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Restoring Africa's Lions: Start With Good Counts

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Disney's new Lion King movie (released July 19th 2019) has put lion conservation in the global spotlight, with millions of dollars being committed to recovering Africa's lion populations through the "Protect the Pride" campaign (a partnership between the Lion Recovery Fund and Disney Conservation Fund). Although this USD\$ 1.5 million from the Disney Conservation Fund (and additional 1.5 million committed from merchandise sales) is small in the context of Lindsey et al. (2018) which highlight that African protected areas require USD\$ 1 billion annually for effective management, the media spotlight and initial donation could be an important catalyst for more funding. This money must be targeted strategically to achieve this goal, which depends on robust measures of lion density and abundance. However, good population estimates of African lions are almost completely lacking (Elliot and Gopalaswamy, 2017).

Lion conservation strategies, policy documents and funding priorities are currently guided by lion population estimates and the IUCN Red List assessment of the lion (Bauer et al., 2015, 2016), which frequently draw on expert opinion or unpublished surveys of variable reliability (Elliot and Gopalaswamy, 2017), leading to inestimable uncertainties or wide confidence intervals (e.g., 90 ± 42 lions; Kirsten et al., 2017). And often, due to underlying data overdispersion, the true confidence intervals are wider than reported (Gopalaswamy et al., 2015). This could have catastrophic consequences since underestimating lion numbers might cause us to triage an otherwise viable population, while overestimating density might cause under-investment in a population that requires active management. Furthermore, non-robust methods can often produce spurious trends in lion population dynamics, which can further mislead conservation investments (Elliot and Gopalaswamy, 2017).
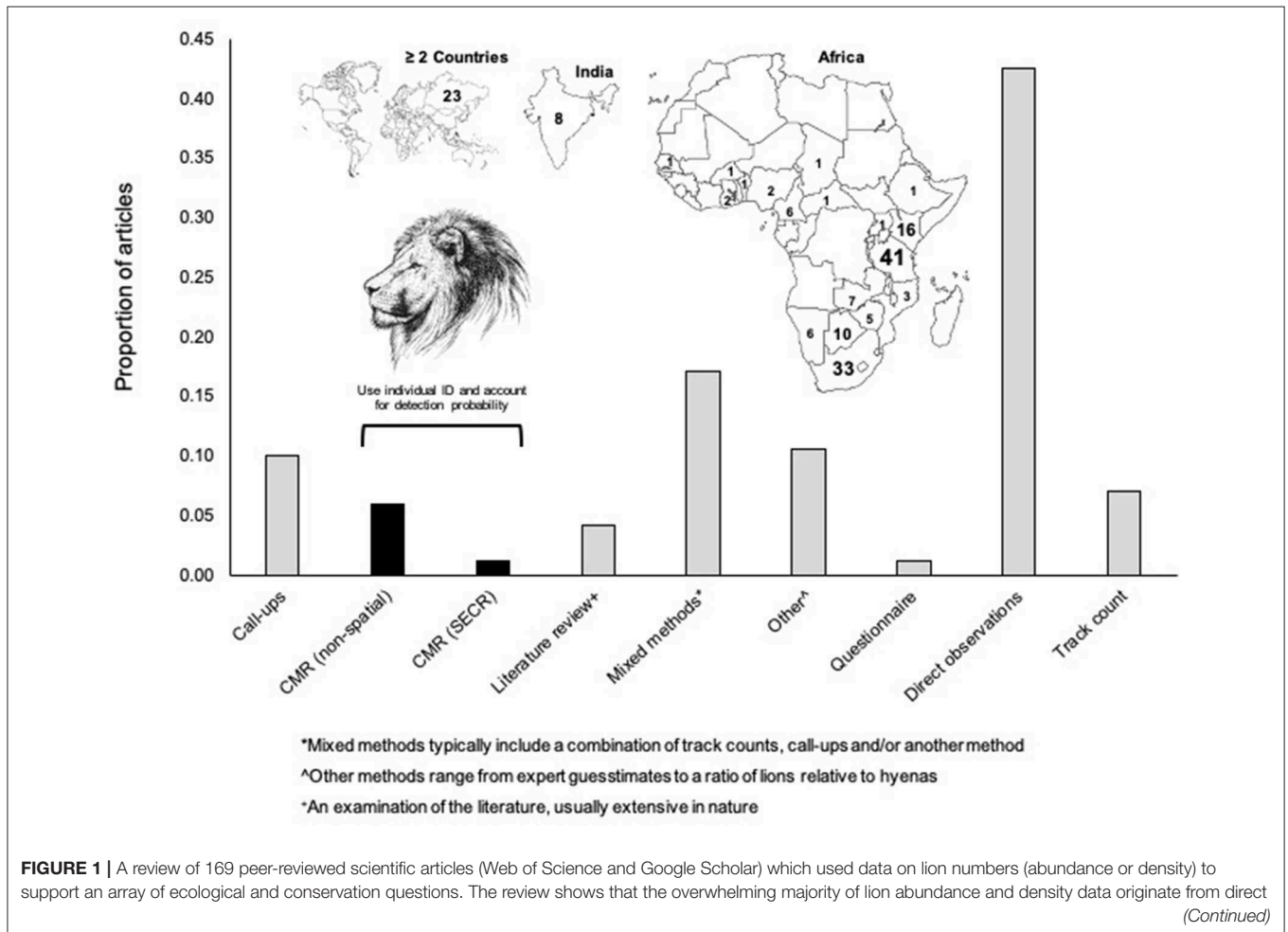
Advances in spatial capture re-capture statistics (SECR methods) now allow for highly robust animal density estimates, and are used routinely for all big cats with the exception of lions for which there are only two published case studies to date (Kane et al., 2015; Elliot and Gopalaswamy, 2017) out of 169 papers we identified in the literature (**Figure 1**). This is a missed opportunity because SECR methods capitalize on individual lion identification to allow estimation of sex-specific movements, territory sizes, and sex-ratios. These parameters provide important insights into population health that the more popular methods (e.g., audio lure surveys or track counts; Omoya et al., 2014) cannot. For example, enlarged movements or home ranges, and skewed sex-ratios, can signal prey depletion and imminent

