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PRACTITIONER'S PERSPECTIVE

Conservation practitioners' perspectives on decision triggers for evidence-based management

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Introduction

Protected area management organizations are on the front line of protecting biodiversity, and effective management is recognized as critical in halting the loss of biodiversity. Evidence-based management can help guide effective management of natural systems by integrating the best available evidence to support management decisions and evaluate management effectiveness. Over recent decades, evidence-based management has started to emerge as an approach, in response to the need for increased transparency and to promote positive conservation outcomes (Ferraro & Pattanayak 2006).

Evidence-based management aims to assist conservation practitioners in making the often difficult decisions about when to intervene in a system to prevent undesirable changes. State-dependent management can support evidence-based management, where appropriate management actions depend on the current state of the system. This approach requires a good understanding of ecosystem processes, to assess when a system is shifting into an undesirable state and when management intervention is required (Nichols & Williams 2006). A proactive application of state-dependent management involves the use of decision triggers, which represent a point or zone in the status of a monitored variable indicating when management intervention is required to address undesirable ecosystem changes (Cook *et al.* 2016; Fig. 1).

Consistent with moves towards evidence-based management, decision triggers have received increasing attention from conservation scientists to assist in the protection of biodiversity (e.g. Biggs & Rogers 2003; Martin *et al.* 2009; Nie & Schultz 2012; Addison, de Bie & Rumpff 2015). From an academic perspective, decision triggers facilitate proactive management through systematic, *a priori* consideration of the desired ecosystem state and the management interventions that can influence the status of that ecosystem (Martin *et al.* 2009; Addison, de Bie & Rumpff 2015). Decision triggers also facilitate the direct use of monitoring data in evidence-based management, something criticized by academics as lacking in conservation (Lindenmayer, Piggott & Wintle 2013).

From a management perspective, decision triggers offer conservation practitioners greater clarity about when and where to intervene in a system (Bennetts *et al.* 2007; Guntenspergen 2014). This could help avoid disastrous instances where monitoring data have tracked species decline to local extinction, with no process in place (like decision triggers) to trigger timely management intervention (e.g. the local extinction of the greater glider in an Australian protected area; Lindenmayer, Piggott & Wintle 2013). Decision triggers can also improve transparency of management, communicating supporting evidence and justification for why and when practitioners intend to intervene in response to a breached trigger (Nie & Schultz 2012). This is increasingly important for practitioners in jurisdictions where failure to act, or effectively communicate the rationale for inaction, can expose organizations to litigation (Fischman & Ruhl 2015).

Several recent methodological advances to set decision triggers suggest growing support from the academic community for the integration of decision triggers into evidence-based management (Cook *et al.* 2016). However, there has been little consideration of whether practitioners in management organizations support the use of decision triggers. A collaborative approach between conservation scientists and practitioners is necessary to understand practitioners' experience with developing and implementing decision triggers. Such a collaborative approach can be rare in conservation; however, it has the potential to provide valuable insights into what features of decision triggers are required to enable greater adoption. These

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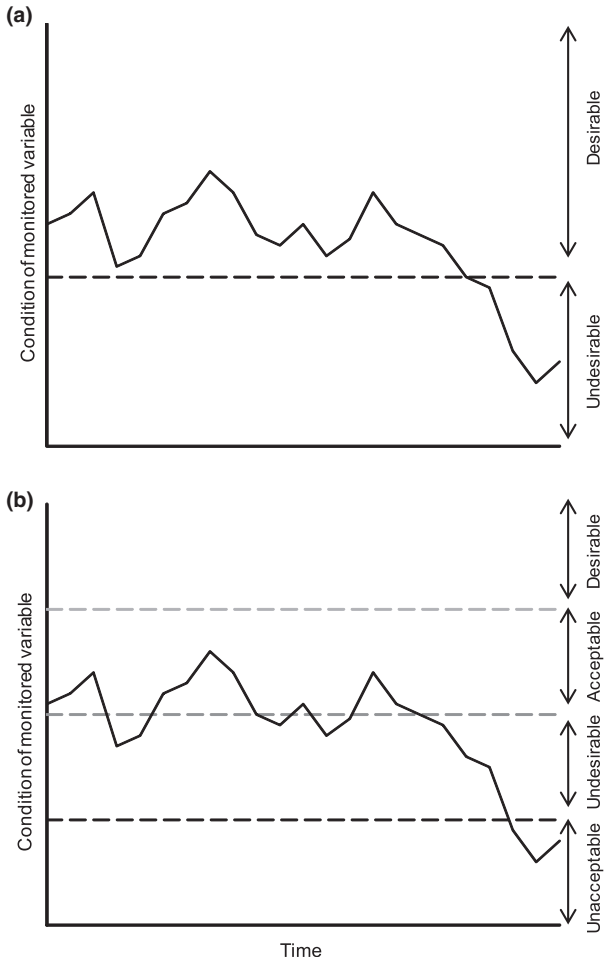

