Cape Peninsula University of Technology

THE ROLE OF A DECISION SUPPORT FRAMEWORK FOR PROTECTED AREA MANAGEMENT EFFECTIVENESS: A CASE STUDY FROM THE WESTERN CAPE, SOUTH AFRICA

By

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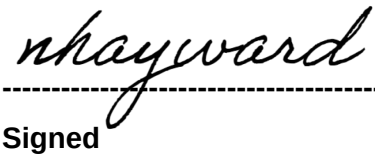
DECLARATION

I, Natalie Hayward, declare that the contents of this dissertation/thesis represent my own unaided work, and that the dissertation/thesis has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.



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ABSTRACT

Since the early 1990's there has been a concerted and focussed effort aimed at better understanding the effectiveness of protected areas (PA) in achieving conservation outcomes, the mechanisms to measure management effectiveness and ultimately, the drivers of effectiveness and conservation outcomes. PAs are the largest planned land use globally where land is set aside intentionally for nature conservation and managers need to account for the investment and state of biodiversity. Most tools to track and report protected area management effectiveness (PAME) are not designed for outcomes measurement, the results often oversimplifying complexity, potentially distorting management effectiveness indications and misinterpreting conservation outcomes. PAME requires sound planning to ensure that assumptions about the impact of actions and associated interventions achieve biodiversity representation and persistence, with due consideration for the social-ecological systems within which PAs exist. Decision support frameworks can help interpret PA context and clarify assumptions about management intervention impact. Without these frameworks, strategies may be misguided, and responses to perceived threats might be ad hoc. This thesis examines changes in PAME assessment results for statutory PAs in a biodiversity hotspot in the Western Cape, South Africa before and after applying a decision support framework, the Conservation Standards for the Practice of Conservation, using the Management Effectiveness Tracking Tool (METT-SA). The thesis also investigates the use of evidence by practitioners for PA management planning and review, and the contribution of the Conservation Standards for PA management planning and review. Findings show that METT-SA scores improved significantly after applying the framework, attributed to time between assessments, management plans, and input and output of PA management elements. Scores for outcome indicators however declined, suggesting that while overall scores can improve, they may mask limitations in implementation and/or misaligned PA objectives and strategy that fail to achieve positive conservation outcomes. The METT-SA highlights administrative and process gaps but does not drive a positive conservation outcome. Practitioners use multiple sources of evidence for management planning and review, relying on expert opinion and analysed data most frequently. The application of the Conservation Standards as a decision support framework for management panning introduced structure, the early integration of evidence, and stakeholder participation in planning. The METT-SA has limitations as a standalone measure of PAME. PAME assessment tools like METT-SA must be supplemented by site level monitoring and evaluation to accurately determine the condition and trend of the attributes that underpin the significance of PAs. Employing a decision support framework or adaptive management approach is likely to improve the quality of planning by introducing stakeholder engagement and scientific evidence. Moreover, adaptive management promotes a more systemic thinking in management, moving away from an insular outlook to PA management.

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GLOSSARY OF TERMS

Term	Definition
Basic management	Management effectiveness category of 33% to 67% (Leverington, Hockings & Costa, 2008).
Critical management activity	Any activity that prevents, halts or mitigates any irreplaceable or unacceptable loss to natural or cultural resources (Ervin, 2003).
Decision support framework	A cohesive set of tools and guidelines within which one may structure the planning and management of a conservation program or project from problem formulation to action, monitoring and reporting (Schwartz *et al*., 2017). Decision support frameworks help to step through multiple components of a decision (Hemming *et al*., 2021).
Ecologist	In the context of this study, a practitioner in the employ of the Conservation Agency whose function includes the provision of ecological decision support, contribute to and/or facilitate protected areas (PA) management planning and review and management effectiveness assessments, facilitate implementation of management actions, develop annual ecological monitoring programmes, lead ecological monitoring programme and protocol design and data analysis, and develop capability, provision of information, facilitate link between science and management (networking, research, etc.).
Evidence	Relevant information (data, studies, syntheses, or theory) used to assess one or more assumptions (hypotheses) related to a question of interest (CMP, 2020).
Human well-being value	Those components of human well-being affected by the status of ecological and cultural values. All human well-being values at a site should collectively represent the array of human well-being needs dependent on the ecological and cultural values (CMP, 2020).
Inadequate management	Management effectiveness category of 0% to 33% (Leverington, Hockings & Costa, 2008).
Indicator	Quantitative or qualitative variables that provide useful information about a criterion and can be used to help compile a picture of the status and trends in PA effectiveness.

Key attribute	Aspects of a value's biology or ecology that, if present, define a healthy value and, if missing or altered, would lead to the outright loss or extreme degradation of that target over time (Also known as key ecological attribute) (CMP, 2020).
Manager	In the context of this study, a practitioner in the employ of the Conservation Agency whose function includes overall management of and accountability for the PA, coordination, planning and implementation of management activities and annual operations, project management, risk mitigation and management, eco-tourism, stakeholder and community engagement, law enforcement and compliance monitoring, environmental education and awareness, job creation.
Protected area (CBD definition)	The Convention of Biological Diversity (CBD) definition: a geographically defined area, which is designated or regulated and managed to achieve specific conservation objectives (Dudley *et al*., 2005).
Protected area	The World Conservation Union (IUCN) definition: An area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means, (Worboys, 2015).
Protected area value	The biological, cultural and socio-economic aspects which underpin the purpose of the protected area. An element of biodiversity or cultural asset, which can be a species, habitat, or ecological system that encompasses the biodiversity and cultural assets of the protected area. Synonymous with 'Conservation Target' in the Conservation Measures Partnership (CMP) lexicon (CMP, 2020).
Sound management	Management effectiveness category of 67% to 100% (Leverington, Hockings & Costa, 2008).
Theory of Change	A series of assumptions that are causally linked, about how a set of actions lead to intermediate results and longer-term goals (CMP, 2020).

CHAPTER 1: INTRODUCTION

'A good decision should be judged on the process that was used to arrive at that decision' (Fuller *et al*., 2020).

1.1 Protected area management effectiveness

Since the early 1990's there has been a concerted and focussed effort aimed at better understanding the effectiveness of protected areas (PA) in achieving conservation outcomes, the mechanisms to measure management effectiveness and ultimately, the drivers of effectiveness and conservation outcomes (Hockings, 2003; Coad *et al*., 2015; Geldmann *et al*., 2021; Stolton *et al*., 2019). In 1997, the IUCN's World Commission for Protected Areas (WCPA) established a Task Force to address the subject of management effectiveness and developed a PA management framework within which systems and standards for assessment and reporting could be arranged (Hockings, 2003). In 2004, the Convention on Biological Diversity (CBD) agreed to a Programme of Work for Protected Areas (PoWPA) to by 2010 and 2012 for terrestrial and marine protected areas respectively, establish and maintain effectively managed national networks of protected areas located in ecologically representative areas (Dudley *et al.*, 2005). The PoWPA aimed to align efforts of the CBD and the IUCN for PAs to mitigate the risk of 'paper parks', raised at the IUCN's 5th World Parks Congress in 2003 (Dudley *et al.*, 2005; Leverington *et al.*, 2010a; Hockings, Leverington & Cook, 2015). The PoWPA set targets for PAs to be effectively managed, based on participatory evidence-based planning and management plans with clear biodiversity objectives, management strategies and monitoring programmes, coupled with stakeholder engagement (Dudley *et al.*, 2005). Subsequently, strategic plans set by the CBD and adopted by the Parties included targets for PA coverage as a mechanism to curb biodiversity loss (CBD, 2010; Stolton *et al.*, 2019; CBD, 2021). Research suggests that spatially, targets are being met, although biodiversity continues to decline (Leverington *et al.*, 2010b; Coad *et al.*, 2015, UNDP, SCBD & UNEP-WCMC, 2021). The role of PAs in reducing the rate of biodiversity loss is thus becoming all the more important (Smit, Maze & van Wilgen, 2024). PAs require effective management and adequate resourcing to reduce the loss of biodiversity within these areas intentionally set aside to conserve and protect biodiversity (Leverington *et al*, 2010; Geldmann *et al*., 2021.). However, considered land use planning outside of PAs and sustainable practices adjacent to PAs are also required to support biodiversity conservation within and outside of PAs (Margules & Pressey, 2000; Smit, Maze & van Wilgen, 2024).

Based on the lessons learnt from the Strategic Plan for Biodiversity 2011-2020, the CBD's Post 2020 Global Biodiversity Framework (GBF) established an enhanced stage for PAs, challenging Parties to shift focus from quantity to quality (UNDP, SCBD & UNEP-WCMC, 2021). Target 3 of the 2022 Kunming-Montreal GBF requires Parties to achieve by 2030 the effective management of ecologically representative PA networks of 30 % of terrestrial, freshwater, coastal and marine areas. Effectively conserved and managed means that positive biodiversity outcomes must be the

management objective (CBD, 2021). The Post 2020 GBF highlighted the need for improved monitoring of conservation outcomes (CBD, 2021). Biodiversity outcomes should thus be central to measurements of site level protected area management effectiveness (PAME) (Juffe-Bignoli *et al.*, 2014; Geldmann *et al.*, 2021).

PAME is defined by the IUCN as 'the assessment of how well the PA is being managed, primarily the extent to which management is protecting values and achieving goals and objectives' (Hockings *et al.*, 2006). The CBD PoWPA defines *effective management* as 'using participatory and science-based site planning processes that incorporate clear biodiversity objectives, targets, management strategies and monitoring programmes, drawing upon existing methodologies and a long-term management plan with active stakeholder involvement' (Dudley *et al.*, 2005). Leverington *et al.*, (2010a; 2010b) highlight four complementary levels of PAME assessment:

1. Level 1: Coarse scale or regional assessment in terms of PA coverage, i.e., location and extent of biodiversity representation at the network level, followed by,
2. Level 2: Coarse scale assessment of the relationship between PAs and anthropogenic impact such as habitat transformation i.e., no ecological change or destruction or reduced ecological change or reduction, followed by,
3. Level 3: Site level management effectiveness assessment, which is the subject of this thesis (Chapter 2), using rapid score-card questionnaires such as the management effectiveness tracking tool (METT) aimed at improving site level management and accountability by evaluating PA context, appropriateness of planning and design, resourcing, and processes towards outcomes, and lastly,
4. Level 4: Detailed site level monitoring and reporting on the status and trends in PA values, also the subject of this thesis (Chapter 3) placing emphasis on PA management planning and review. Level 4 detail underpins judgements made about outcomes in the Level 3 assessment).

Managers are under pressure to measure the effectiveness of biodiversity conservation in a scientifically sound, practical, and comparable manner and to monitor and evaluate the condition of PAs and pressures on PAs (Parrish, Braun & Unnasch, 2003; Growcock, Sutherland & Stathis, 2009). PAME assessment is enhanced by information generated from robust, long-term monitoring of the status of PA values and ecological integrity and from trends in management effectiveness indicators (Leverington, Hockings & Costa, 2008). Methodologies to report at this level (level 4 outcomes monitoring noted above) are targeted towards measuring *conservation effectiveness*, i.e., outcomes of PA management towards conserving biodiversity values and achieving objectives and should supplement PAME assessment at level 3 using tools such as the METT (Leverington *et al.*, 2010a). At the global scale, PAME Level 3 is reported as the percentage coverage of PAs assessed in the World Database for Protected Areas (WDPA) (UNDP, SCBD & UNEP-WCMC, 2021).

However, this does not include the condition of biodiversity within these PA's (Geldmann *et al*., 2021).