population collapse (Tumenta et al., 2010). Furthermore, the precision of SECR density estimates will allow future surveys to examine population change, and since these methods track individuals over time, repeat surveys allow estimation of vital rates, such as mean survival (Karanth et al., 2006). Therefore, SECR methods have the potential to both guide conservation interventions and provide crucial insights about lion population dynamics.

A potential argument made against the use of SECR is its cost, particularly that of searching for lions with a vehicle. Braczkowski et al. (in press) spent approximately USD$ 3690 on their 93-day SECR lion survey in Queen Elizabeth National Park (USD$ 900 for vehicle and petrol costs, and USD$ 2790 on food and lodging). However, the costs of Rafiq et al. (2019) SECR survey cost only US$ 300 when a citizen science approach using tourist vehicles on Safari was used and this was comparable to spoor surveys and cheaper than camera trap or call in surveys. The employment of citizen science could be a scalable and robust way to use SECR in lion range states that suffer from a shortage of funds (Rafiq et al., 2019). Additionally in areas where lions are shy due to anthropogenic pressures such as poaching, snaring, trophy hunting, and war it is foreseeable that detection rates will

be low. Kane et al. (2015) showed the utility of using camera traps and SECR for lions in the Niokolo Koba National Park (NKNP) in Senegal. However, this study's sample size was low and has not been shown to work over a larger scale. The large country-wide lion census currently being implemented by the Kenya Wildlife Service across Kenya has also used call-up surveys and foot-based searches coupled with photography of individual lions. These methods have proved sufficient even in regions where lion detections are low (e.g., Laikipia is known to have shy lions but in a 3-month survey there over 300 lion detections were recorded).

SECR-derived population estimates are typically lower compared to non-spatial CR methods (Noss et al., 2012), and other methods generate estimates with large uncertainty. So we fear lion populations across Africa are not as large or stable as currently thought. Therefore, we argue that rigorous, on-ground, SECR monitoring methods should be urgently implemented across all African lion populations, and the last remaining population of lions in Asia (Gir National Park, India). A project of a similar ambition to Kenya's national lion survey, which incorporates the latest SECR methods is envisaged. Accurate continent-wide counts would then underpin

FIGURE 1 | A review of 169 peer-reviewed scientific articles (Web of Science and Google Scholar) which used data on lion numbers (abundance or density) to support an array of ecological and conservation questions. The review shows that the overwhelming majority of lion abundance and density data originate from direct

(Continued)

FIGURE 1 | observations of identified individuals, mixed methods, call-ups (i.e., Audio lure), or track surveys. Most studies have also been implemented in Tanzania, South Africa, Kenya, and Botswana (≥2 countries refers to studies that used lion data for meta-analysis, reviews or multiple country surveys). The protocol we utilized for this literature review is provided in **Supplementary Information 1**. The studies which used direct observations mainly used individual identification of animals and assumed that all individuals seen accounted for the total population (i.e., a total count of known individuals).

lion recovery efforts, ensuring adequate allocation of resources from funding efforts like the "Protect the Pride" campaign, and others like it. These could be directed to where they will have the greatest impact.

AUTHOR CONTRIBUTIONS

ABr conceived the idea with AG. ABr and JA wrote the manuscript. AG, JA, NE, HP, ABe, MM, and DB provided input on the manuscript. ABr and ABe performed the literature review.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fevo.2020.00138/full#supplementary-material

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