Fig. 1. Decision triggers (horizontal dashed lines) representing a target for management intervention, such as the point between: (a) desirable and undesirable states of a monitored variable, or (b) desirable, acceptable, undesirable and unacceptable states of a monitored variable (adapted from Cook *et al.* (2016)).

insights can then guide more targeted research to support the wider application of decision triggers for conservation.

To facilitate collaboration, conservation practitioners from 10 protected area management organizations in Australia and New Zealand came together for a two-day workshop in 2014 to share ideas and accelerate progress towards the development of decision triggers for protected area management (Table 1). The organizations involved represent the overwhelming majority of government and non-government organizations responsible for managing protected areas in Australia and New Zealand. These organizations manage an extensive and diverse terrestrial and marine estate covering over 400 million hectares (Department of the Environment 2014) and are globally recognized as leaders in conservation management approaches.

Fifteen conservation practitioners were involved in the workshop, nominated as the staff members within each organization with the most knowledge about decision triggers and in-house approaches to evidence-based management (e.g. monitoring, evaluation, reporting and adaptive management; see Cook *et al.* (2016) for an outline of approaches to evidence-based management). The workshop focus was to (i) document organizations' motivations for using decision triggers, (ii) determine whether there is support for the use of decision triggers in evidence-based management, (iii) share examples of the use of decision triggers, (iv) identify barriers impeding the development and implementation of decision triggers in practice, and (v) discuss solutions to address these barriers. The workshop involved a questionnaire, structured interviews and group discussion to ensure all participants had an opportunity to share their perspectives.

Table 1. The protected area management organizations involved in this study

Organization name	Types of protected areas managed: Terrestrial	Marine
Bush Heritage, Australia	●	
Department of Conservation, New Zealand	●	●
Parks Australia, Department of the Environment, Australia	●	●
New South Wales National Parks and Wildlife Service, Australia	●	●
Northern Territory Parks and Wildlife Commission, Australia	●	●
Parks Victoria, Australia	●	●
Queensland Parks and Wildlife Service, Australia	●	●
South Australian Department of Environment, Water and Natural Resources, Australia	●	●
Tasmanian Parks and Wildlife Service, Australia	●	●
Western Australia Department of Parks and Wildlife, Australia	●	●

Here, we discuss the workshop findings, their relevance to conservation practice, and provide key recommendations to assist the conservation community in applying decision triggers to support evidence-based management.

Motivations for adopting or implementing decision triggers

A wide range of organizational motivations for developing and using decision triggers were articulated by conservation practitioners, going well beyond the desire to safeguard against negative conservation outcomes (Fig. 2). Decision triggers were primarily viewed as useful for supporting decision-making by providing clarity about when and how to act, removing the need for guess work, and guarding against the paralysing effects of uncertainty. Improving transparency of decisions was also a prime motivation (Fig. 2). This has become a significant issue, with increasing levels of scrutiny and mounting pressure

Fig. 2. The motivations for organizations developing and using decision triggers, ordered from most to least frequently cited by the Australian and New Zealand organizations. The proportion of organizations is illustrated in the grey shading of the pie charts (out of 10 organizations), with the number of organizations citing each motivation shown in parentheses.

for accountability from donors, the public and government, particularly in challenging socio-political contexts (Ferraro & Pattanayak 2006).

