício OR Mauritania OR Mauritânia OR Mauritanie OR Mauritië OR Mauritius OR Mayotte OR Moçambique OR Morocco OR Mosambiek OR Mosambik OR Mouritanië OR Mozambik OR Mozambique OR Namibia OR Namíbia OR Namibie OR Namibië OR Niger OR Níger OR Nigeria OR Nigéria OR Nigerië OR Oeganda OR Ouganda OR Principe OR Quênia OR “República Centroafricana” OR “República Centro-Africana” OR “República dos Camarões” OR “Republika Południowej Afryki” OR “Republika Srodkowoafrykańska” OR “Republika Zielonego Przylądka” OR “République Centrafricaine” OR Reunião OR Reunion OR Reunión OR Réunion OR Ruanda OR Rwanda OR “Saara Ocidental” OR “Sahara Occidental” OR “Sahara Zachodnia” OR Zambia OR “Santo Tomé” OR “Sao Tome” OR Senegal OR Sénégal OR “Sentraal-Afrikaanse Republiek” OR “Sentralafrikanske republikk” OR “Serra Leoa” OR Seszele OR Seychelle OR Seychellen OR Seychellene OR Seychellerna OR Seychelles OR “Sierra Leona” OR “Sierra Leone” OR Simbabwe OR Soedan OR Somalia OR Somália OR Somalie OR Somalië OR “Sør-Sudan” OR “Soudan du Sud” OR “South Sudan” OR Suazi OR Suazilandia OR Suazilândia OR Sudán OR Sudão OR Südsudan OR “Suid-Soedan” OR Swasiland OR Swaziland OR Sydsudan OR Tansania OR Tanzania OR Tanzânia OR Tanzanie OR Tanzanië OR Tchad OR Togo OR Tschad OR Tsjaad OR Tsjad OR Tunesië OR Tunesien OR Túnez OR Tunezja OR Tunisia OR Tunísia OR Tunisie OR Tunisië OR Tunisien OR Uganda OR Västsahara OR “Vest-Sahara” OR “Wes-Sahara” OR “Westelijke Sahara” OR “Western Sahara” OR “Westsahara” OR Zambia OR Zâmbia OR Zambie OR Zambië OR “Zentralafrikanische Republik” OR Zimbábue OR Zimbabwe” in order to represent the 53 countries of the African continent (United Nations Economic Commission for Africa, 2018), except South Africa. This search returned 31 papers. Two papers were omitted due to irrelevance whereby the lion was mentioned only for referencing purposes in the Discussion section of the respective journals. Upon screening, only eight papers had a first author from a “Rest of Africa” affiliation: one from Benin, one from Kenya, and six from Zimbabwe.

Original articles were defined as reports that investigated a clearly defined study objective or hypothesis. All other types of articles were excluded from the analysis, including book reviews, case reports, commentaries, and editorials. The database included the following indexes: SCI-EXPANDED, SSCI, A&HCI, ESCI.

A number of article characteristics, which are broadly characterized into two categories, were assigned to each article. In the first category, metrics-based screenings that were derived directly from *Web of Science* database include: (i) number of citations per articles, (ii) whether the article was published in

a South African or international journal, and (iii) countries listed in the author affiliation. In the second category, we extracted 10 article characteristics for each article from the abstract, or, if not clear, from reading the full article: (i) mode of disciplinarity, (ii) justification for degree of disciplinarity (see **Supplementary Material**), (iii) single species or multiple species studies, (iv) the countries of study site(s), (v) the science disciplines covered, (vi) the inclusion of social-science and/or economics component to the research, and accompanying justifications, (vii) classification of the journal type based on its degree of disciplinarity, (ix) classification of the main thematic discipline associated with the journal, (x) gender of the first author. All study authors were classified as either male or female according to the first or middle name listed in the article, with the understanding that many names are associated with only one gender (e.g., “Mary” is female and “Henry” is male). If only initials of the first name were used in the list of authors, we sought further publications from the same group of authors or performed an Internet search using the Google search engine to find the first name. If an author’s gender could not be ascertained by initial inspection of his or her first name alone, attempts were made to locate gender-specific information about that author by performing Internet searches, and by visiting personal or institutional websites (in several instances, the sites included photographs or curricula vitae). Authors of two papers were excluded because their gender could not be determined even by these additional means.

Expert opinion, of the second collaborator, Rob Slotow, was used to group each journal article according to the five modes of research, namely: α -science, disciplinary, multidisciplinary, interdisciplinary, and transdisciplinary. Insights were drawn from a conceptual framework (**Supplementary Material**) to distinguish among the modes of research applied in each paper. As a means to obtain clarity on the ways that research sub-components self-organize with increasing complexity in the multidisciplinary and interdisciplinary modes, systems approach diagramming techniques, in the form of (i) influence and (ii) Ishikawa fishbone diagrams (Kudryavtsev and GavriloVA, 2017) were applied to observe the aggregation of sub-components around higher level concepts. Furthermore, we apply a cause-and-effect analysis from a systems thinking perspective (Reynolds and Holwell, 2010) and systems dynamics concepts (Morecroft, 2015) in order to (i) structure the interplay of linkages that govern the ways in which research has been conducted in lion conservation, and, (ii) identify whether there is a shift, if any, which is gaining momentum in shaping current conservation understanding.

The country affiliation of each first author was categorized as USA, Europe, South Africa, rest of Africa, or other countries (Other). Using the InCites™ tool of Web of Science/Thomson Reuters (WoS™), we applied bibliometric and author profiling to evaluate which countries in the world are producing research with higher research citation impact. Presently, there are several measures to calculate citation impact indicators. From basic calculations such as: raw citation counts; citations per publication; the h-index; geometric means (Fairclough and Thelwall, 2015) to field normalized citation score (Waltman

et al., 2011), source normalized indicators (Waltman and van Eck, 2015), amongst others. For the purposes of this study, raw citation counts, and citations per publications, were used. For the citation pattern analysis, we divided papers into three periods: those published in 1990–2005, in 2006–2013, and from 2014 to 31 August 2018. The division into three periods took into account: creating a time series which allowed us to understand change in pattern over time; the number of papers published over time; getting a reasonably balanced sampling; providing fairness for papers to accumulate citations; and being comparable within a time period. This resulted in unequal duration of time periods, but ones which we believe provide insights without inordinate bias in any particular direction. The time periods were decided *a priori*, and then the analysis of patterns undertaken, so that there was no bias of the results influencing the time periods selected. Furthermore, we applied Wagner et al. (2011) structuralist lens, that subsumes both cognitive (knowledge disciplines, citations) and social structures, i.e., power relations in lion research in terms of research ownership and first authorship gender representation.

