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Review

How to improve threatened species management: An Australian perspective

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ABSTRACT

Targeted threatened species management is a central component of efforts to prevent species extinction. Despite the development of a range of management frameworks to improve conservation outcomes over the past decade, threatened species management is still commonly characterised as ad hoc. Although there are notable successes, many management programs are ineffective, with relatively few species experiencing improvements in their conservation status. We identify underlying factors that commonly lead to ineffective and inefficient management. Drawing attention to some of the key challenges, and suggesting ways forward, may lead to improved management effectiveness and better conservation outcomes. We highlight six key areas where improvements are needed: 1) stakeholder engagement and communication; 2) fostering strong leadership and the development of achievable long-term goals; 3) knowledge of target species' biology and threats, particularly focusing on filling knowledge gaps that impede management, while noting that in many cases there will be a need for conservation management to proceed initially despite knowledge gaps; 4) setting objectives with measurable outcomes; 5) strategic monitoring to evaluate management effectiveness; and 6) greater accountability for species declines and failure to recover species to ensure timely action and guard against complacency. We demonstrate the importance of these six key areas by providing examples of innovative approaches leading to successful species management. We also discuss overarching factors outside the realm of management influence that can help or impede conservation success. Clear recognition of factors that make species' management more straightforward – or more challenging – is important for setting realistic management objectives, outlining strategic action, and prioritising resources. We also highlight the need to more clearly demonstrate the benefit of current investment, and communicate that the risk of under-investment is species extinctions. Together, improvements in conservation practice, along with increased resource allocation and re-evaluation of the prioritisation of competing interests that threaten species, will help enhance conservation outcomes for threatened species.

1. Introduction

Threatened species management, based on assessments of species extinction risk, threat identification, prioritisation of species for management, and implementation of targeted management actions, is central to curbing biodiversity loss (Primack, 2006). Despite substantial efforts, notable success has been achieved for relatively few species, and as a result, few threatened species have recovered sufficiently following management interventions to allow delisting (Bottrill et al., 2011; Male and Bean, 2005). In part, this failure can be attributed to a severe lack of resources (Evans et al., 2016; McCarthy et al., 2012). For example in Australia, McCarthy et al. (2008) found that funding for threatened birds was inadequate to prevent further extinctions and facilitate recovery for most listed species, but also that a relatively small increase in resourcing could substantially improve the conservation status of many species. Australian environmental spending is disproportionately low, with Australia one of only several developed countries featuring in the top 40 underfunded countries for conservation spending (Waldron et al., 2013). Further, there has been a sharp reduction in funding over the past decade, with less than five cents for every $100 of government spending in 2018 directed to biodiversity conservation (ACF, 2018). However, there are several other prominent reasons for the worsening conservation status of many threatened species, such as a failure to address major threats (Johnson et al., 2017), poor enforcement of

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existing legal protections (Harrison et al., 2016), increasing ignorance of scientific evidence (Sutherland and Wordley, 2017), and a culture of apathy (Russell-Smith et al., 2015). In combination, these issues contribute to inaction or inefficient last minute attempts to rescue species on the brink of extinction (Woinarski et al., 2017).

While part of the blame for ongoing species declines can be attributed to funding shortfalls or socio-political issues, in practice, species declines could also be halted by improving the effectiveness of on-ground conservation effort (Sunderland et al., 2009; Toomey et al., 2017). Although there are examples of successful recovery efforts (see Garnett et al., 2018), many other projects are marred by ad hoc and inefficient planning and implementation (Ferraro and Pattanayak, 2006; Pullin et al., 2004; Sutherland et al., 2004). Further, the effectiveness of conservation management is often poorly evaluated, making it difficult to assess how effective each action was, or what species trajectories would have been in the absence of management intervention (Cresswell and Murphy, 2016). A range of decision frameworks and tools have emerged from conservation planning research to address these challenges (see review by Schwartz et al. (2018)), and there have been substantial advances in the practice of expert elicitation (Hemming et al., 2018). While the increasing use of decision frameworks and support tools over the past 20 years has contributed to enhanced outcomes, there is still substantial room for improvement (Cook et al., 2010; Ferraro and Pattanayak, 2006).

Here we address challenges that can impede conservation management of threatened species in Australia. We have taken an Australian perspective for several key reasons. These include the fact that Australia supports a highly diverse and endemic range of species and ecosystems, some of which have been recently lost (e.g. 35% of modern global mammal extinctions have occurred in Australia (Woinarski et al., 2015)), and many more that are threatened (see: Australian Government, 2018). Australia also has a large and diverse array of species recovery programs, with some failures but also prominent successes, upon which to learn from and improve (Garnett et al., 2018). Finally, there is a strong tradition of research excellence in conservation and environmental management in Australia, thus there is scope and capacity within the nation to improve conservation management standards (Harrison, 2006).