There are approximately 95 PAME assessment methodologies (Coad *et al*., 2015) of which the scope and scale of methodologies vary, with Rapid Assessment and Prioritization of Protected Area Management (Ervin, 2003) and the METT (Stolton *et al.*, 2003) being the most widely used (Hockings, Leverington & Cook, 2015; Stolton *et al*., 2019). The choice of tool is often governed by the funder (e.g., since 2002, METT is mandatory for Global Environment Facility (GEF) projects (Stolton & Dudley, 2016)) and/or country context (Carbutt & Goodman, 2013; Hockings, Leverington & Cook, 2015; Stolton *et al.*, 2019). Like most PAME tools, the METT is judgment based; a scoring system linked to several indicators arranged within the six elements of management identified in the WCPA framework as PA context, planning, inputs, process, outputs and outcomes (Leverington, Hockings & Costa, 2008). Judgements are made by practitioners, those who make day-to day decisions and those who make decisions at the strategic level about resource allocation and management prioritisation (Cook, Carter & Hockings, 2014). However, the accuracy of data is almost never assessed and there is generally a lack of empirical evidence and quantitative data about PA management effectiveness (Cook, Hockings & Carter, 2010; Carbutt & Goodman, 2013; Cook, Carter & Hockings, 2014). Additionally, quantitative data about biodiversity outcomes are often not captured (Coad *et al*., 2015).

As Party to the CBD, the METT is mandatory in South Africa for the assessment of PAME and has been adapted to suit South African conditions (METT-SA) (Cowan, Mpongoma & Britton, 2010; Stolton *et al.*, 2019). South Africa recognises 10 kinds of PAs managed by 12 different statutory management authorities, creating a variety of management styles and standards that lead to complexity in management effectiveness assessment and reporting (GRAA & DEA, 2014). The METT-SA introduced standardisation in assessment and reporting for South Africa (Goodman, 2003; Cowan, Mpongoma & Britton, 2010; Carbutt & Goodman, 2013; CapeNature, 2022). During 2010 South Africa undertook its first formal nationwide assessment of the management effectiveness of 230 state managed PAs (70% of PAs listed in the South African Register of Protected Areas), 14% of which achieved an average score above 67% (Cowan, Mpongoma & Britton, 2010; Carbutt & Goodman, 2013; GRAA & DEA, 2014). To improve management effectiveness, the then Department of Environmental Affairs (DEA) (now the Department of Forestry, Fisheries and the Environment (DFFE)) set a target in 2012 for 60% of state managed PAs to achieve a METT-SA score higher than 67% by the end of the 2014 (GRAA & DEA, 2014). However, a nationwide score reliability study found concerning variability in scores between the conservation agencies (GRAA & DEA, 2015a). Subsequently measures to facilitate standardisation and best practice for assessments were developed, but the report was silent on standards required to improve decision support, evidence for planning informants and PAME assessment (GRAA & DEA, 2015b). The disparity in PAME

assessment is due to an overreliance on qualitative data to inform assessments, coupled with a lack of operating procedures to govern assessment consistency (Carbutt & Goodman, 2013).

There are strengths and weaknesses associated with PA management, and a good understanding of where these lie and their root causes, is necessary to improve management processes and maximise conservation outcomes (Hockings, 2003; Coad *et al.*, 2015). Conservation outcomes assessment, i.e., Level 4 detailed monitoring and reporting on the status and trends in PA values, is considered the most challenging aspect of PAME (Stolton *et al.*, 2019). Practitioners are challenged when selecting indicators for monitoring, while those selected may fail to account for external threats (Wahlén, 2014). Indicator type and number thus require careful consideration in view of PA objectives, and financial and human resources (Salzer & Salafsky, 2006; Hockings *et al*., 2009a; Timko & Innes, 2009). A systematic approach to planning can help introduce rigor in the selection of PA values and their associated attributes and indicators (Margoluis *et al*., 2009; 2013).

Due to the default qualitative nature of the METT methodology and vulnerability to disparity in results, an overall METT score must be considered with caution (Coad *et al*., 2015; Stolton *et al*., 2019). Thus, PAME assessments using the METT must be informed by the results of site-specific monitoring and evaluation programmes coupled with the application of assessment best practice (Carbutt & Goodman, 2013). An overall score can oversimplify complex issues (Hockings, Leverington & Cook, 2015) or mask critical gaps in specific aspects of management (Coad *et al*., 2015). To address the risk of disparity, standard operating guidelines to govern application, indicator interpretation and moderation of results can help (Hayward, 2019). However, more needs to be done for a structured systematic approach to decision making and associated PA management planning informed by evidence (Kingsford & Biggs, 2013) and outcomes monitoring (Geldmann *et al.*, 2019) that extends beyond only ecological variables (Stem *et al*., 2005).

The effective management of a PA means that the PA is achieving its objectives and conserving the values representative of the overall biodiversity and cultural assets of the PA (Hockings, Leverington & Cook, 2015). However, the causal effects between management inputs and conservation outcomes are uncertain, making it hard to identify the drivers of effective management (Geldmann *et al.*, 2013; Geldmann *et al.*, 2019, Wauchope *et al.*, 2022). To improve understanding of these drivers, correlations between PAME assessment results and the condition of biodiversity is often a research focus (e.g., wildlife populations, human resources (Zimsky *et al.*, 2010; Geldmann *et al*., 2013; Gill *et al.*, 2017; Coad *et al*., 2019)). PAs can be effective in reducing biodiversity loss at the regional scale, halting habitat transformation by, for example, inappropriate fire occurrence and deforestation (Nolte & Agrawal, 2012; Powlen, Gavin & Jones, 2021), or locally by providing a focussed law enforcement and compliance monitoring effort (Read, West & Kelaher, 2015). However, the contribution of PAs to wildlife populations may be species specific as wildlife populations move through a landscape (Kiffner *et al*., 2020; Wauchope *et al.*, 2022). Therefore, a

management strength such as PA legal status, does not necessarily imply PA performance (Kiffner *et al*., 2020; Geldmann *et al*., 2019). Effective management is dependent upon adequate human and financial resources (Gill *et al.*, 2017; Coad *et al*., 2019; Powlen, Gavin & Jones, 2021), the reduction of pressures outside PAs (Geldmann *et al*., 2019) and time for implementation of plans (Geldmann *et al*., 2015). However, improved PAME assessment using tools such as METT scores do not imply improved biodiversity conservation (Geldmann *et al*., 2015).

Critically, the conservation of PA values requires focussed attention on the specifics needed for the management of these values as opposed to a general improved resourcing of PAs (Leverington *et al*., 2010b). Information related to the biodiversity, threats and PA objectives, and information on human and financial resources is therefore foundational to PAME and subsequent assessment (Pullin & Knight, 2005; Growcock, Sutherland & Stathis, 2009; Timko & Innes, 2009; Geldmann *et al*., 2021). As such, PA management planning requires a systematic process that considers these aspects.

1.2 Decision support frameworks and planning towards management effectiveness

Decision making starts with proper formulation of a problem (Bower *et al.*, 2018) but the quality of a decision can only really be determined retrospectively (Matheson, 2005). Therefore, the outcome of a decision is often not controllable, although how decisions are made may be controlled (Wong-Parodi *et al*., 2020). Hemming *et al.* (2021) highlight that the application of decision science is aimed at '…knowing how to think through the components of a decision…' using decision support frameworks and tools. Schwartz *et al*. (2017) identify 'conservation frameworks' to guide planning and decision support, with a focus on 'structuring how to think about a conservation challenge in order to find effective solutions'. Decision support frameworks help navigate uncertainty and complexity inherent in a system where multiple stakeholders represent varying and/or conflicting values and objectives, while a variety of factors may contribute to the state of an issue at hand (Wright *et al*., 2020). In response to the complexity of social-ecological systems, various decision support frameworks have been developed to facilitate an improved understanding of these systems to define conservation goals, management objectives and develop strategies (Margoluis *et al*., 2009; Margoluis *et al*., 2013; Schwartz *et al*., 2017; Gillson *et al*., 2019; Wright *et al*., 2020; Roux *et al*., 2022). For example, adaptive management for conservation is strengthened by planning and decision support that, through retrospection and feedback loops, identifies and answers questions critical to achieving desired outcomes (Schwartz *et al*., 2017).

An audit of METT-SA assessments for statutory PAs in the Western Cape Province reported that management plans were outdated and/or lacking clear objectives, noting a disparity between management plans and operational plans, while habitats and ecological processes were not clearly articulated or linked to management interventions (GRAA & DEA, 2015b). PAME assessments are therefore useful to identify strengths and weaknesses in management and policy and can help

prioritise interventions to improve management and allocate resources (Goodman, 2003; Hockings, Leverington & Cook, 2015). However, decision support frameworks are necessary to facilitate PA management planning, clarifying assumptions and the measurement of conservation outcomes, thereby complementing PAME (Timko & Innes, 2009).

Using decision support frameworks for PA management planning can help because they provide a deliberate, transparent, replicable, and engaging process for insightful decision-making that links actions to objectives (Wright *et al.*, 2020). Decision support frameworks integrate conservation science (use of evidence e.g. the status of a species or ecosystem) and social science (e.g. stakeholder/actor perceptions and behaviours) in the development of strategy, scenario planning and measurement of success, enabling conservation efforts in complex social-ecological systems (Knight *et al*., 2011; Wright *et al.*, 2020). At the conceptual stage of PA management planning, decision support frameworks help practitioners systematically source information and articulate PA values, establish condition, identify and evaluate threats, pressures and the factors that threaten values as foundation to policy and planning (CMP, 2020; Salafsky *et al.*, 2022). The status of a suite of values that comprises biodiversity, cultural and human well-being assets and an associated suite of thresholds for variation, thus forms the basis of outcomes monitoring (Biggs & Rogers, 2003; CMP, 2013; 2020). Outcomes are however not guaranteed, thus the application of a thoughtful iterative decision-making process, coupled with feedback loops, that instils confidence, is essential (Fuller *et al*., 2020). Furthermore, practitioners must be efficient in their selection of interventions to manage biodiversity and document the outcomes of interventions to improve decision making (Margoluis *et al*., 2009).

Adaptive Management is a decision-support framework well suited to complex and unpredictable and dynamic social-ecological systems (Gillson *et al*., 2018). Adaptive management acknowledges that PA management in these complex and dynamic systems requires change as structured and ongoing learning and understanding improves (van Wilgen & Biggs, 2011). Strategic Adaptive Management (SAM), developed by South African National Parks (SANParks), is based upon the strategic selection of PA values that represent biodiversity and social attributes of the park, with associated defined acceptable upper and lower limits of variability that act as triggers for management intervention (Biggs *et al.*, 2011). The adaptive management framework thus facilitates iterative decision making under uncertainty, through learning by doing and retrospection (Roux *et al*., 2022). The Conservation Standards for the Practice of Conservation (the 'Conservation Standards'), developed by the Conservation Measures Partnership (CMP) is a commonly applied framework for conservation planning and adaptive management (Bower *et al*., 2018; Schwartz *et al*., 2017; CMP 2020). The framework emphasises the adaptive management cycle and evidence base, planning by clearly articulated goals and objectives, a selection of conservation targets with a range of thresholds for variation, intervention prioritisation, outcomes evaluation and learning (Redford *et al.*, 2018). The benefit of the Conservation Standards lies in the framework facilitating conservation

planning in the manner of theory of change or hypotheses of how strategies may unfold, and its facility for application in 'data rich' and 'data poor' contexts (Bower *et al.*, 2018). Hemming *et al*. (2021) identify the Conservation Standards as an approach to translate conservation science into conservation action in a collaborative fashion.

The application of decision support frameworks, such as SAM and/or the Conservation Standards, helps practitioners apply a systematic approach to planning, coupled with feedback loops for learning and review. This entails articulating PA values and associated threats and establishing the condition of PA values in the conceptual stage of planning. Furthermore, frameworks facilitate an evaluation of the social-ecological context followed by developing strategies. Finally, frameworks enable setting objectives, underpinned by appropriate indicators for evaluating the impact of actions and trends in PA values with feedback loops to facilitate learning (Kingsford & Biggs, 2012; CMP, 2020; Roux *et al*., 2022). Importantly, the application of decision support frameworks enables the development of PA value viability monitoring frameworks across PAs with similar contexts (Kingsford & Biggs, 2012; Carr *et al.*, 2017; Meltzer, Ezzy & Hines, 2019). There is not a single optimal decision support framework, and a mixed approach may help to develop fit for purpose strategies according to PA context that are linked to appropriate monitoring programmes (Schwartz *et al*., 2017; Bower *et al.*, 2018). The choice of framework or mixed approach should however provide an adaptive management structure to facilitate evidence-based planning and management, and results driven conservation action (Margoluis *et al*., 2013).

