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IN PERSPECTIVE

Enhancing invasive alien plant eradication outcomes: Lessons learned from South Africa

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Abstract

Several attempts to eradicate invasive alien species have been initiated in South Africa and despite no formal eradication declaration, several species have been brought down to low levels or are now absent from the country. Based on an expert workshop with South African implementing agencies on best nationwide eradication practices, we recommend that eradication programmes should be well coordinated, and characterised by collaboration between implementing agencies, researchers and practitioners. Countries should have a list of eradication targets informed by the best available science, with targets ranked according to priority. The best eradication model should be used consistently until eradication is achieved. While most of these priority areas are not novel, it does provide a perspective from a biodiverse African country with limited funding, based on 16 years of experience in implementing eradication programmes. It corroborates challenges experienced elsewhere in the world and contributes to enhancing eradication outcomes globally.

KEYWORDS
coordination, eradication, invasive alien species, prioritisation

Résumé

Plusieurs tentatives d'éradication d'espèces exotiques envahissantes ont été entreprises en Afrique du Sud et, malgré l'absence d'une déclaration officielle d'éradication, plusieurs espèces ont été réduites à des niveaux faibles ou sont désormais absentes du pays. Sur la base d'un atelier d'experts avec les agences sud-africaines de mise en œuvre sur les meilleures pratiques d'éradication à l'échelle nationale, nous recommandons que les programmes d'éradication soient bien coordonnés et caractérisés par une collaboration entre les agences de mise en œuvre, les chercheurs et les professionnels. Les pays devraient disposer d'une liste d'objectifs d'éradication fondés sur les meilleures données scientifiques disponibles, les objectifs étant classés par ordre de priorité. Le meilleur modèle d'éradication doit être utilisé de manière cohérente jusqu'à ce que l'éradication soit réalisée. Bien que la plupart de ces domaines prioritaires ne soient pas nouveaux, cela présente le point de vue d'un pays

africain riche en biodiversité et disposant d'un financement limité, sur la base de 16 années d'expérience dans la mise en œuvre de programmes d'éradication. Il confirme les défis rencontrés ailleurs dans le monde et contribue à améliorer les résultats de l'éradication au niveau mondial.

1 | INTRODUCTION

Invasive alien species can exert significant negative ecological impacts on invaded ecosystems, disrupt ecosystem services and threaten human well-being (Mack et al., 2000; Pejchar & Mooney, 2009; Vilà et al., 2011; Erckie et al., 2022). To mitigate such impacts and promote native biodiversity recovery in invaded ecosystems, management of invasive alien species is required and largely involves their removal (Weidlich et al., 2020). Management of invasive alien species is most effective before a species becomes widespread, since when still limited to small areas, nationwide eradication (complete removal of all individuals and propagules of a population of an alien species from a country to which there is a negligible likelihood of reinvasion) is a viable option (Pluess et al., 2012; Wilson et al., 2016; Zengeya & Wilson, 2020). Eradication of invasive alien species can lead to the permanent improvement of biodiversity indicators (Wilson et al., 2013). However, eradication operations can be fraught with challenges, even when rigorous methodology is applied, which can limit their success (Simberloff, 2003). For example, failure to define the total distribution of the invasive alien species, insufficient funds to see the project through to completion and tenacious biology of some invasive alien species can limit the success of eradication operations (Gardener et al., 2010).

More than 8750 alien plant species have been introduced to South Africa, with about 559 terrestrial plant species establishing naturalised populations in the country (Irlich et al., 2014; Le Maitre et al., 2011; Richardson et al., 2020; van Wilgen & Wilson, 2018). At least 42 eradication projects have been initiated or are under consideration in South Africa, with the majority targeting terrestrial or freshwater plants (van Wilgen & Wilson, 2018). Many populations of several 'eradication targets' have been brought down to low levels (Zengeya & Wilson, 2020). The ability to eradicate invasive alien species in South Africa was enhanced by the establishment of a national body to coordinate and intensify eradication efforts in 2008, i.e. the Invasive Species Programme (later became part of the Biological Invasions Directorate which was later changed to Directorate: Biodiversity Evidence) of the South African National Biodiversity Institute (SANBI) (Wilson et al., 2013). The work done by SANBI is augmented by other public entities (e.g. South African National Parks) and municipalities (e.g. City of Cape Town) (referred to as 'implementing agencies' here), and to a lesser extent private landowners.

With 16 years having passed since the introduction of the Invasive Species Programme and with it the intensification of eradication efforts in South Africa, there are key lessons that can be learned on how best to implement nationwide eradication operations in Africa to guarantee enhanced eradication outcomes. Using South Africa as a case study, we contribute to the debate on how best to implement nationwide eradication operations to guarantee enhanced eradication outcomes.