RESULTS

The general search conducted on the “*Panthera leo*” topic generated 937 research papers published from 1990 to 2018 in the *Web of Science Core Collection* database. In the second and more focused bibliometric search, we returned 249 unique lion research papers with at least an author having a South African affiliation. This represents 26.6% of the total number of publications based on the “*Panthera leo*” topic (**Table 1**). **Table 1** shows the distribution of papers by geographical location of study area and first author affiliation. The majority of the studies were conducted in South Africa (61.8%), followed by the “Rest of Africa” locations (22.9%). It is noteworthy that despite the geographical range of the lion and its importance for conservation understanding and management, only 22 studies (8.8%) out of the 249 shared South Africa and the “Rest of Africa” as study sites. In contrast, with respect to the first author affiliation of the papers, South African, European and USA affiliations share the majority of representation at 63.1, 17.3, and 14.5%, respectively. Only 2.4% of the papers of the “Rest of Africa” countries have a first author affiliation. For the third bibliometric search where the focus was on identifying whether “Rest of Africa” authors have been leading (as first authors) lion-related research in South Africa, the dataset constituted of 31 publications. Only eight of these publications bear first authors from the “Rest of Africa” and none of these eight publications involved South Africa as part of their study site. This indicates that “Rest of Africa” authors have not been leading any lion-related research by using South Africa as part of their study site(s). Moreover, five of these papers included co-authors from first world countries, that is, Europe and USA.

Of the 249 papers, 50 papers (20.1%) were published in a South African journal. 221 (88.8%) papers were published in journals which were categorized as having disciplinary audiences. The rest appeared in journals with a multi-disciplinary focus. In terms of research mode, α -science

TABLE 1 | Distribution of papers by geographical location of study area and first author affiliation.

Geographical location		First author affiliation	
Study area	Papers published	Geographical region	Papers published
South Africa	154 (61.8)	South Africa	157 (63.1)
Rest of Africa	57 (22.9)	Europe	43 (17.3)
SA + Rest of African countries	22 (8.8)	USA	36 (14.5)
SA+ Rest of Africa + Other countries	10 (4.0)	Rest of Africa	6 (2.4)
SA + Other countries	3 (1.2)	Other countries	7 (2.8)
Europe	2 (0.8)		
SA+ Africa +Europe	1 (0.4)		
Total number of papers on the topic <i>Panthera leo</i>			937
Number of these papers with a South African body as affiliation			249 (26.6)

Figures in brackets indicate percentage. SA, South Africa.

comprised 10.8% of papers, disciplinary 59.8%, multidisciplinary 17.7%, interdisciplinary 11.2%, and transdisciplinary 0.4% of the papers (Figure 1A). Following the systematic scrutiny of the 249 journal articles, 15 sub-disciplines were identified as forming the researched components in lion research (see Figure 1B). The majority of papers were veterinary science-based, studied lion predation and their prey, or lion population studies, or addressed conservation issues. Research at the α -science level was more focused on increasing the mechanistic understanding of the life science aspects in lion research, from veterinary sciences, physiology, population, predation, or paleobiology studies. At the disciplinary and multidisciplinary level, the research foci were more widespread across all the research sub-disciplines. In contrast, interdisciplinary research constituted mostly of the investigations within the conservation, hunting, human-wildlife conflict, and tourism domains. There was a marked increase in studies in the multidisciplinary and interdisciplinary mode over time (Figure 1A). Only one article of the 249 which studied conservation and cross-border trade of bones, was classified as transdisciplinary (Figure 1B).

Multiple species research was mostly conducted within disciplinary studies (38.2%), and multi-species study was not a requirement for multidisciplinary or interdisciplinary work (Figure 1C). 111 articles researched the lion as the single species under investigation. Multispecies papers included other intraguild predators, mostly multiple species (44.6%), cheetah *Acinonyx jubatus* (4.0%), hyaenids (2.4%), wild dogs *Lycaon pictus* (2.0%), or leopards *Panthera pardus* (1.6%). Ungulates were studied mainly with respect to their role in the prey-predator dynamics and human-wildlife conflict. Pathogens such as parasites, bacteria, and viruses of lion or other carnivores comprised 18 (7.2%) papers.

The contents of multidisciplinary papers were mapped out in order to observe how the different components aggregate into

knowledge clusters using an influence diagram (Figure 2A), and three main clusters were identified: genetics and disease, biology and conservation, and socio-economic factors (Figure 2A).

20 articles (8.0%) used social science methods and/or economic analyses, and, interestingly, these were published mainly in disciplinary ($n = 14$), rather than multidisciplinary ($n = 1$), or interdisciplinary ($n = 5$) journals. Only a single article was categorized as transdisciplinary. It dealt with transborder bone trade, and was published in a multidisciplinary journal. We use a fishbone diagram, which is primarily used for problem identification in complex situations, to portray the social and economic components within the lion research database. Each branch represents a major research theme, and the associated sub-themes correspond to specific research problems addressed in that paper. The upper portion of the diagram illustrates five main research components for social and practical management (Figure 2B). Hunting and conservation dealt with the surveys of hunting, the co-production of reward system among stakeholders, and appraisal of hunters' skill in age estimation of lions. Researchers also engaged with communities to assess the impacts of kraaling and herding. A number of studies assessed the ways and means to improve conservation through survey methodology carried out by practitioners. The social implications of human-wildlife conflict were assessed in order to determine the tolerance level of communities under conflictual situations. Interviews and focus group discussions were carried out to identify reform needs, and to facilitate the changing of community behavior on herding practices, and identify their education needs in this respect.