1.3 The use of evidence

PA management planning and associated decision making should be informed by site-based evidence to evaluate the effectiveness of interventions applied to mitigate threats to PA values (Dudley *et al.*, 2005; Pullin & Knight, 2005). However, practitioners rely heavily on management experience as opposed to scientific evidence for management planning and decision making (Hockings, 2003; Pullin & Knight, 2005; Cook, Hockings & Carter, 2010) while there is a general lack of empirical evidence and quantitative data for PAME (Carbutt & Goodman, 2013; Cook, Carter & Hockings, 2014). For example, an assessment of the State of the Parks in Australia found that information on PA value condition, threats and management was limited or outdated for most parks (Hockings *et al.*, 2009b). A survey of management plan compilers in Australia and the United Kingdom found that practitioners relied heavily on experience and expert opinion rather than scientific information to inform decision making, despite the institutionalisation of monitoring programmes (Pullin & Knight, 2005). Similarly, a global study on the effectiveness of marine protected areas found that the result of scientific monitoring is rarely used to inform management (Gill *et al.*, 2017) and an investigation of evidence reported to evaluate the consequence of management action found a heavy reliance on experience (Cook, Hockings & Carter, 2010). A study in South Africa found disparity between PA assessment results, implying a largely qualitative approach to PAME assessment (Carbutt & Goodman, 2013). More recently, the contribution concept

of systematic reviews and evidence-based practice has become the focus of PAME research (Cook, Possingham & Fuller, 2013; Cook *et al*., 2017; Cooke *et al*., 2017; Gillson *et al*., 2019).

Often the time to source, access and synthesise evidence are potential hurdles (Giehl *et al*., 2023). Another hurdle is the need to often act quickly despite limited evidence (Pullin & Knight, 2005; Cook, Hockings & Carter, 2010). Despite this, practitioners tend to rely more on empirical evidence related to the status of values and threats, whereas experience is more heavily relied upon to evaluate success of interventions (Cook, Hockings & Carter, 2010). The reliance on experience and expert opinion does however raise the risk of using outdated information and a reluctance to take on new evidence (Walsh, Dicks & Sutherland, 2014). The source and type of evidence used by practitioners in making decisions (management planning process) and assessment of PAME, requires deeper understanding (Cook, Hockings & Carter, 2010).

1.4 Research problem

PAs are considered cornerstones for *in situ* biodiversity conservation and serve as a mechanism to curb biodiversity loss (Hockings, 2003; Chape *et al*., 2005; UNDP, SCBD & UNEP-WCMC, 2021). PAs exist in complex social-ecological systems (Schwartz *et al.*, 2017) and are increasingly pressured to balance the requirements of species and ecosystems that they protect and benefits to people (Worboys, 2015). Practitioners are pressured to demonstrate impact and the contribution of PAs to society (Parrish, Braun & Unnasch, 2003). Globally, there is an overreliance on coarse scale PAME assessment as an indicator of how well PAs are conserving values and achieving these objectives even though tools to track effectiveness are proven to be insufficient for the measurement of outcomes (Geldmann *et al*., 2013; Cook, Carter & Hockings, 2014; Coad *et al.*, 2015; Geldmann *et al*., 2015; Stolton *et al*., 2019). Furthermore, an absence of decision support frameworks to guide PA management planning leads to misdirected interventions or interventions aimed at ad hoc perceptions of threats, this coupled with a paucity of evidence to inform planning and validate management effectiveness assessment results, compounds the issue (Parrish, Braun & Unnasch, 2003; Dudley *et al*., 2007; Kapos *et al.*, 2008). The application of a decision support framework for a systematic approach to PA management planning, can enable practitioners to be explicit in their assumptions and prompt the use of evidence and/or documenting evidence requirements during planning, implementation and PAME assessment (Margoluis *et al*., 2009; Kingsford & Biggs, 2012; Salafsky *et al*., 2022). As such, the application of a decision support framework as a standard for PA management planning may facilitate effective management and the measurement thereof in scientific, practical, and comparable ways at site level and across a PA network by clarifying assumptions at the onset of planning. This research aims to demonstrate the contribution of a decision support framework to PA management planning for PA management effectiveness.

1.5 Research aims and objectives

This research follows the rationale that the PA management plan is a series of hypotheses about interventions that will lead to conservation outcomes, i.e. theory of change; a series of decisions about the actions required to ensure representation and persistence of PA values over the long term (Hockings *et al*., 2006). For a PA management plan to direct the variation within which PA values may acceptably fluctuate (Biggs & Rogers, 2003), adequate proxies for the measurement of species, ecosystems and processes are necessary, the selection of which requires sourcing, gathering and using evidence. Establishing whether species and ecosystems are being maintained, coupled with understanding contributing management conditions, are required to evaluate the effectiveness of a PA (Coad *et al*., 2015). PAME assessment results should thus be based on the results of outcomes monitoring coupled with management data (Cook, Carter & Hockings, 2014; Geldmann *et al*., 2021).

The thesis is a comparative study undertaken in the context of pre and post application of an intervention, the intervention being the introduction of the Conservation Standards decision support framework for PA management planning. The aim is firstly to investigate whether the introduction of the decision support framework for PA management planning influenced the results of PAME assessments undertaken using METT-SA results and establish the drivers of change in PAME. And secondly, to investigate practitioner perceptions on their use of evidence as it relates to source and type and means of access to evidence for PA management planning and review. Finally, this thesis aims to explore the contribution of the decision support framework to PA management planning.

The objectives of the thesis are:

a) Investigate change in PA management effectiveness between METT-SA assessments undertaken before and after the application of the decision support framework.
b) Investigate trends in PA management effectiveness and drivers of change.
c) Investigate practitioner perceptions on the use of evidence for PA management planning and review.
d) Investigate practitioner perceptions on the contribution of a decision support framework to promoting evidence-based PA management planning.

1.6 Thesis outline

In Chapter 2, I address objectives a) and b). I theorise that the application of a decision support framework to PA management planning can improve METT-SA results based on the assumption that the framework will emphasise the foundational, conceptual stage of planning; the stage that requires the selection and articulation of PA values and the establishment of thresholds, and tested assumptions about management intervention impact. My assumption is that a systematic, collaborative approach to planning will generate an in-depth evidence-based understanding of PA context as a basis for sound planning. Given the appropriate resources, implementation should in theory produce outputs that result in outcomes. I consider METT-SA data in the context of pre and

post application of the Conservation Standards considering the change in overall scores over time. I also examine change over time in indicators grouped according to international best practice and individually to understand the drivers of change. Change in indicators are considered in this manner for a richer understanding of change and to identify strategic pressure points for intervention.

I use the findings of Chapter 2 to build a case in Chapter 3 for the contribution of the Conservation Standards decision support framework as a standard for evidence-based, systematic PA management planning and conservation outcomes evaluation for adaptive management. I do this by addressing objectives c) and d).

In the final Chapter of the thesis, I consider the overall results and draw conclusions based on the findings of Chapters 2 and 3. I consider study design strengths and limitations, and I make recommendations for the application of PAME and PA management planning at the management and policy levels in the context of practice, research and capacity building. Content chapters 2 and 3 are prepared in the format of standalone papers for submission for publication, as such, some overlap may exist in study area and context.

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CHAPTER 2: TICKING THE BOX: DOES A DECISION SUPPORT FRAMEWORK FOR MANAGEMENT PLANNING IMPROVE PROTECTED AREA MANAGEMENT EFFECTIVENESS?

Abstract

A long-standing question in conservation is whether protected area (PA) management is meeting its objectives and conserving PA values for the conservation of biodiversity and associated ecosystem services and cultural values over the long term. Tools that track and report protected area management effectiveness (PAME) tend to oversimplify complexity and potentially distort management effectiveness results and misinterpret conservation outcomes. The use of decision support frameworks to facilitate a systematic, consistent, evidence-based and collaborative approach for management planning may improve PAME. Here I ask whether a decision support framework applied to the PA management planning process improves PAME, using the results of the management effectiveness tracking tool (METT-SA) in South Africa. For this I use METT-SA results for assessments of 38 statutory PAs in the Cape Floristic Region over a period of seven years during which a decision support framework was implemented for PA management planning, which allows for a before-after comparison. Overall, the METT-SA score was significantly higher after the decision support framework was implemented, with 76% of PAs improving. Significant change was driven by time between assessments, management plans, and input and output PA management elements. A decline in scores was evident across four of the six outcomes indicators, with the biggest decline in ecological processes and ecosystem services. I conclude that the METT-SA provides the framework for PA management and promotes compliance with aspects of management perceived to drive effectiveness, but it does not assess the quality of planning required for management plans to drive a positive conservation outcome. Producing management plans, increasing inputs and complying with indicator requirements improves METT-SA scores but mask pitfalls that may be associated with misaligned PA objectives and strategy, that may result in an inability to achieve positive conservation outcomes even when PAs are adequately resourced.

2.1 Introduction

The role of protected areas (PA) is to ensure that biodiversity is adequately represented and persists over the long term (Margules & Pressey, 2000). Despite increases in PA coverage globally, biodiversity continues to decline (Leverington *et al.,* 2010; Coad *et al.,* 2015; UNDP, SCBD & UNEP-WCMC, 2021). Practitioners are thus faced with questions like 'are we conserving what we say we are' (Parrish, Braun & Unnasch, 2003), are we doing 'conservation in the dark' (Cook, Hockings & Carter, 2010), and 'how well is the biodiversity doing?' (Salzer & Salafsky, 2006). PAs can only contribute to conservation when effectively managed (Gill *et al.,* 2017). For this, Parties to the Convention on Biological Diversity (CBD) measure and report effectiveness using tools developed within PA management effectiveness (PAME) frameworks (Hockings, Stolton & Dudley, 2000; Ervin, 2003a; Hockings, 2003; Parrish, Braun & Unnasch, 2003; Dudley *et al.,* 2005; Stolton *et al.,* 2007; Cowan, Mpongoma & Britton, 2010; Stolton *et al*., 2019).

Ecological systems are complex, as is the social-ecological landscape within which PAs exist (Kingsford & Biggs, 2012). PA decision making should be iterative due to complexity, uncertainty, and potentially unguaranteed outcomes (Schwartz *et al*., 2017). Defining PA values – the cultural and ecological attributes underpinning the significance of PAs – is a crucial first step in understanding the context of a PA for management planning and implementing management actions (Hockings *et al*., 2006; Kingsford & Biggs, 2012). Deciding on and selecting a suite of PA values representative of overall biodiversity and cultural assets and establishing their condition, current and desired, is foundational to conservation action (Carr *et al*., 2017; CMP; 2020). It is also important to specify acceptable ranges of variation for the condition of PA values, which typically forms part of target-setting in an adaptive management process (Biggs & Rogers, 2003).

Adaptive management, a decision-support framework well suited to complex, unpredictable and dynamic social-ecological systems, seeks to navigate complexity through theory of change and iteration (Gillson *et al*., 2019). It facilitates iterative decision making under uncertainty, through learning by doing (Roux *et al*., 2022). The Conservation Standards for the Practice of Conservation (CMP 2013; 2020; Bower *et al*., 2018; Schwartz *et al*., 2017) is a commonly applied framework for adaptive management, emphasising conservation targets (in this case, PA values), clearly articulated goals and objectives, intervention prioritisation, outcomes evaluation and learning (Redford *et al.,* 2018). A PA management plan can thus be viewed as a series of hypotheses, the application of management actions being the experiment testing such hypotheses or assumptions about the outcome of a management action (Hockings *et al*., 2006).