We focus on what can be done to improve threatened species management under current constraints. We acknowledge the need for societal changes in human values and their interaction with the environment (Abson et al., 2017), along with a substantial funding increase (Johnson et al., 2017; Waldron et al., 2013). We also address other over-arching factors outside the realm of management control that can impede conservation success. We consider that despite there being a range of program management frameworks readily available, a large implementation gap remains. We provide illustrative case studies of innovative approaches leading to successful species management, noting that 'success' is context-specific and that long-term success will often require continuation of current management trajectories. The views outlined below are the result of a three day workshop of conservation practitioners and researchers with long-term experience in threatened species management, where we worked to collectively identify pitfalls that can lead to ineffective and inefficient management. By drawing attention to some of the key challenges, and providing ways forward, we hope to present a perspective that leads to improved conservation effectiveness and better conservation outcomes.

2. Challenges and solutions in threatened species management

Once a decision to manage a threatened species has been made, the management process consists of three broad stages; 1) conceptualisation and planning, 2) management implementation and evaluation, and 3) program evaluation and revision (Fig. 1). These broad categories reflect a standard management cycle (e.g. Schwartz et al., 2018). Below, we identify common challenges that occur across each of these stages and provide examples of how they have been overcome. In addition, we discuss challenges in two overarching elements that profoundly impact management; stakeholder engagement and communication, and leadership and personnel. Our evaluation is not exhaustive, but rather reflects personal experience with issues that most commonly arise in the context of threatened species management in Australia. We refer the reader to Schwartz et al. (2018) for guidance on decisions support tools and frameworks for conservation management. We provide a range of species-specific case-studies of successful management programs overcoming many of the challenges discussed in the following section (see Supporting Material Table S1 for additional examples).

2.1. Conceptualisation and planning

A key set of interrelated deficiencies in threatened species management can stem from management that is based on inadequate understanding of the target species' ecology or threats (Fig. 1). These deficiencies result in poor problem definition, and a lack of clear and realistic objectives. Although the need for robust understanding of the target species' ecology and threat impacts is well established (Caughley and Gunn, 1996), in reality it is poorly adhered to, and often undervalued. Attaining sufficient ecological knowledge generally requires detailed field work to ascertain, among other things, the target species' distribution, habitat requirements, life history parameters, population trajectories, and threat impacts (Table S1; example 1). These processes need to be understood across the target species' entire distribution (to make informed choices of where to prioritise management), or the proportion of the species' distribution where management efforts will be implemented. Because threat impacts and threat tolerance are shaped by environmental and biotic processes that vary across environmental space (Scheele et al., 2017a), information obtained for one population is not always transferable to other populations. It is also crucial to understand interactions between multiple threats and the capacity for changes in one element of a system to amplify the impacts of other threats. Many present day management practices remain focused on a single threat despite growing scientific understanding of the importance of considering threat interactions (Scheele et al., 2017a).

While there is a clear need for more ecological research, constrained budgets mean that research must be strategic, with a focus on resolving uncertainty that will improve management decisions. The development of a conceptual model of the target system can help identify knowledge gaps and where to focus research. For example, Bode et al. (2017) used expert opinion to develop an ecosystem model linking malleefowl (*Leipoa ocellata*) persistence with abiotic and biotic processes in mallee ecosystems. The model helped managers identify direct and indirect threats facing the species, the likely response of populations when each threat interaction is managed, and the most uncertain threat interactions that require further research.

While inadequate knowledge of a target species' ecology and threat impacts can hamper decisions about management alternatives, in many cases there is a need for conservation management to proceed – or at least be initiated – despite knowledge gaps. In such cases, management is commonly guided by expert judgement. For example, expert judgment informed a decision to undertake aerial phosphite application in 1997 to control *Phytophthora cinnamomi* in key areas in south west Western Australia, despite uncertainty about phytotoxicity. Urgent management was deemed necessary because the rapid spread of *P. cinnamomi* was driving the local extinction of at least 11 threatened plant species. Importantly, the early, incisive intervention that was based on expert judgement was complimented with monitoring and evaluation of management effectiveness. Monitoring revealed that populations of most species have stabilised following phosphite application (Barrett and Yates, 2015), and that phytotoxic effects are minimal in these vegetation systems (Rathbone and Barrett, 2018).

Challenges arising from ecological uncertainty are often