Decision triggers were also viewed as valuable for assisting in reporting management outcomes, by improving the communication of organizations' decision processes and clearly demonstrating the evidence used to support decisions (Fig. 2). Other objectives for using decision triggers included improving the cost-effectiveness of management, helping prioritize management decisions and facilitating management effectiveness evaluation. These motivations are in line with conservation organizations from around the world that are under increasing pressure to be publicly and legally accountable for their conservation outcomes (Ferraro & Pattanayak 2006; Fischman & Ruhl 2015).

Support for and progress towards implementing decision triggers

Conservation practitioners from all 10 organizations believe that decision triggers are an important part of evidence-based management. The majority (nine out of 10) of the organizations were beginning to consider or in the early stages of developing decision triggers for specific case studies (see Section 4 for details). This finding is in line with the development and use of decision triggers by conservation organizations around the world, such as the USA (Martin *et al.* 2011) and South Africa (Biggs & Rogers 2003). It also reflects the views expressed by scientists that decision triggers can facilitate evidence-based management (Fischman & Ruhl 2015; Cook *et al.* 2016).

Similar to the diverse terminology for decision triggers used in the peer-review literature (Cook *et al.* 2016), the terminology used by organizations was highly variable, including 'trigger points', 'thresholds', 'thresholds of potential concern' and 'limits of acceptable change'. Practitioners agreed that standardizing terminology was important to facilitate collaboration and communication, and a preference was expressed for terms that evoked the imperative for action, such as 'decision trigger', 'intervention point' or 'trigger for adjustment', rather than those that could be confused with ecological thresholds, where small changes in a variable lead to large changes in an ecosystem state (Groffman *et al.* 2006).

The need for a clear distinction between ecological thresholds and decision triggers was an important issue for practitioners, to reiterate that ecological thresholds are not a necessary precursor for decision triggers (a stance supported in the scientific literature; Bennetts *et al.* 2007; Addison, de Bie & Rumpff 2015). This misconception was seen as an impediment to communicating decision trigger needs with the academic community. This was echoed in broad agreement that decision triggers may need to be based on value judgements, such as organizational or stakeholder priorities, as well as ecological knowledge about ecosystem states. Practitioners were interested in identifying a process that could be structured to ensure it was transparent and based on the best available evidence. They also sought versatility, including the ability to set multiple triggers representing when management intervention is required across the spectrum of desirable to unacceptable ecosystem states (Fig. 1).

Examples of the application of decision triggers

While there is strong support for decision triggers, different organizations were at very different stages of considering, developing or implementing decision triggers. Four organizations were in the early stages of considering using decision triggers, but were unsure about how to proceed. Five organizations were in the process of developing decision triggers for specific case studies, often for issues with political pressure for transparency because management interventions are controversial (e.g. controlling over-abundant native wildlife). One organization was actively using a decision trigger for evidence-based management in a situation where there were strong causal links established between indicators and outcomes, and long-term biodiversity monitoring data were available. However, this was an isolated example.

A degree of broad organizational-level support for decision triggers was clearly demonstrated by the majority (eight) of organizations having isolated case studies where decision triggers were used for a high priority or a high profile management issue. Examples of existing applications were for significant threats to biodiversity (e.g. fire

or invasive species management; six organizations), setting quotas for harvesting or controlling native species (two organizations) and determining when to remove threatened populations from the wild (two organizations). The application of decision triggers to date has generally focused on threat management. Most (seven) organizations see value in developing decision triggers for species and ecosystem management but found this significantly more challenging.

Cases where decision triggers had been applied generally reflected well-studied threat management issues subject to high levels of socio-political scrutiny, such as sustainable harvest of native wildlife (e.g. magpie geese) or management of popular recreation activities that can impact biodiversity (e.g. horse riding in wilderness areas). This is in keeping with examples of decision triggers for threat management from other countries, such as impacts of recreation on the reproductive success of golden eagles in the USA (Martin *et al.* 2011).