Managers are under pressure to measure the effectiveness of biodiversity conservation in a scientifically sound, practical, and comparable manner (Parrish, Braun & Unnasch, 2003), and to monitor and evaluate the condition of PA values and associated pressures (Growcock, Sutherland & Stathis, 2009). Globally, there is an overreliance on management effectiveness assessment as an

indicator of how well PAs are conserving their values and achieving objectives, even though tools to track effectiveness e.g. the management effectiveness tracking tool (METT) are proven to be weak or unsuitable for the measurement of outcomes (Leverington, Hockings & Costa, 2008; Cowan, Mpongoma & Britton, 2010; Zimsky *et al*., 2010; Geldmann *et al*., 2013; Coad *et al*., 2015; Geldmann *et al*., 2015; Stolton & Dudley, 2016; Stolton *et al*., 2019). Furthermore, an absence of decision support frameworks to guide planning results in misdirected interventions or interventions aimed at 'ad hoc perceptions of threat' (Salafsky & Margoluis, 1999). A paucity of evidence to inform planning and validate management effectiveness assessment results compounds the issue (Coad *et al*., 2015; Kapos *et al*., 2008). A decision support framework is a systematic approach to management planning that enables practitioners to be explicit in their assumptions of what actions may work (Margoluis *et al*., 2013) and may prompt the use of evidence and/or documenting evidence requirements during planning, implementation and management effectiveness assessment (Cook *et al*., 2012; Salafsky *et al.,* 2019, 2022). As such, the application of a decision support framework as a standard to PA management planning, may facilitate PAME and the measurement thereof in scientific, practical, and comparable ways at site level and across a PA network.

The body of PAME research has focussed on frameworks for, and tools to measure PAME (Hockings, 2003; Ervin, 2003a; Leverington *et al*., 2010, Stolton *et al*., 2019) and the relationships between management effectiveness and conservation outcomes (Growcock, Sutherland & Stathis, 2009; Timko & Innes, 2009; Zimsky *et al*., 2010; Graham *et al.,* 2021; Wauchope *et al.,* 2022). Other studies investigated the effectiveness of PAs in reducing threats to biodiversity (Chape *et al*., 2005; Nolte & Agrawal, 2012; Geldmann *et al*., 2013; Read, West & Kelaher, 2015; Geldmann *et al*., 2019; Powlen, Gavin & Jones, 2021), indicators of management effectiveness (Dudley *et al*., 2007; Gill *et al*., 2017; Geldmann *et al*., 2018; Coad *et al*., 2019; Kiffner *et al*., 2020; Geldmann *et al*., 2021) and the management effectiveness of PAs over time (Leverington, Hockings & Costa, 2008; Cowan, Mpongoma & Britton, 2010; Leverington *et al*., 2010; Geldmann *et al*., 2015). More recently, studies have focussed on expanding management effectiveness assessment to incorporate social-ecological systems (Zafra-Calvo & Geldmann, 2020; Ghoddousi, Loos & Kuemmerle, 2022).

The quality of management planning essential for eventually achieving conservation outcomes, is rarely considered. In South Africa, the emphasis placed on administration of the tool to assess management effectiveness and validate scores (GRAA & DEA, 2015) could come at the cost of PA management planning, implementation and PAME, and has become largely administrative. PA legal status does not necessarily imply PA performance (Kiffner *et al*., 2020; Wauchope *et al*., 2022) in ensuring the persistence of species and ecological processes (Parrish, Braun & Unnasch, 2003) over and above the protection implied by land legally secured for conservation (Margules & Pressey, 2000). Further, the existence of a PA management plan may also not necessarily imply PA management is ensuring the persistence of species and ecological processes.

The most widely used tool implemented globally to measure PAME is the METT (Stolton, Dudley & Hockings, 2021). Developed in 1999, it is a simple Likert-scale questionnaire-based assessment tool designed according to the IUCN World Commission for Protected Areas (WCPA) framework for PA management (Stolton *et al.,* 2019). The framework, based on adaptive management principles, follows a cyclical logic that by understanding context this leads to planning, informs inputs, leads to process, produces outputs, and results in outcomes (Hockings, *et al.,* 2006). The METT, often adapted to suit local conditions of a region (e.g. South Africa's METT-SA) or donor funder prescriptions (e.g. the Global Environment Facility, GEF), is designed within this framework and comprises 30 indicators that can be scored per management element (i.e. context, planning, inputs, process, outputs, outcomes), to produce an indication of performance at indicator level, at management element level or overall (Stolton & Dudley, 2016). Although based on adaptive management logic, the tool is not designed to evaluate quality of planning, merely the existence of said plans (Stolton & Dudley, 2016)

Conservation outcomes evaluation is only possible through a 'concise understanding of what management is aiming to accomplish and what specific PA values are to be conserved' (Hockings *et al*., 2006). Threat abatement strategies may overlook the need to restore crucial ecological attributes of PA values, resulting in an inability of the strategy to improve the condition of values (Parrish, Braun & Unnasch, 2003). Furthermore, PAs differ in biological and social characteristics, pressures and use, requiring site-specific interventions for management (Hockings *et al.,* 2006). Not utilising an appropriate systematic decision support framework for management planning may lead to vague objectives and unclear linkages between assumptions, action and expected outcome (Kapos *et al.,* 2008). Practitioners grapple with selecting indicators to measure success of their management interventions and 'have not been systematic, strategic, or focussed in their choices' (Margoluis *et al.,* 2013). The time lag between action and ecological response may mask the ineffectiveness of the strategy (Parrish, Braun & Unnasch, 2003) while monitoring resources may be inappropriately allocated (Salzer & Salafsky, 2006). Geldmann *et al.* (2013) advocate for improved emphasis on 'causal links between interventions and the outcomes being measured'. Decision support frameworks applied to planning help by making best-available understanding of such causality explicit, allowing for testing and improvement over time (Kingsford & Biggs, 2012; Margoluis *et al.,* 2009; Salafsky *et al.,* 2022).

This study aims to investigate change in PA management effectiveness over time in the context of applying a decision support framework to PA management planning, specifically 1) whether there is a difference in management effectiveness scores since the application of a decision support framework to management planning, and 2) understanding drivers of change in management effectiveness scores. Data analysis therefore considers METT-SA data in the context of pre application (control) of an intervention and post application of the intervention (i.e. the intervention being the application of a decision support framework to PA management planning).

2.2 Methods

2.2.1 Study area and protected area scope

The Cape Floristic Region (CFR) encompasses a large portion of the south-western corner of South Africa and comprises unique biodiversity characterised by high concentrations of endemic taxa and is known as a biodiversity hotspot of global significance (Myers *et al*., 2000; Cowling *et al*., 2003). The biodiversity is comprised of complex and valuable coastal, lowland fynbos, midland and mountain fynbos, renosterveld, succulent karoo, mainland thicket, and freshwater ecosystems (Mucina & Rutherford, 2011).

CapeNature, established under the Western Cape Biodiversity Act, 2021 (Act 6 of 2021) (Western Cape Government, 2021), is responsible for nature conservation in this south-western corner of South Africa known as the Western Cape Province (CapeNature, 2023). There are 38 statutory provincial PA complexes (Fig. 2.1; Table S2.1) comprising 112 nature reserve parcels under the direct management of CapeNature (the 'conservation agency') that are subject to PAME assessment annually to bi-annually using the METT-SA (Cowan, Mpongoma & Britton, 2010; CapeNature, 2022).

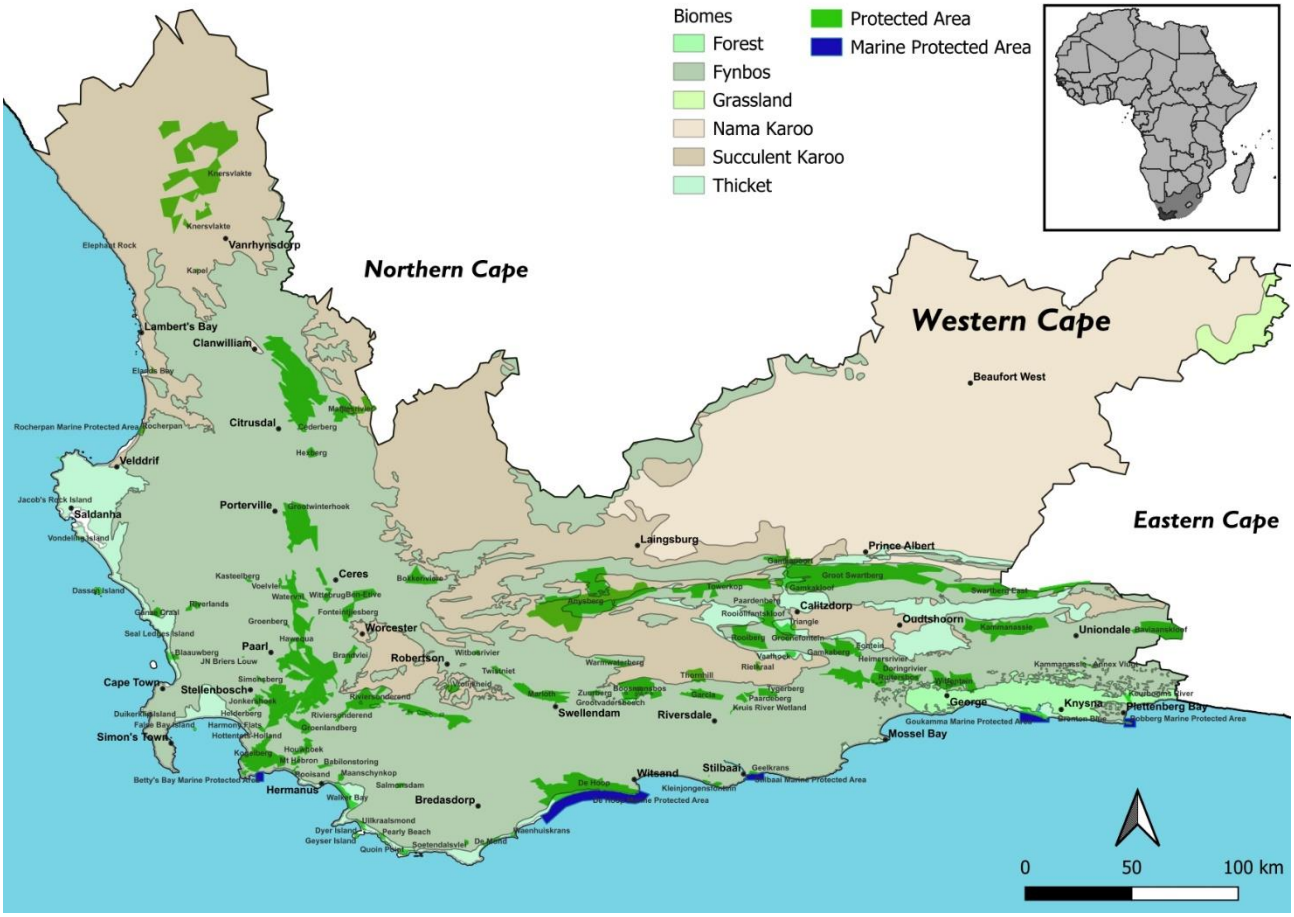

Figure 2.1 Map of the Western Cape Province, South Africa, depicting the biomes and protected areas that are the subject of this study and managed by the conservation agency.

During 2015, METT-SA assessment results for these PAs were evaluated against PA management plans: PA management objectives, operational plans, monitoring programmes and state of

biodiversity reports, to establish how well plans were set up to facilitate adaptive management and evaluate outcomes (Hayward, 2015). Results indicated that plans strove for adaptive management with the provision of objectives and actions, and mechanisms for monitoring and review, but a misalignment between interventions and monitoring, and occurrence of broad objectives that were hard to measure, impeded the adaptive management cycle. The conservation agency then piloted and adopted The Conservation Standards for the Practice of Conservation (hereafter the 'Conservation Standards') decision support framework that is based on adaptive management and evidence-based conservation principles in 2017-2018 for the drafting of PA management plans (CMP, 2020; Hayward, 2021). Prior to 2017, PA management plans were drafted by managers or small planning teams in the absence of a decision support framework. Since 2018, the Conservation Standards were applied with the aim of producing PA management plans consistently containing articulated PA values, measurable PA goals and objectives and clear assumptions linking action to outcomes as guided by a systematic evidence-based process (Hayward, 2021).