The lower portion illustrates the economic implications of conservation (Figure 2B). One research paper, classified as TD, quantified cross-border bone trade. The economics of hunting and conservation involved studies to understand the economic off-take involved in hunting, and surveys of hunting sales, operations, and clients, and also an assessment of the cost of conservation, and an evaluation of extra-limital species and the associated conservation risks. Prediction and modeling techniques were applied in the development of business management models for conservation tourism-based activities, and used to identify the potential for optimizing income from hunting. Conservation management practices such as kraaling and herding were evaluated for their economic feasibility. Predator management studies focused on the biology and economics of reserves. The impacts of predation on the economic sustainability of the communities were also investigated. As part of creating understanding on the economic implications of human-wildlife conflict, expert surveys were conducted to gather information on the ways to maximize investment in conservation against risks from socio-economic factors. Studies also assessed the value of different types of land use, and the threat of diseases.

The number of citations accumulated by research modes over time provides an idea of the knowledge base being used to scrutinize the lion in wildlife conservation research. The disciplinary mode remained pervasive (59.8%), with the highest proportion of citations over time, compared to α -science (10.8%), multidisciplinary (17.3%), or interdisciplinary (11.2%) works. Transdisciplinary research in lion research

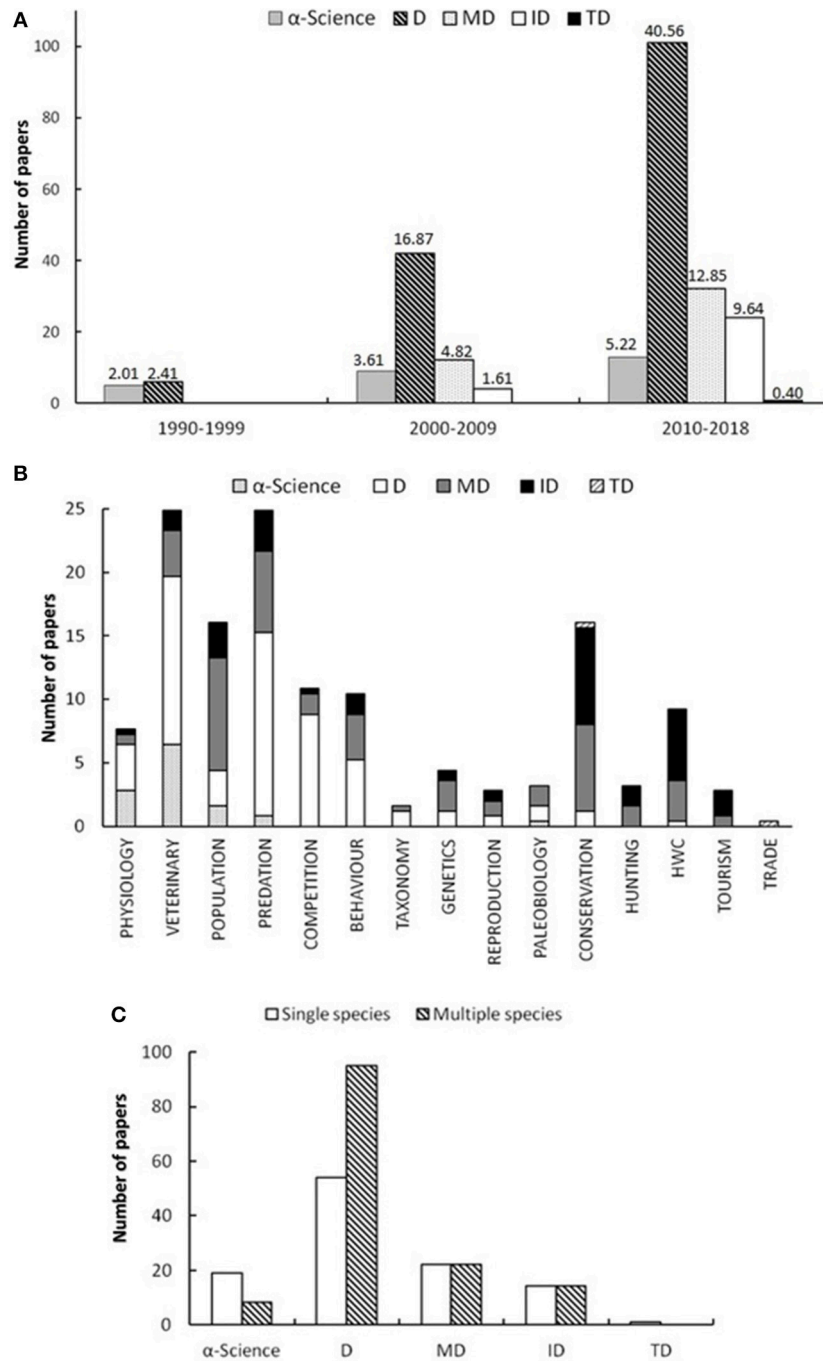
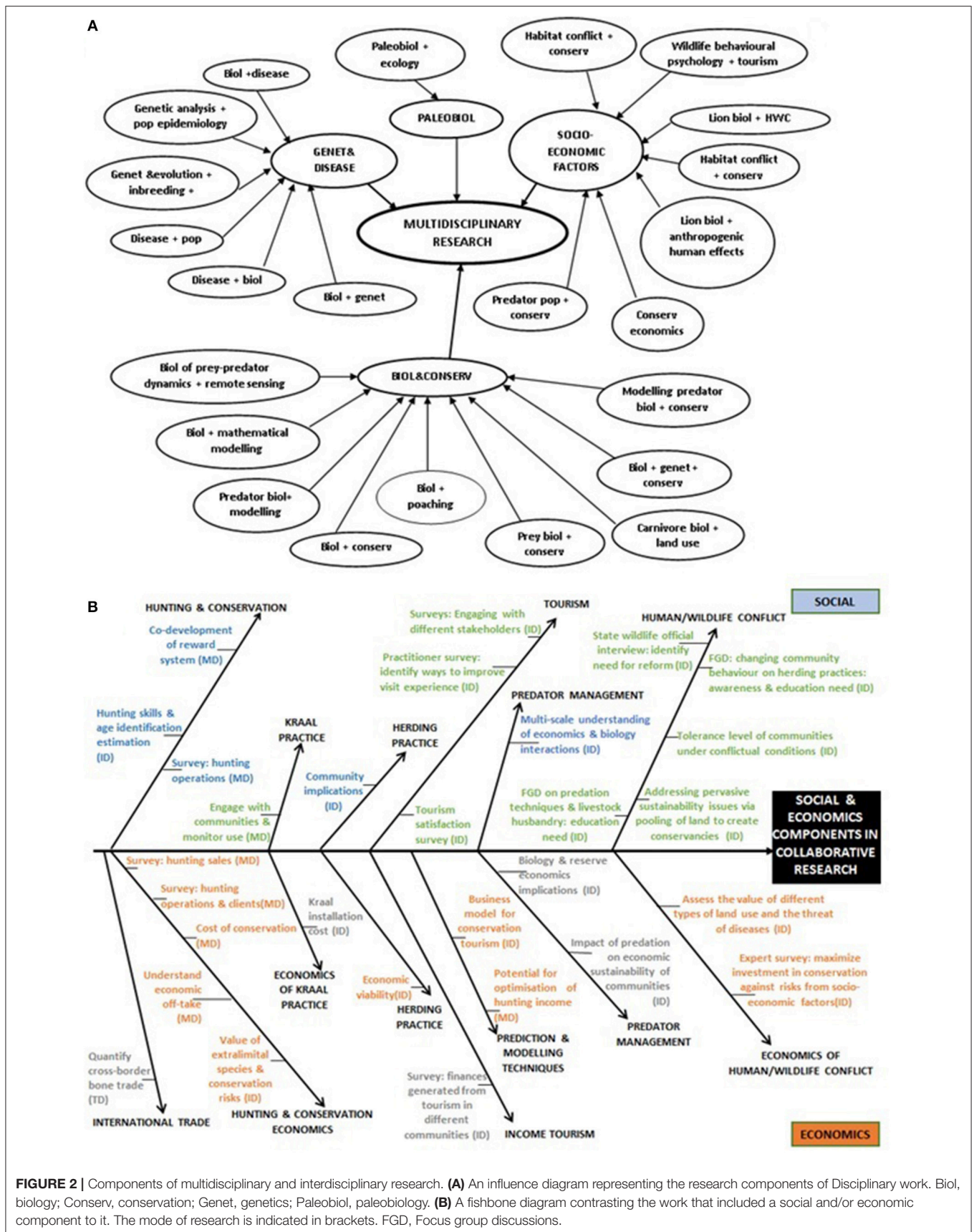
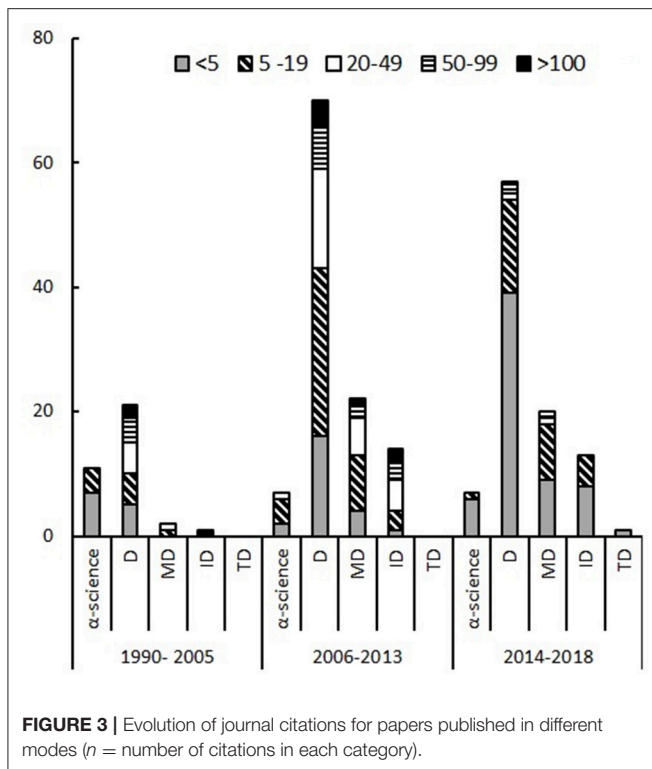