All organizations involved in the workshop have frameworks in place to guide evidence-based management, broadly based on the high-level steps of management effectiveness evaluation (Hockings *et al.* 2006) and adaptive management (Holling 1978). Despite having these general frameworks in place, none of the organizations have a systematic process or methodology to develop and apply decision triggers at finer scales within their frameworks. Instead, decision triggers have been developed on a case-by-case basis, with a variety of methods used by organizations and minimal communication or knowledge sharing between organizations prior to the workshop.

In the three cases where long-term research and monitoring data were available, decision triggers were defined quantitatively using the monitoring data (e.g. control charts, where decision triggers are based on the variability of baseline monitoring data; Morrison 2008). There were also three cases where expert opinion was used to define key biological indicators and decision triggers (e.g. tracking the health of ecological communities in marine protected areas). In these cases, practitioners suggested that expert-derived decision triggers were preliminary, being evaluated and updated once new evidence (e.g. monitoring or research data) becomes available. While there was agreement that ideally decision triggers should be based on a sound ecological understanding, there was also recognition that there are other critical factors in management decisions. One organization shared their experience of setting a decision trigger in response to community concern despite direct conflict with the available scientific evidence, reflecting the reality that societal values must also be accommodated in conservation decision-making.

A key message from all practitioners was that organizations commonly lack the technical guidance to clearly translate high-level management objectives into quantitative values of desirable versus undesirable ecosystem state, which can guide where to set decision triggers. Also important are methods to help set robust decision triggers that guide when and where to act. Practitioners are calling for advice on the process and methods necessary to support the routine development of decision triggers, but emphasized that a one-size-fits-all approach will not work. Instead, there would need to be a range of methods available to handle the different management contexts (e.g. from data rich to data poor). It was clear from practitioners that these methods need to be sufficiently flexible and fit within existing evidence-based management frameworks to facilitate adoption by organizations.

Barriers impeding the development and implementation of decision triggers

During the workshop, practitioners were asked to record operational barriers (issues within the organizations) and scientific knowledge gaps (knowledge or techniques) impeding the development and implementation of decision triggers within their organization. The barriers and knowledge gaps recorded by practitioners represented their personal opinions, not the official position of their organization. The professional experience of the practitioners meant that they were well placed to provide insights into the most pertinent challenges that conservation organizations face. Practitioners listed as many or few barriers and knowledge gaps as they deemed appropriate. They identified a total of 58 operational barriers and 53 scientific knowledge gaps impeding the development and implementation of decision triggers (Table 2).

Practitioners revealed that most organizations are facing similar challenges, which appear to be hampering the routine use of decision triggers in evidence-based management (Table 2). The operational barriers identified fell into eight broad categories. Insufficient resources (i.e. financial commitments and staff with relevant expertise) and a lack of a process and methods for developing decision triggers across different contexts were the most frequent operational barriers faced. These barriers are unsurprising given lack of resourcing is a widely cited issue for protected area management (Ferraro & Pattanayak 2006).

A reoccurring theme was the absence of an overarching process and robust methods to assist in integrating decision triggers into their management approach. There was no support for reinventing the wheel through a stand-alone process for decision trigger development. Organizations were very clear that they already have evidence-based management frameworks that include some initial steps in developing decision triggers, such as setting management objectives and developing indicators. Rather, practitioners called for technical guidance to develop decision triggers that fits within existing frameworks. Practitioners also highlighted that organizations often had limited capacity to implement methods that require highly specialized skills. Instead, practitioners were calling for robust and accessible methods to set meaningful decision triggers that do not rely on modelling skills.