2.2.2 Protected area management effectiveness assessment

PAME assessment is mandatory in South Africa as the country is a Party to the CBD (Cowan, Mpongoma & Britton, 2010). PAME is assessed using the METT (Stolton *et al*., 2003), adapted to suit South African conditions (Management Effectiveness Tracking Tool-South Africa (METT-SA) Version 1.0.0), and is the mandatory PAME assessment methodology for South Africa (Cowan, Mpongoma & Britton, 2010).

The methodology is a rapid assessment based on a scorecard questionnaire (Dudley *et al.,* 2007; Hockings, Leverington & Cook, 2015; Stolton *et al.,* 2019). The tool is judgment based; a scoring system linked to indicators arranged within six elements of the WCPA's PA management framework i.e. context, planning, inputs, process, outputs, and outcomes (Hockings, 2003; Hockings *et al*., 2006). The scorecard questionnaire is based on a four-point scale of 0 to 3, whereby assessors select the most appropriate response according to qualitative statements that provide indicator-specific guidance about the meaning of each point on the scale (Stolton *et al*., 2003; Dudley *et al.,* 2007). Ratings are not static and are intended to illustrate progression or improvement and for the purpose of reporting, a rating of '0' can be interpreted as 'no or negligible progress'; '1' as 'some progress'; '2' as 'good but room for improvement' and '3' as 'approaching an optimum situation' (Leverington *et al*., 2008). This could be further translated into the categories: '0' as 'no management', '1' as 'inadequate management', '2' as 'basic management' and '3' as 'sound management' (Leverington, Hockings & Costa, 2008). Individual indicator scores are summed to create a composite METT score reflected as a percentage, which is the proxy for overall management effectiveness for a PA (Dudley *et al.,* 2007). For global reporting of overall effectiveness for PAs, Leverington, Hockings & Costa (2008) established three categories of management effectiveness, *viz.* 'inadequate management' (an overall METT score of 0-33%), 'basic management' (an overall METT score of 34-67%) and 'sound management' (an overall METT score

of more than 67%). Thus, PAs scoring an overall percentage of more than 67% are considered in the ‘sound management’ category and effectively managed (Stolton *et al.,* 2019).

The METT-SA comprises 70 indicators spread across the six elements of the PA management framework and collects supplementary information on PA legal status, size, biome and threats (METT-SA Ver. 1.0.0). The tool comprises questions arranged on the abovementioned four-point improvement scale and a two-point compliance scale of ‘0’ ‘No’ and ‘1’ ‘Yes’. For PAs managed by the conservation agency, PAME assessments are undertaken annually or bi-annually using the METT-SA (CapeNature, 2022). Prior to the application of the Conservation Standards in 2017-2018, PA management plans were drafted in the absence of any decision support framework. In the absence of a systematic decision support framework for management planning, objectives can be vague and assumptions linking action to outcome are unclear (Kapos *et al.,* 2008). The aim of applying the Conservation Standards was for the consistent collaborative production of PA management plans containing clearly articulated measurable PA goals and objectives, PA values with defined thresholds linked to goals, and alignment between PA goals, values, threats, implementation frameworks and monitoring (Hayward, 2021).

To investigate whether the application of the Conservation Standards had any influence on management effectiveness following the adoption of the framework for management planning, METT-SA data for the 38 PA complexes were analysed to investigate change in management effectiveness pre and post application of the Conservation Standards. METT-SA data were thus analysed in the context of ‘before’ assessments (i.e. METT-SA assessments conducted prior to the application of a decision support framework for management plans) and ‘after’ assessments. This approach followed the logic that the PA management plan in its articulation of PA values underpinning the significance of the PA as representative of overall biodiversity and cultural assets, is foundational to conservation action (CMP, 2013; 2020; Parrish, Braun & Unnasch, 2003). The assumption being that by the preparation of a management plan, following a systematic process and articulating actions aimed at restoring or maintaining defined PA values with established thresholds of variation, positive conservation outcomes would be measurable and could be expected (Parrish, Braun & Unnasch, 2003), leading to improved METT-SA scores. Plans drafted using the Conservation Standards applied the philosophy of the framework by articulating PA values and linking PA values, threats, assumptions of interventions that could work, and the outcomes being measured (CMP, 2013, 2020; Parrish, Braun & Unnasch, 2003).

Noting several iterations of the METT-SA since its adoption by South Africa, an appropriate timeframe for comparative analysis and selection of METT-SA datasets to serve as ‘before’ assessments pre-Conservation Standards, was undertaken. All datasets since the application of METT-SA by the conservation agency were evaluated against the most recent iteration of the tool, the METT-SA Ver. 1.0.0 administered by the Department of Forestry, Fisheries and the Environment (DFFE, 2023). Criteria for dataset selection included consistency in METT-SA management

elements (e.g. the 'outcomes' element was introduced in a later version of METT-SA), the presence/absence of and wording of indicators, and detail of the criteria per indicator rating scale. The evaluation was applied to METT-SA datasets from 2011 to 2022.

METT-SA iterations prior to 2015 were found to be inconsistent in a) the number of management elements; b) the presence or absence of indicators contained in the tool; c) the wording of indicators; and d) explanatory criteria per indicator rating (e.g. indicator rating criteria on the scale for 'heritage knowledge' changed with each iteration of the METT-SA). As such, inconsistencies in the METT-SA likely solicited varied/inconsistent interpretations and associated variable scoring with each iteration of the METT-SA prior to 2015 (Table S2.2). Consequently, the METT-SA datasets for 2015 were considered as 'before' assessments, pre-Conservation Standards. The 2022 METT-SA dataset was considered 'after' assessments, i.e. post-Conservation Standards. The METT-SA underwent some minor amendments between 2015 and 2022, and nine indicators were excluded from analysis since amendments in the wording of these indicators may have created inconsistent interpretation and associated scoring. Thus 61 indicators (maximum number of questions, n = 61) remained for analysis (Table S2.2) with 2015 being before and 2022 being after application of the Conservation Standards. The duration between before and after assessment was seven years, apart from one PA (Hexrivier Nature Reserve Complex) for which no 2015 assessment was available and a 2018 assessment was used instead (Table S2.2).

For each PA complex, the total score was derived following the approach by Geldmann *et al.* (2015). The METT-SA comprises indicators (questions) rated on a scale of '0' (No) and '1' (Yes) and a progressive scale of '0', '1', '2' and '3'. To avoid an inflated perception of change between before and after assessments, indicators rated on the scale of '0' and '1' were separated from indicators rated on a progressive scale of '0' to '3'. For this study, indicators rated on a scale of '0' and '1' are referred to as 'compliance indicators' since there is no room for progression. The indicator condition is either met ('1') or not ('0'). Indicators rated on a scale of '0 to '3' are referred to as 'progression indicators' as indicators represent areas of management requiring a systematic process to 'approaching an optimum situation'. Therefore, for Progression Indicators (^{PI}), the standardised Max Questions n = 39 and for Compliance Indicators (^{CI}) n = 22, calculated as:

Max Score^{PI} = n x 3 for a maximum score of 117

Max Score^{CI} = n x 1 for a maximum score of 22

Total Maximum Score was calculated as the total sum of ratings per question. T Max = $\sum^{ratings}$

To avoid deflation of scores introduced by site level 'not applicable' indicators, an Adjusted Total Score (Adjusted TS) per PA was calculated by subtracting the value of the Not Applicable (N/A) questions from Questions Max where:

Adjusted TS = Score Max^{PI} - (Count N/A x 3) or

Adjusted TS = Score Max^{CI} - (Count N/A x 1).

Thus, composite METT Score (METT Score) per PA for Compliance Indicators and Progression Indicators each, was calculated by dividing T Max by the Adjusted TS, multiplied by 100 to derive the METT Score as a percentage:

METT Score = (T Max / Adjusted TS) x 100

2.2.3 Grouping indicators

To gain a richer evaluation of management effectiveness over and above METT Score and individual indicator performance, indicators were analysed in the groupings of the IUCN WCPA's *management elements* of 'Context', 'Planning', 'Inputs', 'Process', 'Outputs' and 'Outcomes' (Hockings *et al*., 2006). Indicators were then grouped for analysis according to the more recent IUCN-WCPA Green List Standard for protected and conserved areas *Components of successful nature conservation* that comprise 'good governance', 'sound design and planning', 'effective management', and 'successful conservation outcomes' (IUCN & WCPA, 2017) (Table S2.3). METT-SA indicators could not be grouped according to Social-Ecological Systems (SES) frameworks proposed by Ostrom (2009), Geldmann *et al*. (2015) and Ghoddousi, Loos & Kuemmerle (2022) due to limited indicators in the METT-SA to assess change in socio-economic or resource use categories. The indicators 'Sustainable extractive use' and 'Socio-economic benefit assessment' were deemed relevant but were excluded from the study due to indicator inconsistency over METT-SA iterations and subsequent incomparability. Finally, indicators were analysed individually to isolate potential drivers of management effectiveness results.

2.2.4 Data analysis

Data analysis was conducted using R Statistical Software (v4.3.2 R Core Team, 2023). Data were analysed to compare overall score between assessments undertaken before application of the Conservation Standards and assessments undertaken after application of the Conservation Standards per PA complex. Indicator data were analysed in abovementioned groupings and individually.

To investigate how METT-SA scores per PA and per indicator changed between assessments before and after application of the Conservation Standards, a Shapiro-Wilk test and QQ plots were applied to test normality. For normally distributed data, a Paired T-test was applied, otherwise a Wilcoxon test for paired samples was applied (with package "exactRankTests" (Hothorn & Hornik, 2022). The trend in METT mean scores was determined by investigating the frequency distribution of METT mean score for each assessment for all indicators, compliance indicators (Indicators ^{CI}) and progression indicators (Indicators ^{PI}), using the Kolmogorov-Smirnov test with packages "FSA" (Ogle *et al.,* 2023) and "Matching" (Sekhon, 2011).

To determine whether there was significant improvement or decline for indicator groupings between assessments undertaken before and after application of the Conservation Standards, a paired T-test

was applied to normally distributed data and a Wilcoxon test applied for paired data (using package “rstatix” (Kassambara, 2023) where data were not normally distributed.

To investigate the relationship between the management element ‘Planning’ and component of successful nature conservation ‘Sound Design and Planning’ and overall METT Score, a general linear model (GLM) using a gaussian family with "identity" as link was fitted with the log (overall METT Score) as dependent variable and ‘Assessment period’ and log (Planning) and log (Sound Design and Planning) as independent variables. For the ‘Assessment period’ the before assessment estimate was incorporated into the intercept and has a value of zero. The post hoc Tukey analysis for the GLM was conducted using the package “multcomp” (Hothorn, Bretz & Westfall, 2008).

To investigate the relationship between the indicator ‘management plan’ and overall METT Score, a linear regression model was fitted with the overall METT Score as dependent variable and a cube root transformed ‘management plan’ as independent variable after a GLM including the ‘Assessment Period’ indicated that it could be dropped out of the model as it did not significantly influence the model. Model validation showed a similar variance for the residuals and no pattern, and residuals showed normal distribution, validating a GLM was the best model to use.

Finally, to investigate the relationship between overall METT Score and the management element ‘Outcomes’, a GLM using a gaussian family with "identity" as link was fitted with the overall METT Score as dependent variable and Outcome indicators (achievement of biodiversity targets, ecosystem services, ecological processes, cultural heritage condition assessment) as independent variables. Model validation showed a similar variance for the residuals and no pattern for all models, and residuals showed normal distribution. The post hoc Tukey analysis for the GLM was conducted using the package “emmeans” (Lenth, 2024).

2.3 Results

2.3.1 Changes in Protected Area Management Effectiveness between assessments

For management effectiveness between the before and after assessment, seven (18%) PAs shifted from ‘basic management’ into ‘sound management’ and three (8%) PAs declined in management effectiveness, shifting from ‘sound management’ into ‘basic management’ (Fig. 2.2). There were no PAs in the category of ‘inadequate management’. The METT Score across the 38 PAs improved significantly between assessments ($t = -4.157$, $df = 37$, p-value <0.0001). For assessments undertaken after application of the Conservation Standards, 76% of PAs improved in their METT-SA scores, 18% of PAs declined, while 5% remained the same (Table 2.1; Fig.S2.1).