FIGURE 1 | Patterns of publication of papers on lions with South African authorship. **(A)** Evolution of mode of research over time (D, Disciplinary; MD, Multidisciplinary; ID, Interdisciplinary; TD, Transdisciplinary). Number indicates percentage in that category of 249 papers. **(B)** Classification of research components (sub-disciplines) studied in the research articles, noting that an article may have included more than one component, categorized by mode of research as per **(A)** (HWC, Human-wildlife conflict). **(C)** Single species vs. Multiple species as focus of study, grouped by mode of research.

is new and has the lowest percentage of citation at 0.8%. Compared to 1990–2005, the period 2006–2013 shows the recognition of more collaborative works at the multidisciplinary and interdisciplinary levels (**Figure 3**). For the first decade, there was a single citation for an ID paper, whereas in

the second and third decades, ID papers accumulated 14 and 13 citations, respectively. This represents an interesting trend. Even though the number of papers that fall into the multidisciplinary and interdisciplinary modes were small in the pre-2006 period, their impact was high since the number of





citations earned were up to 49 for MD papers and >100 for the ID papers. Overall, citations for alpha-science remained comparatively low compared to papers in the discipline research mode. No α -science studies were cited more than 50 times (Figure 3). For the most recent time frame, no paper has reached >100 citations due to the time lag required to accumulate citations.

In terms of citations cumulated by single and multiple species papers, the general trend was that both single species and multiple species papers fluctuated over time with a marked increase from the year 2000 onwards. However, researchers cited multi-species papers more frequently than those where the lion was investigated as a single species, especially after 2005 (Figure 4). For multiple species papers, citations peaked at $n = 557$ for the year 2008 whereas for papers published where the lion is observed as a single species, the citation number peaked at $n = 360$ for the year 2013.