2 | METHODS

A workshop was convened for researchers and practitioners from South African implementing agencies working on invasive alien plants. The workshop was held via Zoom (23 September 2020) (https://zoom.us/) and attended by 17 participants, and lasted for 2 h. Participants were from the Cape Peninsula University of Technology, Centre for Invasion Biology, City of Cape Town, SANBI and Stellenbosch University. Participant experience with working on invasive alien plants ranged from 5 to 39 years, with an average of 12.5 years. The lead author facilitated the workshop. The facilitator started the workshop with a presentation summarising the aims of the workshop. The floor was then opened for a structured participative discussion on: (1) how invasive alien plant species are selected for eradication; (2) how invasive alien plant species eradication plans are developed and implemented; (3) practical challenges to eradication and (4) potential solutions to the practical challenges. Time was allocated to identifying and discussing alternative views and sharing experiences. The workshop was recorded after permission to record was granted by all participants.

3 | RESULTS AND DISCUSSION

From the workshop, we were able to identify five priority areas that are paramount to a successful nationwide plant eradication programme. These are (1) ensuring effective oversight to facilitate coordination and collaboration; (2) having a list of national eradication targets that are informed by the best available science; (3) prioritising eradication targets to guide national eradication planning; (4) selecting the best eradication model to enhance eradication outcomes and (5) consistency and willingness to see the projects through to completion. While most of these priority areas are not novel, the results of this workshop do provide a perspective from a biodiverse African country with limited funding based on 16 years of experience in implementing eradication programmes. These areas are discussed in detail below.

3.1 | Ensure effective oversight to facilitate coordination and collaboration

The introduction of the Invasive Species Programme enhanced eradication efforts in South Africa by allowing for a national body to coordinate and channel funds and resources towards eradication (Wilson et al., 2013). We believe that nominating a government department or unit to serve as a focal point to coordinate national eradication efforts by providing support and resources, assisting with communication between dissimilar groups, creating benchmarks, identifying strategies to enhance eradication efforts and coordinating efforts to enact and revise policies will increase the ability of a country to eradicate invasive alien species. Such a department or unit can aid implementing agencies in sharing eradication plans, reviewing them together, exploring opportunities for working together on sites or species of interest and allowing for the pooling of funding where possible. Furthermore, a network which includes private landowners who are interested in conducting eradication operations on their properties can be created to enhance collaboration and/or provide guidance on best practices. Collaboration between researchers and practitioners should be strengthened so that they can work together to develop tools—such as simple models to assess progress and predict success (see, e.g. Panetta & Lawes, 2007) that can guide eradication efforts—and focus research on identified gaps (Funk et al., 2020), and national government and/or implementing agencies should prioritise the funding of such research. Student research projects can be co-developed by researchers and practitioners to address critical research gaps.

3.2 | Have a list of national eradication targets that are informed by the best available science

The workshop established that the selection of invasive alien species targeted for eradication is mainly informed by the Alien and Invasive Species Regulations (A&IS) that were promulgated under the National Environmental Biodiversity Act (NEM:BA) (Act 10 of 2004) (NEMBA, 2004). These regulations provide a list of invasive alien species that require management and separate them into eradication and non-eradication targets. Inclusion of invasive alien species on these lists was initially largely informed by expert opinion. However, this created significant challenges to eradication as some widespread invasive alien species were inappropriately assigned as eradication targets. For example, *Melaleuca hypericifolia* Sm. was assigned as an eradication target but recent literature suggests that the suitability of the species as a target for nationwide eradication is limited by the extent of its plantings (Hickley et al., 2017; SANBI, unpublished data). To remedy this, risk analyses are increasingly being relied upon (Kumschick et al., 2020) to inform the list of species targeted for management, as is the case elsewhere in the world (Booy et al., 2017), and therefore eradication targets are becoming more accurately identified. A key component of assigning eradication targets is whether it is feasible and desirable to eradicate them and such a decision requires a feasibility of eradication study (i.e. a scientific assessment of how feasible and desirable it is to eradicate the invasive alien species and resources required to achieve this) (e.g. Matthys et al., 2022), which is incorporated into the risk analysis. Implementing agencies select their targets from the NEM:BA A&IS Regulations based on their legal mandates and/or priorities and implement taxon-specific eradication plans. Implementing agencies also select targets that are not listed in the NEMBA A&IS Regulations if there is sufficient documented evidence to show that there is a high potential for eradication, which warrants in-depth investigation and an incursion response (van Wilgen & Wilson, 2018). Countries should curate a list of eradication targets that are informed by the best available science to guide eradication operations. Such a list should have legal standing and implementing agencies should select their targets from that list.