Analyses of the frequency distribution of METT Score for All Indicators, Progression Indicators (PI) and Compliance Indicators (CI) respectively, all showed a similar distribution, with no significant difference in the frequency distribution between assessments (All Indicators: $D = 0.1$, $k = 10$, $n = 38$, $p = 1$; Compliance Indicators: $D = 0.1$, $k = 10$, $n = 38$, $p = 1$; Progression Indicators : $D = 0.2$, $k = 10$, $n = 38$, $p = 0.88$; Fig. 2.3).

2.3.2 Changes in grouped Protected Area Management Effectiveness indicators

For indicators grouped as components of successful nature conservation there was significant improvement in METT Score (All and CI), Good Governance (CI) and Effective Management (PI and CI), with significant decline in Successful Conservation Outcomes ($p > 0.05$; Fig. 2.4; Table S2.4). There was no change in METT Score (PI), Good Governance (PI) and Sound Design and Planning (All and CI).

For indicators grouped as management elements, there was no difference for Context (All and PI), Planning (All and PI), Process (All, PI and CI) and Outputs (PI) ($p > 0.05$; Fig. 2.5; Table S2.5). Significant improvement was detected for Context CI, Inputs (All, PI and CI), and Outputs (All and CI) ($p < 0.05$). A significant decline was observed for Planning (CI) and Outcomes (All and PI) ($p < 0.05$). The frequency distribution of management elements (PI) in a range of 'no or negligible progress' to 'optimum status' illustrated a shift in Context towards Optimum status while for Planning, Process, Inputs and Outputs, progress ranged in the 'good with room for improvement' category. For Outcomes there was some progress (Fig. 2.6). Improvement and decline is attributed to the performance of individual indicators comprising each management element (Figures S2.2 to S2.7; Table S2.6 and S2.7).

2.3.3 Changes in Protected Area Management Effectiveness indicators

Of the 22 CI indicators, 71% were in the 'sound management' category for before assessment, compared to 86% for after assessment. Overall, 42% of indicators improved, 3% declined and 13% remained stable (Table 2.2). Improving indicators included capital budget, servitude register, health and safety audit, staff housing policy and integrated compliance plan. Declining indicators related to procedures for the management of heritage collections. Stable indicators related to internal rules, risk assessment, restoration plan, relationship with researchers, tourism grading and insurance (Table S2.6). The percentage change in score for indicators ranged from 94% improvement (e.g. staff housing policy) to a 6% decline (e.g. procedures for management of heritage collections) (Fig. 2.7).

Of the 39 PI indicators, 56% were in the 'sound management' category for before assessments and 44% for after assessments. Overall, 51% improved, 41% declined and 8% remained stable (Table 2.2). Indicators that improved included PA management plan, delineation of a PA zone of influence, human resource capacity (adequate for critical management activities only), adequacy of operational budget (adequate for critical management activities and reliant on external funding) and functioning human resource management systems. Other improving indicators included PA boundary demarcation, biodiversity knowledge and understanding, adequacy of operational equipment and transport fleet, maintenance of tourism infrastructure, public relations and communications programme, and functioning of law enforcement and compliance systems. Most indicators scored in the 'good but room for improvement category' (Fig. S2.2 to S2.6; Table S2.7). Indicators that declined

included PA legal status, development and implementation of education and awareness programmes, and adequacy of operational and tourism infrastructure. Other declines were observed in monitoring and evaluation programme, administrative support system, and staff development and productivity (Fig. S2.2 to S2.6; Table S2.7). A decline was observed across four of the six outcomes indicators, with the biggest decline in ecological processes and ecosystem services (Fig. S2.7; Table S2.7). The percentage change in scores ranged from 31% improvement (e.g. adequacy of operational budget) to a 25% decline (e.g. implementation of education and awareness programme) (Fig. 2.8).

2.3.4 Factors influencing change in management effectiveness

Assessment period ($F = 17.77$, $df = 1$, $df_{residuals} = 74$, $p < 0.001$) and the management element 'Planning' ($F = 167.80$, $df = 1$, $df_{residuals} = 73$, $p < 0.001$) both significantly influenced the overall METT Score (Table 2.3, Fig 2.9) and accounted for 72% of the variability in the overall METT Score. The after assessment had a 6% higher overall METT Score than the before assessment ($t = 4.91$, $p < 0.001$). The estimate for 'Planning' was 0.20 ($t = 12.95$, $p < 0.001$), thus for every 1% increase in 'Planning' there would be an 0.20% increase in overall METT Score.

The Assessment period ($F = 14.96$, $df = 1$, $df_{residuals} = 74$, $p < 0.001$) and component of successful nature conservation 'Sound Design and Planning' ($F = 129.71$, $df = 1$, $df_{residuals} = 73$, $p < 0.001$) significantly influenced and accounted for 66% of the variability in the overall METT Score. The after assessment had 6% higher overall METT Score than the before assessment ($t = 5.07$, $p < 0.001$). The estimate for 'Sound Design and Planning' was 0.35 ($t = 11.39$, $p < 0.001$). For every 1% increase in 'Sound Design and Planning' there would be a 0.35% increase in the overall METT Score.

The indicator 'Management Plan' accounted for 57% of the variability in the METT Score. The estimate for 'Management Plan' was 13.35 ($t = 9.84$, $p < 0.001$). As 'Management Plan' indicator ratings increase there would be an increase in overall METT Score.

There was a significant relationship between Overall METT Score, Assessment period and indicators 'Achievement of Biodiversity Targets' and 'Ecological Processes' (Table 2.4, $p < 0.05$). There were significant two-way interactions between indicators 'Achievement of Biodiversity Targets' and 'Ecological Processes', 'Assessment period' and 'Ecosystem Services', 'Achievement of Biodiversity Targets' and 'Ecosystem Services', 'Ecological Processes' and 'Cultural Heritage Condition Assessment' (Table 2.4, $p < 0.05$). There was one three-way interaction showing a significant relationship between 'Assessment period', 'Ecological Processes' and 'Cultural Heritage Condition Assessment' (Table 2.4, $p = 0.042$). These outcome indicators accounted for 78% of the variability in the overall METT Score. There was a significant three-way interaction of 'Ecological Processes' and 'Cultural Heritage Condition Assessment' with 'Assessment period' with the last assessments having a higher overall METT Scores than in the first assessments (Table 2.5, $p = 0.006$). Several two-way interactions in the model (Table 2.5) complicated the interpretations rendering it difficult to

interpret single point relationships in the model, because they may have been masked by the interactions.

Table 2.1. Comparison of METT-SA scores between assessments before (2015) and after (2022) application of the decision support framework, arranged in order of the largest positive to a negative change in METT-SA Score.

Protected Area Complex	Before Assessment (%)	After Assessment (%)	Change	
Knersvlakte NR	60	78	18	↑
Still Bay MPA	67	79	12	↑
Waterval NR Complex	61	71	10	↑
Grootwinterhoek NR Complex	69	78	9	↑
De Mond NR Complex	68	76	8	↑
De Hoop MPA	70	78	8	↑
Rocherpan NR Complex	68	76	8	↑
Hexrivier NR Complex	62	69	7	↑
Brenton Blue Butterfly NR	67	73	6	↑
Goukamma MPA	68	74	6	↑
Anysberg NR	71	76	5	↑
Cederberg NR Complex	69	74	5	↑
Vrolijkheid NR Complex	70	74	4	↑
Island and Rocks Complex	45	49	4	↑
Penguin (Bird) Island NR Complex	71	75	4	↑
Dassen Island NR	73	77	4	↑
Riverlands NR Complex	67	71	4	↑
Marloth NR Complex	68	72	4	↑
Swartberg NR Complex	75	77	2	↑
Betties Bay MPA	71	73	2	↑
Goukamma NR Complex	67	69	2	↑
Kammanassie NR	74	76	2	↑

Protected Area Complex	Before Assessment (%)	After Assessment (%)	Change	
Grootvadersbosch NR Complex	70	72	2	↑
Kogelberg NR Complex	72	74	2	↑
Outeniqua NR Complex	67	69	2	↑
Walker Bay NR Complex	67	69	2	↑
Robberg MPA	74	76	2	↑
Keurbooms River NR	75	76	1	↑
De Hoop NR Complex	70	71	1	↑
Dyer Island NR Complex	74	74	0	↔
Robberg NR Complex	74	74	0	↔
Geelkrans NR Complex	74	73	1	↓
Gamkaberg NR Complex	81	80	1	↓
Salmonsdam NR	71	69	2	↓
Driftsands NR	70	66	4	↓
Babilonstoring NR Complex	71	67	4	↓
Hottentots Holland NR Complex	72	68	4	↓
Limietberg NR Complex	74	67	7	↓
AVERAGE METT-SA SCORE	69.4% ± 5.8 (Mean±SD)	72.6% ± 5.4 (Mean±SD)	**4**	**↑**

Table 2.2. Change in METT-SA indicator scores (as percentage) between assessments before (2015) and after (2022) application of the decision support framework.

	Compliance Indicators (n = 22)		Progressive Indicators (n = 39)	
	Before Assessment	After Assessment	Before Assessment	After Assessment
Sound management category (%)	71	86	56	44
Percentage indicators improved (%)	-	42	-	51
Percentage indicators declined (%)	-	3	-	41
Percentage indicators favourably stable (%)	-	13	-	8

Table 2.3. General linear model (GLM) results for analysis of variance (ANOVA) between variables. The Df represents the degrees of freedom. Level of significance is represented by *.

Analysis of Deviance Table	Df	Deviance	Residual Df	Residual Deviance	F	p.value	Significance
NULL			75	0.61			
Assessment period	1	0.04	74	0.57	17.77	< 0.001	***
log (Planning)	1	0.40	73	0.17	167.80	< 0.001	***

Table 2.4. Analysis of variance (ANOVA) results for the general linear model (GLM) of the overall METT Score with Outcome indicators as independent variables. Df represents the degrees of freedom. Level of significance is represented by *.

	Df	Deviance	Residual Df	Residual Deviance	F	p-value	Significance
NULL			66	2306.37			
Assessment period	1	141.53	65	2164.85	14.32	< 0.001	***
Achievement of Biodiversity Targets	1	909.75	64	1255.10	92.02	< 0.001	***
Ecological Processes	1	84.64	63	1170.46	8.56	0.005	**
Ecosystem Services	1	14.29	62	1156.17	1.45	0.235	
Cultural Heritage Condition Assessment	1	26.60	61	1129.57	2.69	0.107	
Assessment period: Achievement of Biodiversity Targets	1	2.00	60	1127.57	0.20	0.654	
Assessment period: Ecological Processes	1	38.38	59	1089.19	3.88	0.054	
Achievement of Biodiversity Targets: Ecological Processes	1	93.86	58	995.33	9.49	0.003	**
Assessment period: Ecosystem Services	1	192.45	57	802.88	19.47	< 0.001	***
Achievement of Biodiversity Targets: Ecosystem Services	1	55.46	56	747.42	5.61	0.022	*
Assessment period: Cultural Heritage Condition Assessment	1	8.30	55	739.12	0.84	0.364	
Ecological Processes: Cultural Heritage Condition Assessment	1	143.85	54	595.27	14.55	< 0.001	***
Ecosystem Services: Cultural Heritage Condition Assessment	1	10.62	53	584.65	1.07	0.305	
Assessment period: Ecological Processes: Cultural Heritage Condition Assessment	1	43.03	52	541.62	4.35	0.042	*
Assessment period: Ecosystem Services: Cultural Heritage Condition Assessment	1	37.43	51	504.19	3.79	0.057	

Table 2.5. Summary results for the general linear model (GLM) of overall METT Score and Outcome indicators. Level of significance is represented by *.