For all three periods, the majority of the papers were from a South African first author affiliation, but this decreased from 69 to 57% and then 60% over time (Table 2). Interestingly, in 1990–2005, Europeans were first authors for about 30% of the papers, but in 2006–2013, this dropped to 22% while 15% of papers were from USA first authors. In 2013–2018, the European first authors dropped to 14%, and USA first authors increased to 22%. Overall, there have been few papers with first authors from other African countries that included an author with a South African affiliation. In terms of gender of the South African first authors, in 1999–2005, 35% of them were female; in 2006–2014 they dropped to female ratio of 23%; and this has now increased

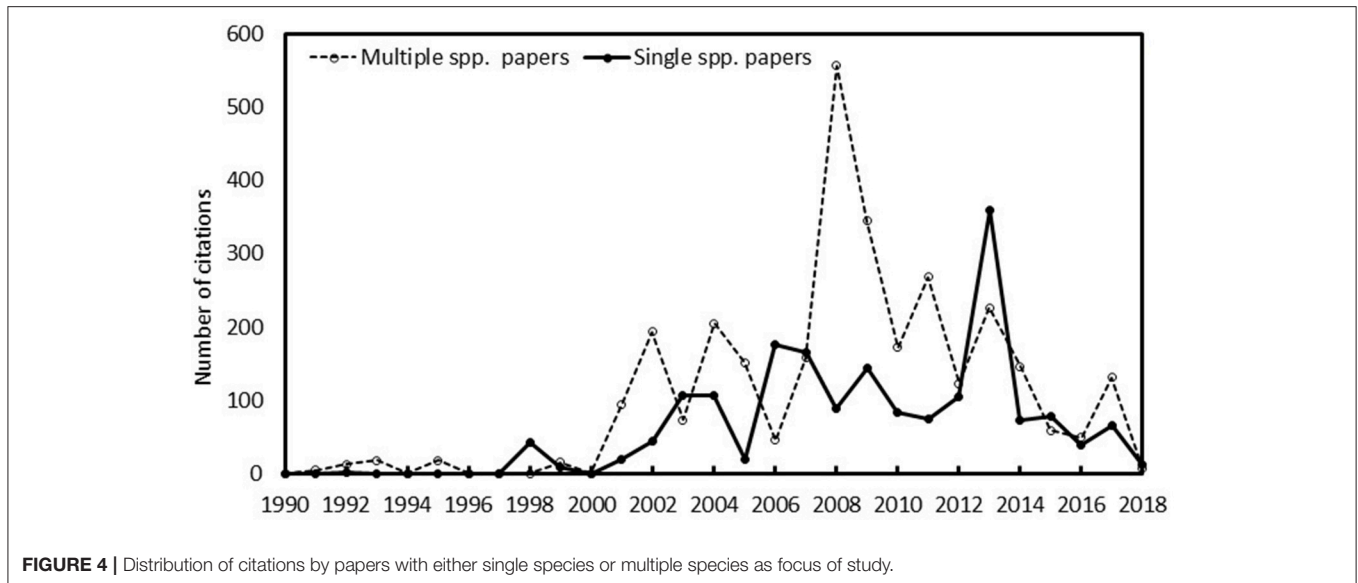
to 44% female in 2013–2018 (Table 2). The international authors were predominantly female, but this shifted over time such that they became 56% male (Table 2). The works of South African first authors are the most cited across all categories (Table 2). Despite the charismatic nature of lions, and the important conservation context, 30.6% of the papers published in 1990–2005, and 20.4% of papers in 2006–2013 were cited <5 times, indicating little impact of a large component of the work. By contrast, 20.3 and 16.8% of the papers from 1990–2005 to 2006–2013 were cited >50 times, indicating a relatively high impact of the work. The papers led by “Rest of Africa” authors were poorly cited (Table 2).

Moreover, the third bibliometric search returned 31 papers and upon screening, only eight papers had a first author from a “Rest of Africa” affiliation: one from Benin, one from Kenya, and six from Zimbabwe. The main implication of this result is that none of these eight publications involved South Africa as part of their study site(s), indicating that “Rest of Africa” authors have not been leading any lion-related research by using South Africa as part of their study site. Moreover, five of these papers included co-authors from first world countries, Europe and USA.

Table 2 Distribution of citations for first authors by affiliation country and gender between 1990 and 2018, divided in three periods (n = number of papers in each category, the percentage for each decadal category are given in brackets). The grand total for the citations in the “1990–2005” period amount to 36 instead of 38, since two entries for South Africa were omitted for lack of reliable gender classification. The sub-totals and grand total represent the number of papers in each sub-category and overall distribution sum.

Generally, male researchers have earned more citations than their female counterparts, and from 1990 to 2018, female researchers (first authors) have never been cited >100 times (Table 2). Following compilation of gender representation and the removal of multiple entries for each author, the gender proportion of researchers in the lion research community consisted of 57.1% ($n = 89$ authors) different male and 42.9% female ($n = 67$) authors. Interestingly, the trends in the last 4 years also indicate that there are currently more papers with female than male authors.

In light of the above analysis, we created a conceptual diagram of the framing and contextualization of research on lions by South Africa-affiliated authors (Figure 5). We used the modes of disciplinarity in the present decade (2010–2018) (Figure 1A), whereby all modes of research are represented, in order to illustrate research configurations in the simple-complicated-complex continuum. The thickness of the black arrows are drawn in proportion to the percentage of papers falling under the corresponding research modes, and we conclude that a vicious, rather than virtuous, cycle is in place (Figure 5), as the research was predominantly disciplinary or multidisciplinary, more aligned toward researcher perspective than conservation assessment, and did not link through to translation. Consequently, the types of conservation framings and biodiversity representations used in research might not fully address the complex conservation problems, but mostly serve toward academic rewards in the form of scholarly publications,



and increasing the breadth of knowledge, rather than toward conservation understanding that can address needs and gaps in translation for application.

DISCUSSION

Lion research was used as a case for establishing a macro-structure of the domain, because it is a well-researched area, and is important in terms of knowledge, as well as posing challenging practical problems that need to be solved based on evidence. The lion has been subjected to much scrutiny, both as a single species and as part of multiple species investigations, to gain an understanding of this large carnivore as well as with respect to its intraguild predators and prey. Additionally, different levels of collaborative configurations make up the disciplinarity spectrum, and, over time, there has been an explosion of research.

The use of bibliometric indicators provides an opportunity to assess the pattern and impact of scientific publications, and to reveal opinionated choices by carrying out international comparisons without being invasive (Moed, 2005). A limitation of this approach is that bibliometric assessment of research performance is based on the central assumption that scientists, who have to communicate research findings, do so by publishing their findings in international peer-reviewed journals. According to Van Raan (2004), this choice unavoidably introduces a limited view of a complex reality for it might be that regionally focused papers in the Global South may contribute significantly to the local context, yet remain uncited, as researchers elsewhere are indifferent to those topics. Moreover, researchers in some countries, especially in the Global South, have different levels of access to some journal database because of financial constraints, selectivity, or publication policies (Lawrence, 2003), and, therefore, might not access journals which could have been relevant to their peer-reviewed work. Nevertheless, the aim of the current research was to establish an architecture of the state

of lion conservation research based on an analysis of a leading bibliometric database.