3.3 | Prioritise eradication targets to guide national eradication planning

Currently, there is no comprehensive and agreed-upon tool which is used to prioritise national eradication targets in South Africa. It is unclear which of the eradication targets should be prioritised and in what order. Instead, a pragmatic approach is often taken. That is, work is done on: (1) invasive alien species that have already been worked on in the past; (2) invasive alien species selected by field experts based on their potential to be successfully eradicated and/or (3) invasive alien species that are known to be major invaders in other parts of the world (Wilson et al., 2013). Such an approach is likely to be ineffective in the long run since resources will continue to be directed towards species that have been managed in the past, but for which eradication remains elusive (the sunk cost fallacy; Magalhães & White, 2016). Prioritisation is key to the effective use of limited resources in the face of competing priorities (Forsyth et al., 2012; Potgieter et al., 2018). Workshop participants highlighted that an alternative approach should be taken by prioritising eradication targets. That is, once the feasibility of eradication studies (including estimates of costs) are done, eradication targets should be ranked according to ease and cost of eradication, and further refined by the threat posed and return on investment.

3.4 | Select the best eradication model to enhance eradication outcomes

Workshop participants recognised that implementation of eradication operations in South Africa is predominantly through contractors. This eradication model best aligns with the country's policy of clearing invasive vegetation by creating jobs, particularly within

historically disadvantaged communities (Turpie et al., 2008; van Wilgen & Wannenburgh, 2016). It is worth noting that the contractor model is widely used globally (e.g. Kerr et al., 2016; Oreska & Aldridge, 2011). Species eradication contracts are issued to community-based companies, who in turn have the responsibility of employing historically disadvantaged individuals from their communities (van Wilgen & Wannenburgh, 2016). Contractors are then trained on how to implement eradication operations and collect relevant field data for monitoring progress towards eradication. After the training, contractors conduct eradication operations, after which regular follow-up clearing is conducted until eradication is achieved or deemed infeasible. In some cases, different eradication models are used; particularly, if the species has one or a few small populations, occurs over a small area, and control methods do not require specialised training. In those cases, staff from implementing agencies can implement eradication operations themselves. In some instances, postgraduate students who are undergoing training on biological invasions and/or volunteer groups (i.e. 'hack groups'; Jubase et al., 2021) can support the implementation of the eradication operations (Geerts et al., 2013, 2017). The workshop indicated that it is best for staff from implementing agencies to be the backbone of conducting eradication operations as this would avoid drawn-out procurement processes with contractors and increase the time available and consistency for clearing teams to be in the field. The other abovementioned models can play a supporting role. Emphasis must be placed on increasing the capacity within implementing agencies so that more of their staff can dedicate time to conducting eradication operations. Given the inherent value of field data to monitoring progress towards eradication, staff from implementing agencies are most likely to ensure that robust data collection standards are set and adhered to (in comparison, data collected by contractors in South Africa has often been rife with errors and inaccuracies). We believe that countries would benefit from choosing the best clearing model that works for their different contexts and guarantees the highest chance of enhanced eradication outcomes.

3.5 | Consistency is crucial to success

For eradication to be successful, there is a need to conduct clearing operations consistently until eradication is achieved (Gardener et al., 2010; Simberloff, 2003). Regular clearing operations which are appropriately timed (following the reproductive biology of the invasive alien species) are likely to result in enhanced eradication outcomes as they reduce existing populations while limiting the establishment of a new generation of individuals. For example, *Sporobolus alterniflorus* (Loisel.) was recorded in 2004 in the Great Brak Estuary, a system along the southern coast of South Africa (Adams et al., 2016). Since 2011, *S. alterniflorus* has been under constant management with significant progress towards eradication made to the extent that the species is suspected to have been eradicated (a formal declaration of eradication is yet to be done) (Adams et al., 2016; Riddin et al., 2016).

4 | CONCLUSION

Management of invasive alien species is key to mitigating their impacts on ecosystems and is best done when they are still limited to small areas because eradication would be a viable option. To enhance nationwide eradication outcomes, it is vital for eradication programmes to be well coordinated, and characterised by collaboration between implementing agencies, researchers and practitioners. Countries should have a list of national eradication targets that are informed by the best available science, and these should be ranked according to priority. The best eradication model should be used, and eradication targets should be managed consistently until eradication is achieved. A perspective, such as this, from a resource-limited biodiverse African country based on 16 years of experience in implementing eradication programmes, corroborates challenges experienced elsewhere in the world and contributes to enhancing eradication outcomes globally.

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CONFLICT OF INTEREST STATEMENT

No conflicts of interest.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analysed in this study.

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