Coefficients:	Estimate	Standard Error	t value	p-value	Significant
(Intercept)	33.01	10.59	3.12	0.003	**
Assessment period Last	21.05	7.39	2.85	0.006	**
Achievement of Biodiversity Targets	20.86	5.46	3.82	< 0.001	***
Ecological Processes	12.24	3.20	3.83	< 0.001	***
Ecosystem Services	0.85	5.05	0.17	0.867	
Cultural Heritage Condition Assessment	-5.61	3.02	-1.86	0.069	
Assessment period Last: Achievement of Biodiversity Targets	-8.86	2.44	-3.63	0.001	***
Assessment period Last: Ecological Processes	17.95	3.36	5.34	< 0.001	***
Achievement of Biodiversity Targets: Ecological Processes	-13.83	2.29	-6.04	< 0.001	***
Assessment period Last: Ecosystem Services	-18.60	4.35	-4.28	< 0.001	***
Achievement of Biodiversity Targets: Ecosystem Services	6.34	2.59	2.45	0.018	*
Assessment period Last: Cultural Heritage Condition Assessment	2.21	3.95	0.56	0.578	
Ecological Processes: Cultural Heritage Condition Assessment	7.91	1.91	4.13	< 0.001	***
Ecosystem Services: Cultural Heritage Condition Assessment	-4.70	2.33	-2.02	0.049	*
Assessment period Last: Ecological Processes:Cultural Heritage Condition Assessment	-6.83	2.41	-2.84	0.006	**
Assessment period Last: Ecosystem Services:Cultural Heritage Condition Assessment	5.86	3.01	1.95	0.057	

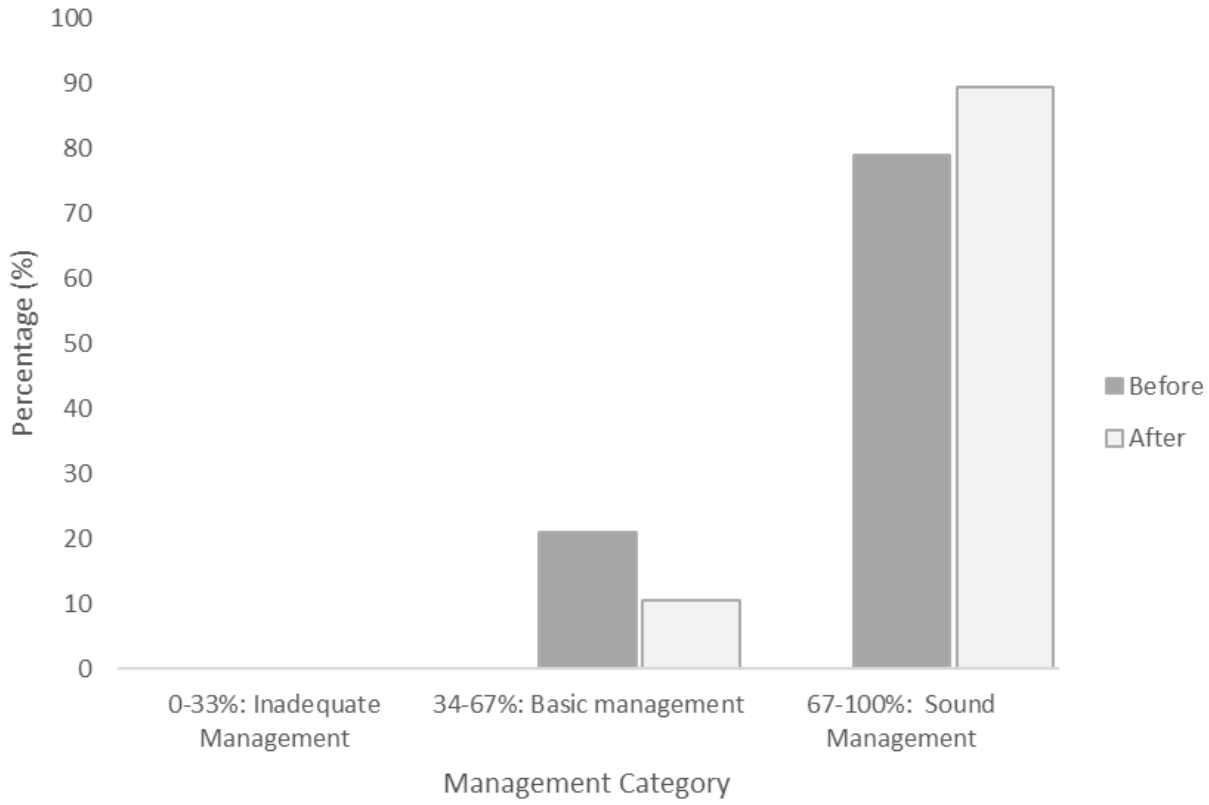

Figure 2.2 Distribution of overall METT-SA Score per management effectiveness category of Inadequate Management, Basic Management and Sound Management before (2015) and after (2022) the application of a decision support framework.

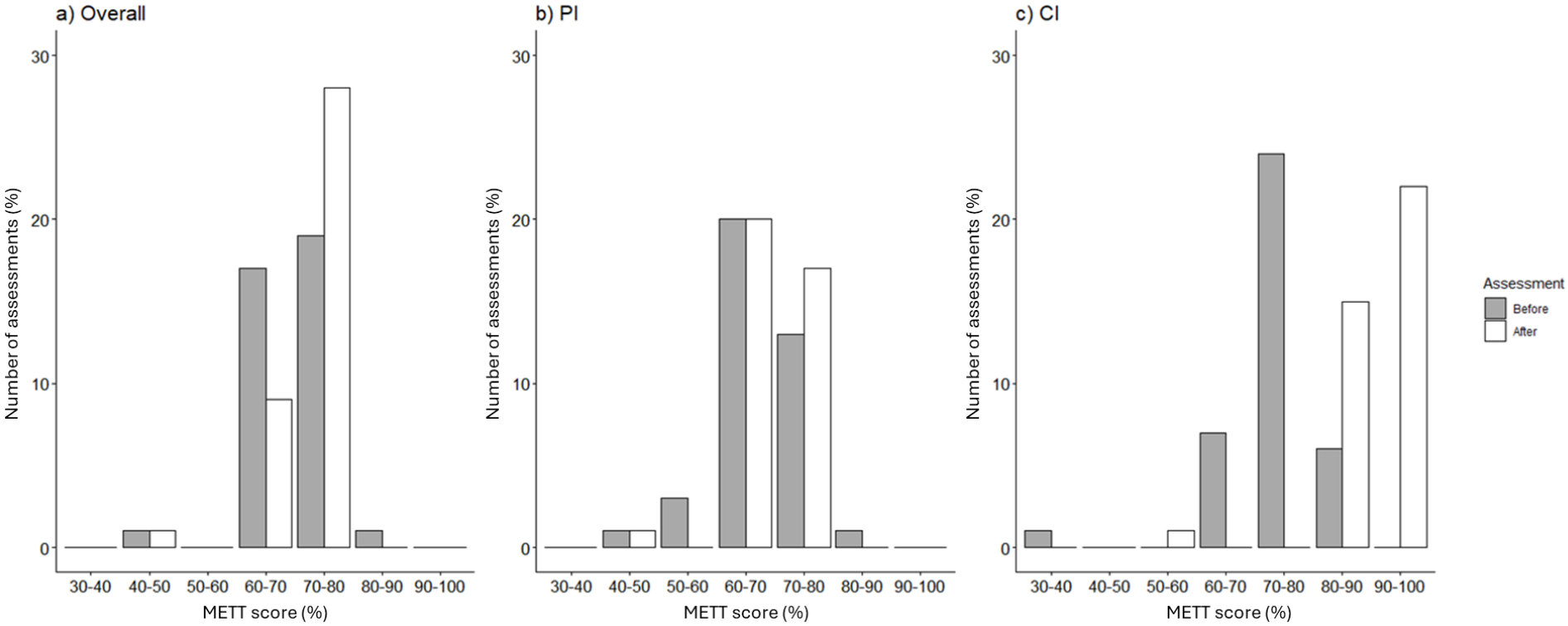

Figure 2.3 The frequency distribution of METT-SA Scores (%) for before (2015) and after (2022) assessments of a) all indicators (Overall), b) progression indicators (PI), and c) compliance indicators (CI) (n = 38).

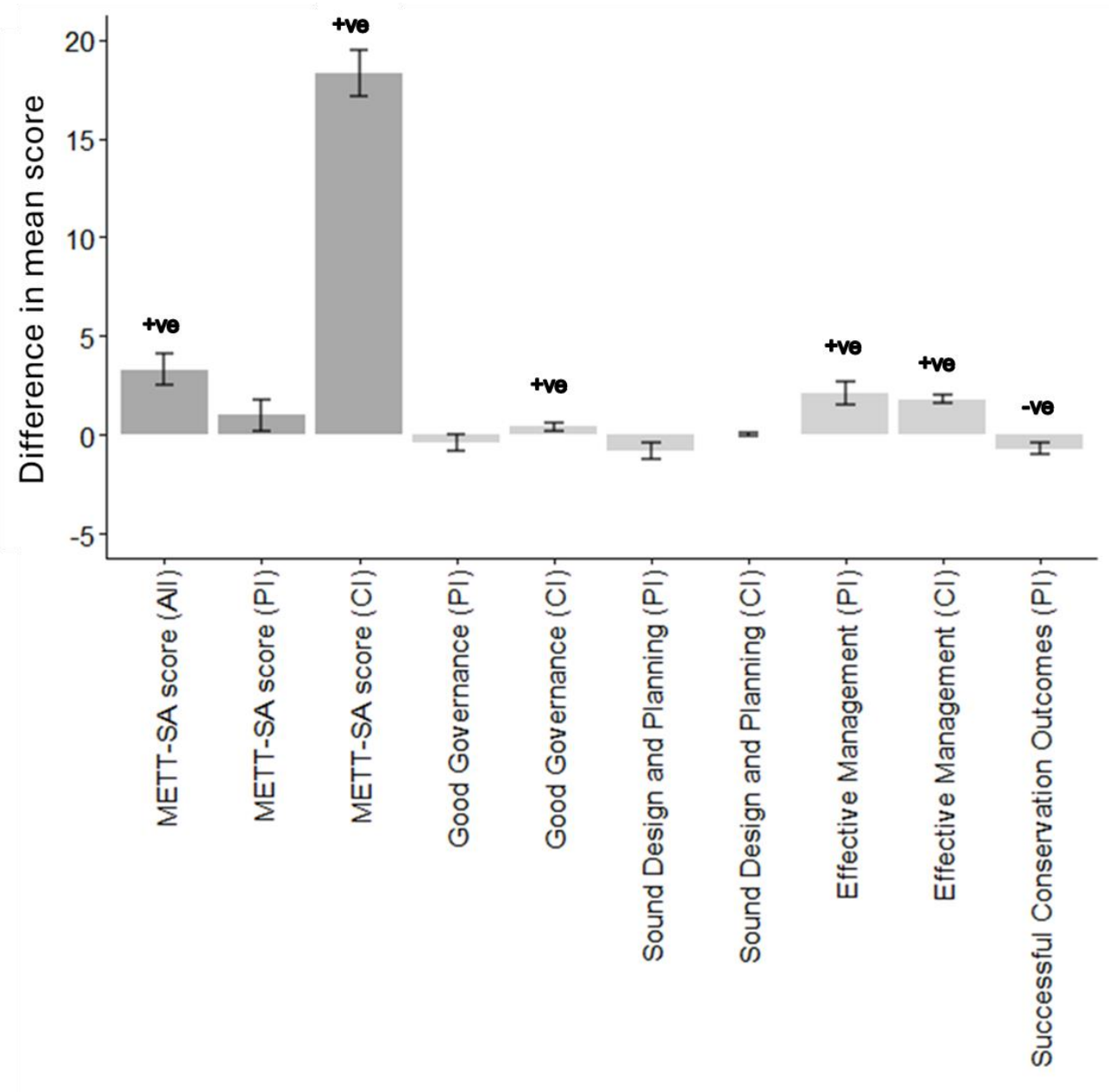

Figure 2.4 The difference in mean score between before (2015) and after (2022) assessments for overall METT-SA score (dark grey) and indicators grouped into components of successful nature conservation in protected areas (light grey). The error bars represent the standard error, +ve indicates a significant improvement and -ve indicates a significant decline in score from first to last assessment.