Bibliometric data are organized in such a way that one can derive information to increase the breadth of first order learning and interpretation on a topic of interest. It was, therefore, possible to create structural relationships that provide clarity about the state of lion research by coining different benchmarks of interest. Moreover, citation analysis was also used to assess scientific impact. According to the seminal work of Merton (1973), when a given article is cited by a researcher, this is an indication that the article was somehow relevant to their study. The citing author highlights the usefulness or applicability of the information included in an article. This acknowledges intellectual or cognitive influence (Confraria et al., 2017), such that, when comparable articles are cited more times than others, the comparison translates into a measure of international scientific influence or impact (Moed, 2005), and enables international comparisons to be more objective (Garfield, 1979). A crucial aspect for analyzing the research performance of countries/regions undertaking lion-centered research is to understand whether their scientific output is having an international impact or influence. The impact of published articles can be regarded as being one crucial aspect of scientific quality, and is thus a “proxy” for quality (Moed, 2005). With increasing demands for accountability (Paasi, 2005; Steneck, 2006), the impact of research on conservation outcomes is a topic of increasing interest and importance. In the case of lion research specifically, conservation efforts often span across sub-disciplines with different knowledge bases and even across national borders. Together with Mode 1 research, which is carried out at the disciplinary level, the more complex forms of research (multidisciplinary, interdisciplinary, and even transdisciplinary) become crucial to enable a systemic expansion of the knowledge-base of research that can also inform, direct, co-facilitate translation and implementation of conservation actions.

We were able to identify epistemic variations, i.e., how do we “know,” and therefore research methodology approaches, that

TABLE 2 | Distribution of citations for first authors by affiliation country and gender between 1990 and 2018 (*n* = number of citations in each category, the percentage for each decadal category are given in brackets).

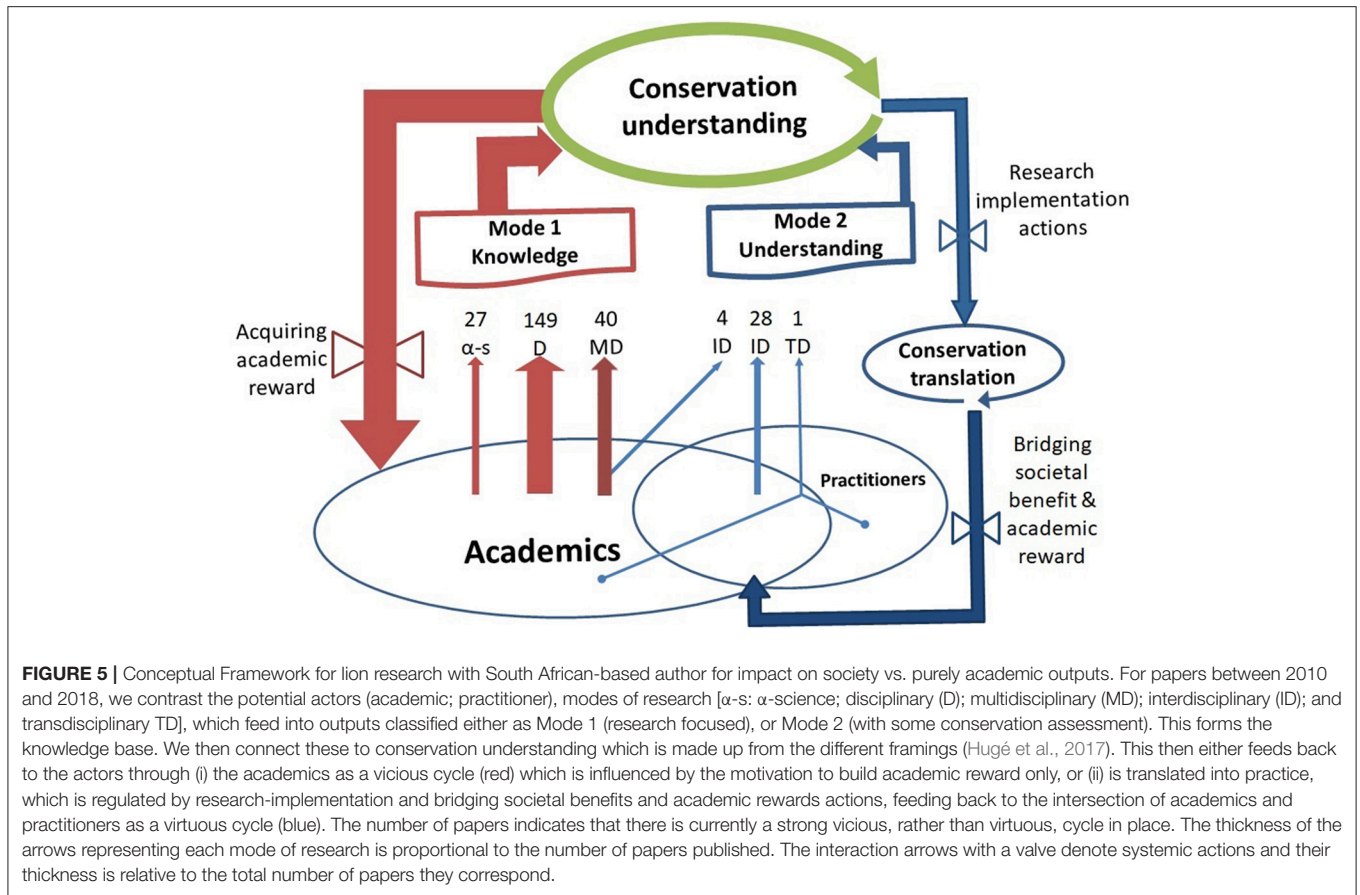
Citation categories	South Africa		USA		Europe		Rest of Africa		Other		Total
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	
1990–2005											
<5	7(19.4)	4 (11.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	11 (30.6)
5–19	6 (16.7)	4 (11.1)	0 (0.0)	0 (0.0)	1 (2.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	11 (30.6)
20–49	3 (8.3)	0 (0.0)	0 (0.0)	1 (2.8)	1 (2.8)	1 (2.8)	0 (0.0)	0 (0.0)	0 (0.0)	1(2.8)	6 (16.7)
50–99	3 (8.3)	1 (2.8)	0 (0.0)	0(0.0)	1 (2.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	5 (13.9)
>100	3(8.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (8.3)
Total	22 (61.1)	9 (25.0)	0 (0.0)	1 (2.8)	3 (8.3)	1 (2.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	36 (100.0)
2006–2013											
<5	9 (8.0)	4 (3.5)	1 (0.9)	3 (2.7)	1 (0.9)	3 (2.7)	1 (0.9)	0 (0.0)	1 (0.9)	0 (0.0)	23 (20.4)
5–19	21 (18.6)	5 (4.4)	2 (1.8)	1 (0.9)	4 (3.5)	7 (6.2)	0 (0.0)	3 (2.7)	0 (0.0)	0 (0.0)	43 (38.1)
20–49	12 (10.6)	4 (3.5)	7 (6.2)	1 (0.9)	1 (0.9)	2 (1.8)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.9)	28 (24.8)
50–99	6 (5.3)	1 (0.9)	0 (0.0)	0 (0.0)	3 (2.7)	2 (1.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	12 (10.6)
>100	3 (2.7)	0 (0.0)	2 (1.8)	0 (0.0)	2 (1.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	7 (6.2)
Total	51 (45.1)	14 (12.4)	12 (10.6)	5 (4.4)	11 (9.7)	14 (12.4)	1 (0.9)	3 (2.7)	1 (0.9)	1 (0.9)	113 (100.0)
2014–2018											
<5	24 (24.5)	17 (17.3)	4 (4.1)	4 (4.1)	6 (6.1)	3 (3.1)	0 (0.0)	2 (2.0)	0 (0.0)	5 (5.1)	65 (66.3)
5–19	8 (8.2)	8 (8.2)	6 (6.1)	2 (2.0)	2 (2.0)	2 (2.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	28 (28.6)
20–49	0 (0.0)	1 (1.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (2.0)
50–99	1 (1.0)	0 (0.0)	1 (1.0)	1 (1.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (3.1)
>100	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Total	33 (33.7)	26 (26.5)	11 (11.2)	7 (7.1)	8 (8.2)	6 (6.1)	0 (0.0)	2 (2.0)	0 (0.0)	5 (5.1)	98 (100.0)