Table 2. Broad categories of operational barriers and scientific knowledge gaps identified as impeding the adoption of a decision triggers by practitioners. Presented as a percentage of the total number of responses cited by practitioners (58 operational barriers and 53 scientific barriers cited)

Description	Percentage
Operational barriers *(categories representing the 58 operational barriers cited)*	
Resources: Insufficient resources (financial, staff capacity and expertise) to develop decision triggers, undertake ongoing monitoring and implement management if trigger is crossed.	26%
Process and methods: The need for an overall process and robust and accessible methods to develop and implement decision triggers that fit within an organization's current processes and skill set.	24%
Competing priorities: The need for a hierarchy of approaches that allows for competing organizational priorities and a balance between reactive and proactive management.	14%
Concerns over inflexibility: Concerns over decision triggers being perceived as inflexible and leaving organizations accountable.	10%
Internal support: The need to clearly articulate the concept and benefits associated with a decision triggers approach to facilitate internal support.	10%
Progress in adaptive management: Organizations are still in the process of developing management objectives, and rolling out adaptive management and monitoring and evaluation frameworks, within which decision triggers would function.	7%
Data management: Insufficient data management systems and access to existing data.	5%
Stakeholder support: A need for social, political and stakeholder support for any trigger level and management action associated with those triggers.	3%
Scientific knowledge gaps *(categories representing the 53 scientific barriers cited)*	
Ecological understanding: A lack of information and knowledge about important ecological aspects including ecological processes, drivers, species, communities, biology, life history, invasive species, rare species, threats and ecological thresholds.	40%
Quality data: A lack of targeted, robust and reliable data to inform the development of decision triggers. Absent or limited baseline data and ongoing monitoring data.	25%
Conceptual models: A lack of developed conceptual models to inform key system interactions and drivers.	11%
Indicators: Ensuring indicators are representative, meaningful, measurable and cost-effective.	8%
Management effectiveness: A lack of information on the potential effectiveness of some management actions in relation to achieving management objectives.	8%
Balancing values: Incorporating stakeholder, community and non-scientific values into threshold setting.	6%
Variability: Poor understanding of the amount of natural environmental variation to ensure a capacity to detect change.	4%

Scientific knowledge gaps were seen as a major issue impeding the adoption of decision triggers, with 53 gaps noted by practitioners, which fit within seven categories (Table 2). In particular, practitioners cited key uncertainties around ecological processes, drivers of change and rare species. Practitioners identified a lack of targeted, robust and reliable baseline and ongoing monitoring data were impeding the adoption and implementation of decision triggers. Practitioners also noted a lack of conceptual models to help guide evidence-based management practices. The scientific knowledge gaps cited in this study represent more general limitations for organizations undertaking evidence-based management that have been echoed by other studies (e.g. Cook *et al.* 2012).

Towards the routine application of decision triggers in evidence-based management

The widespread support for decision triggers within Australian and New Zealand protected area management organizations reflects a global trend in the adoption of more systematic and adaptive processes for conservation management (Guntenspergen 2014). Practitioners believe decision triggers have the potential to be a powerful component of evidence-based management, transparently linking scientific evidence to action and giving decision-makers the confidence to act to avert negative environmental outcomes (Fig. 2).

Support for decision triggers has manifested as *ad hoc* examples, but only for well-understood threats or controversial management issues. Practitioners are keen to adopt decision triggers as part of routine management for a range of threats, species and ecosystems. However, integrating decision triggers into day-to-day management requires methods that can be widely applied. Practitioners were very clear that they would appreciate support from the academic community to overcome the barriers they face.

The organizations represented in this study are globally recognized as leaders in conservation management. These organizations experience operational barriers and scientific challenges that are common to many conservation organizations around the world. The practitioner perspectives presented here will be relevant to practitioners globally and provide a useful platform to discuss broader issues around how to move towards evidence-based management practice. Here, we provide recommendations to assist the conservation community in moving towards the routine use of decision triggers in evidence-based management. We emphasize the requirement for further applied research to help conservation practitioners determine when and how to act to protect biodiversity.

A clear management context for decision triggers

Decision triggers are most relevant to conservation organizations when there is a commitment to state-dependent

management of a system (Nichols & Williams 2006). We stress that state-dependent management is only one approach to evidence-based management and will not be suitable for all conservation management contexts. A take-home message from the workshop was that decision triggers will only be relevant to management contexts, where: (i) there is an organizational commitment to state-dependent management of a system, (ii) desirable and undesirable ecosystem states can be defined, (iii) targeted monitoring data are collected to understand and evaluate ecosystem state, and (iv) there are management options available to manage threatening processes and the keep that system in a desirable state.