The grand total for the citations for the 1990–2005 period amount to 36 instead of 38, since two entries for South Africa were omitted for lack of reliable gender classification. The sub-totals and grand total represent the number of papers in each sub-category and overall distribution sum.

characterize mechanistic knowledge (Mode 1 research–Karlqvist, 1999) vs. holistic and value-laden understanding (Mode 2–Gibbons et al., 1994) (see **Figure 5**). For instance, current findings indicate that there are a high proportion of papers which framed their research in the disciplinary mode, within which the veterinary sciences, predation, and competition and behavior components stand out, leading to Mode 1 outcomes, and feeding in a vicious cycle back to the academics and not feeding into practice. Notably, multidisciplinary and interdisciplinary work increased nearly 3-fold and 6-fold, respectively, in the second and third decades, increasing Mode 2 outputs, conservation understanding, and ability to follow the virtuous cycle of translation into practice and stimulating further problem-solving research. At the multidisciplinary level, clusters emerged, identifying the nature and reach of the scientific output in the areas of genetics and disease, biology and conservation, and social and economic components. At the interdisciplinary level, the shift in the mode of research design and the types of methodologies applied to address research questions highlight the social and economic implications of conservation assessment. Such findings suggest that the different modes of science are driving knowledge production toward the creation of systemic understanding of the conservation needs and priorities, which

are aligned with the different conservation framings that would be applicable for lion research, both in South Africa and its larger geographical range. Such perspectives emphasize inextricable links among human, non-human, and ecosystem elements. For instance, at the global scale, conservation assessments have been shown to lack effectiveness in informing the delivery of conservation action (Mace et al., 2000; Whitten et al., 2001; Brummitt and Lughadha, 2003). Many of the ways in which hunting and wildlife trade operate, as well as their links to livelihood or ecosystem function, are either poorly understood or not properly taken into account (Funston, 2008; Loveridge et al., 2009; Lindsey et al., 2012). Researchers are increasingly solicited to integrate their activities with societal actors, policy-, and decision-makers into their research projects, thus creating a newly emerging model of engaged knowledge translation (Taylor et al., 2015; Western et al., 2015; Lindsey et al., 2016). Such a virtuous cycle, feeding through practitioners into practice, may be emerging in South African-authored lion research (**Figure 5**).

We use the term “biodiversity representations,” here denoted by the research outcomes generated by the 15 subdisciplines, to define the types and/or combination of actors who address the research situation. We concur that this gives rise to an array of research modes resulting in the production knowledge and



understanding that create impact with triple-fold and perpetual cascading benefits for lion-related works. Firstly, in terms of the relevance of the impact created by research output to address complex conservation problems (Jenkins et al., 2012) and secondly, proper conservation research design ensures accountability since the study of biodiversity representations (defined by the sub-discipline categories and therefore, the research mode) involves the use of resources, there is a cost (Myers et al., 2000; Naidoo et al., 2008; Brockington et al., 2012), both real and in terms of opportunity, associated with their use as relevant indicators in prioritizing conservation research. Finally, the advantage also purports to the quality of scholarly papers published which will enrich the peer-reviewed scientific literature, and also improve the reach of practitioners in adopting scholarly publications as a means of information that drive their actions. This occurs optimally at the academic-practitioner interface (Arlettaz et al., 2010; Braunisch et al., 2012). The idea put forward here aligns with the dialectic that, on the one hand, researchers should shift from selfish self-actualizations, based solely on generating papers to gain academic rewards (Henry, 2013), to include social upliftment as part of their achievement (Fleishman et al., 2011; Cook et al., 2013), which we infer is also a means of engaging with issues of power relations by promoting inclusivity. On the other hand, practitioners should rise above

the *status quo* and embrace transformative change by effectively contributing in the research process to address the research-implementation gap (Knight et al., 2008; Braunisch et al., 2012). Scientists and/or practitioners define the research by embedding the reality for the decision-making context and research design (what scale of research is required to address the problem), for a particular problematized situation (designing for problem-context specificity), based on the chosen conservation framing, which then defines the biodiversity representations (Mace, 2014; Hugé et al., 2017) to be investigated. In the present case, it is the lion and the indicators used for its conservation assessment. Ideally, starting from a consultative process between academics and practitioners, research design should be operationalized such that the “research-focused Mode 1” and “conservation assessment Mode 2” nodes interact in a self-reinforcing loop. This step would build optimum critical mass in terms of knowledge-base, conservation understanding, scale of complexity, and consensus among researchers, practitioners and other stakeholders, if applicable, to design and structure the research agendas with a pathway to translation and into practice. This creates a virtuous circle of designing and implementing research to create impact in a path-dependent and coherent way (Figure 5). Based on our results, we believe that lion research by South African based authors is shifting from the vicious to the virtuous circle.