Addressing scientific knowledge gaps and uncertainty

It is clear that incomplete ecological understanding (e.g. the relationship between drivers, pressures and ecosystem states) and a lack of fit-for-purpose monitoring and research are hindering the development of decision triggers and evidence-based management more generally. However, conservation practitioners frequently make decisions under uncertainty and recognize that they do not need perfect information to act.

There will be situations where no information exists for a natural system, and in these situations, it will be crucial to collect baseline monitoring data before decision triggers can be developed. Targeted research may also help to better understand ecosystem processes and determine which threats in a system can be successfully managed. In other situations, decision triggers could be developed using incomplete knowledge, based on conceptual models (e.g. representing expert judgement about ecosystem dynamics) and preliminary monitoring data. In these cases, the feedback loop of adaptive management (Holling 1978) can be used to clarify uncertainty and update decision triggers as new information is gathered. Thus, evaluating limited monitoring data against decision triggers within management frameworks is a practical approach to ensure active conservation can begin, even in the face of incomplete ecological understanding.

Guidance on how to develop decision triggers

The strongest message from practitioners was that they are seeking advice on an overarching process and robust methods necessary to support the routine development of decision triggers. An essential element of any recommendations will be flexibility, such that decision triggers can be developed for different management contexts, rather than prescribing a one-size-fits-all approach. This study has shown that some practitioners appear to be either unaware of the potential of methods available, or are struggling to incorporate these often stand-alone and sometimes complex methods into their organizations' evidence-based management frameworks.

Many essential steps needed for developing decision triggers already exist in most evidence-based management frameworks. Setting of decision triggers should begin with articulating the management context. This includes identifying management priorities and associated management objectives, developing indicators and desirable/undesirable ecosystem states. This aligns with the first step of several evidence-based management frameworks, such as 'decision context' in structured decision-making (Martin *et al.* 2009). Following this, it is also necessary to determine the appropriate management actions available to move the ecosystem towards the desired state, a common step in existing frameworks.

Once preliminary steps have been worked through, decision triggers can then be set. Different methods exist to develop triggers for different contexts, and their appropriateness will depend on the availability of monitoring data, and the complexity of the management context. Where targeted monitoring or research data are available, statistical models can be applied, such as control charts (Morrison 2008) and receiver operating characteristic (ROC) curves (Connors & Cooper 2014). Where baseline data sets are not available, decision triggers can be based on value-based judgements (e.g. utility thresholds, Martin *et al.* 2009). Where decision triggers must be set in the face of multiple competing objectives, participatory modelling approaches can be applied (Addison, de Bie & Rumpff 2015).

The implementation of decision triggers should be followed by the 'monitor' and 'evaluate' steps of evidence-based management, where targeted monitoring data are collected and regularly evaluated against decision trigger(s) to determine when management intervention is required. As with most evidence-based management frameworks, 'review' is a critical iterative step for any decision triggers approach to clarify uncertainty, evaluate the true effectiveness of management interventions and to update the management context and decision triggers when necessary.

Achieving the full potential of decision triggers to support evidence-based conservation will require collaboration between conservation practitioners and scientists to demonstrate a flexible approach that can be applied within existing evidence-based management frameworks across different management contexts. Case studies should be a key part of this research agenda, where decision triggers are applied to managing species, ecosystems and threatening processes to provide practitioners with a clear understanding of how to integrate decision triggers within their organizations' frameworks. This applied research represents a model for bilateral knowledge transfer between practitioners and scientists, where management needs directly inform a research agenda and targeted scientific outputs effectively inform management. This applied research will provide a significant step forward in evidence-based conservation practice.

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Data accessibility

This article is a Practitioner's Perspective, which contains limited data. The social science data used in this article are practitioner opinions and have not been archived.

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Biosketch

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