Following the analysis on the modes of knowledge that constitute the lion research architecture, we scrutinized the ownership of the research. Within post-colonial discourses, issues have been raised, such as where outputs are published as well as who is identified for holding tenure of the research (Knobel et al., 2013). The question that arises in the context of this paper is to what extent is lion research in South Africa being driven by South Africans. The word “by” has been carefully used in the previous sentence to emphasize that the criteria for the search of research articles included South Africa as an address. This means that at least one of the authors needed to have a South African institution as address affiliation. Importantly, many conservation issues are based in the developing world, where most biodiversity exists, and where many of the global challenges are going to play out, such as the effects of climate change on Africa (De Souza et al., 2015). Many societal challenges relate to inequalities, and solutions should not perpetuate inequalities. There are also power or voice imbalances between science in the Global North vs. the Global South, which unequally influence potential solutions that may be imposed on the Global South (Jeffery, 2014; Carbonnier and Kontinen, 2015). Similarly, gender inequalities highlight the strong voice of men relatively to women in scholarly publications, and the associated lack of participation by women in generating the understanding, and influencing the outcomes and solutions, or non-deliberate exclusion by fellow researchers and/or editorial teams (Webb et al., 2008; Cameron et al., 2013; Fox et al., 2016). In fact, in an article on the ethics of collaborative authorship, Henry (2013) drew an analogy between marital conflict and co-authorship as being among the few relationships that are prone to such hyped interpersonal animosity as when co-authors lose trust and respect for one another; implying that power and partnership can be mutually reinforcing or mutually destructive in the academic world. The reason attributed for such a state of affairs is that authorship in peer-reviewed publications is a highly prized academic reward (Henry, 2013). The trend in the present lion research citations highlights a gender imbalance in terms of the level of recognition that papers with female first authors receive in comparison to their male counterparts. Although more females were first authors and had earned more citations in the 2014–2018 period, none of them have been cited >100 times, indicating a gender imbalance in the level of recognition of female first authors. This imbalance may be the outcome of several underlying causes that could be understood, for instance, by systematically investigating the time frame that female researchers entered the life sciences as scientists/researchers.

Of the published lion studies with an author with a South African affiliation, most of the work was conducted by South African first authors, indicating a strong degree of ownership of that work by the South African research community. Patterns of collaboration have changed, with fewer first author papers coming from European authors, and more from USA authors. The author with the highest number of citations is an Australian national, Matt Hayward, with a total number of citations of 1229 for 11 papers published in the WOSTM database; followed by Funston, P., Slotow, R. and Kerley, G.I.H. who are South African nationals with more than 700 citations each. Interestingly, there

are very few first author papers from authors from “Rest of Africa” countries that include a South African-based author, and neither do any African authors figure in the top 20 most cited author list (**Supplementary Material**). Furthermore, the strong presence of South Africa over lion research is emphasized by the fact there are no papers with first author bearing affiliations from the rest of Africa (which includes the range states where lion lives), who have been conducting lion work in South Africa. This indicates that authors from other African countries mainly contribute to research papers as part of a team, and may hint toward a certain degree of North-South power imbalance, or even a power imbalance created from South Africa into the rest of Africa. In today’s polycentric world, effective partnerships between northern and southern research organizations are critical to support evidence-based collective action (Obamba and Mwema, 2009; Carbonnier and Kontinen, 2015). Issues of equity, capacity and accountability in multi-disciplinary, multi-national North-South research projects have been voiced in peer-reviewed publications (Henry, 2013; Jeffery, 2014). These can be interpreted in terms of power differentials, but in order to create a roadmap toward effective solutions to improve partnerships, emphasis could be laid on capacity building in key areas that demand attention (Jazeel, 2016). Viewed in a broader perspective, and given the current findings, do we need to shift our intellectual presuppositions about how, who, why, and where lion research is conducted? Based on this line of thought, Nowotny et al. (2003) embed the power differential within the research domain not by using the term North-South which has a high post-colonial discourse as support, but rather by specifying the real issues that occur within research so that the appropriate changes can be envisaged to resolve the disparity. This can be achieved by emphasizing capacity building related to the integration and distribution of knowledge, on the rapidity of transfers toward partners in the South, while at the same time meeting research excellence which is measured through research productivity metrics and scrutinized by funders and employers in academia (Jeffery, 2014). Conservation efforts have transnational range which extend across many countries in Sub-Saharan Africa and West Africa. In order to make lion conservation more efficient and inclusive, capacity building for researchers and practitioners in the rest of the African countries should be prioritized, as well as empowerment of authors from other African countries by South African academics.

Lion conservation research conducted by South Africa is made up of different levels of research collaborative configurations. Mode 1 research has been the predominant form of peer-reviewed scientific outputs generated from the last three decades driven by academic reward in a vicious circle. In recent years, a subtle shift toward Mode 2 research is perceptible whereby accent is being placed on both societal benefit and academic reward within a virtuous circle of research collaboration, implementation and translation. A certain degree of power imbalance has been detected in terms of the relational dynamics pertaining to power. The works of female first authors have a lower impact and academic recognition in the scientific community, as seen in the number of citations that they earn, although the number of female first authors has exceeded the male researchers

in the last 4 years. Similarly, the contribution and level of recognition attributed to authors from other parts of Africa is poor. We suggest that authors from other parts of Africa should be empowered by the leading South African researchers to build capacity in conservation efforts, and to reinforce the virtuous circle of research-translation action which is slowly gaining momentum.

AUTHOR CONTRIBUTIONS

RS: conception/design of the work and provide approval for publication of the content. NS and RS: acquisition, analysis or interpretation of data for the work, drafting and revising the work critically for important intellectual content, and agree to be

accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fevo.2019.00081/full#supplementary-material>

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