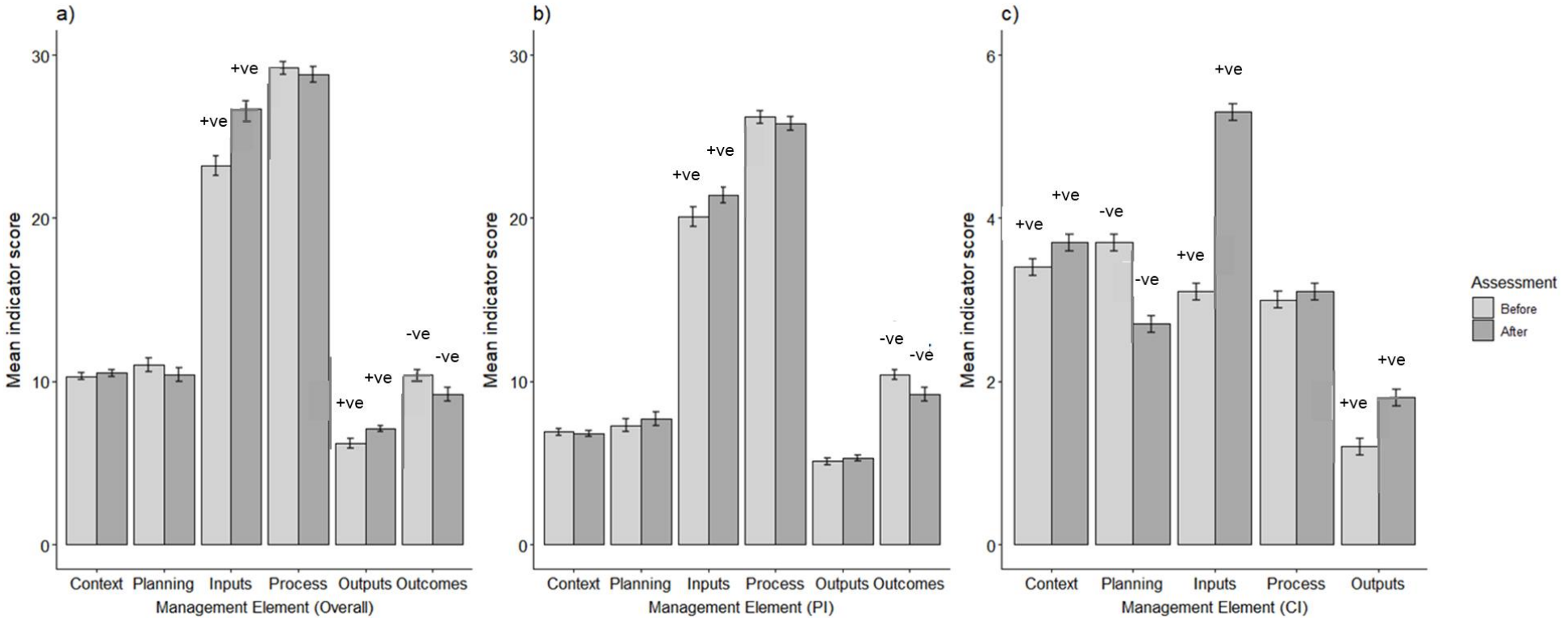

Figure 2.5 Mean score per management element between before (2015) and after (2022) assessments for all indicators (a), progressive indicators (PI) (b) and compliance indicators (CI) (c). The error bars represent the standard error, +ve indicates that a significant improvement and -ve indicates a significant decline in the score.

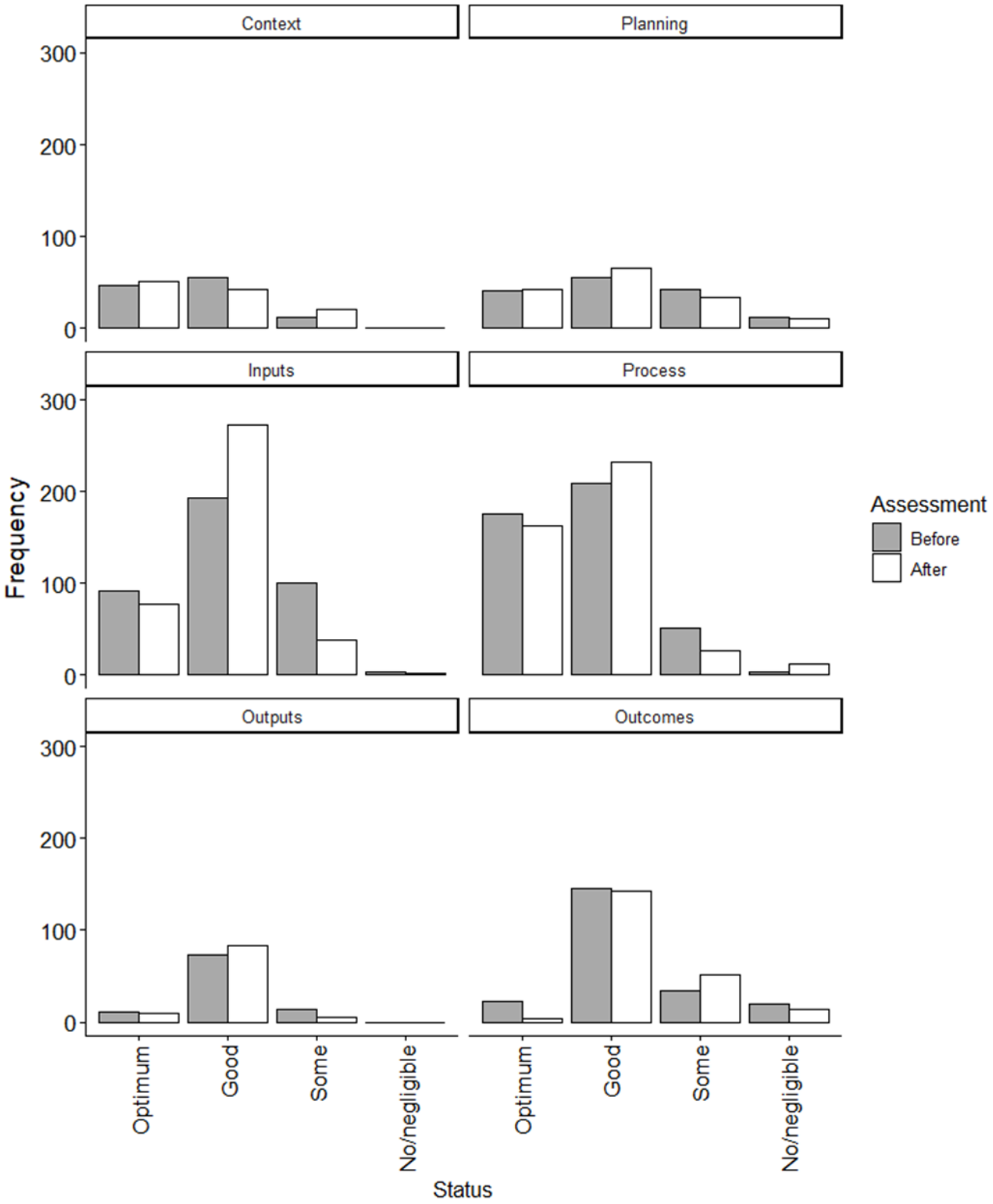

Figure 2.6 Frequency distribution of indicators per management element between before (2015) and after (2022) assessments for progression indicators (PI). ‘Optimum’ reflects indicators that are approaching optimum status, ‘Good’ reflects indicators that have had good progress but there is room for improvement, ‘Some’ reflects indicators where there has been some progress and ‘No/negligible’ reflects indicators where there has been no or negligible progress.

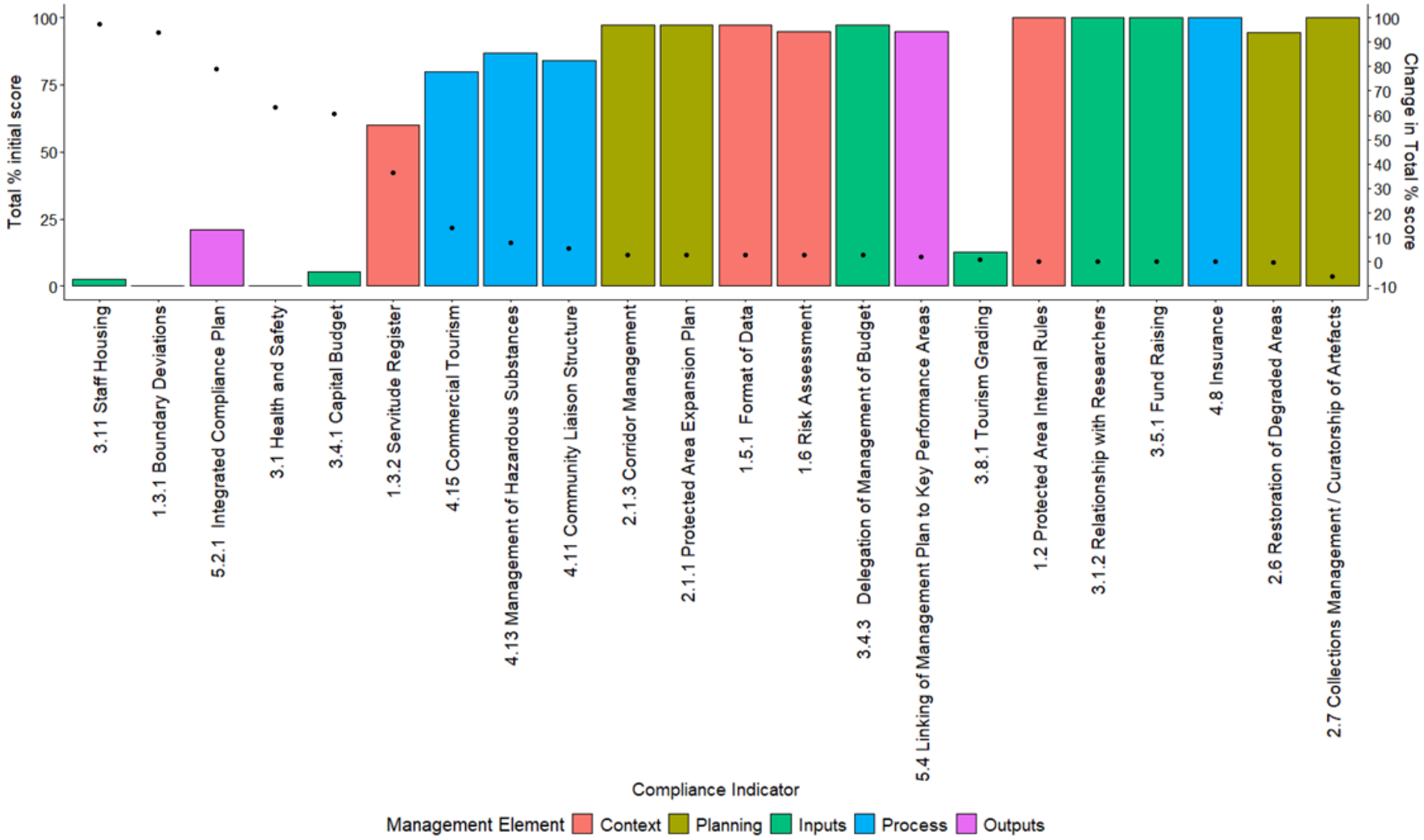

Figure 2.7 Change in compliance indicators (CI) between before (2015) and after (2022) assessment is illustrated where the Total score (%) per indicator initial score is represented by the bars in the plot (left x-axis) and the dots represent the change in the Total score (%) per indicator between assessments (right x-axis). Note that the right x-axis starts at a value of negative 10.

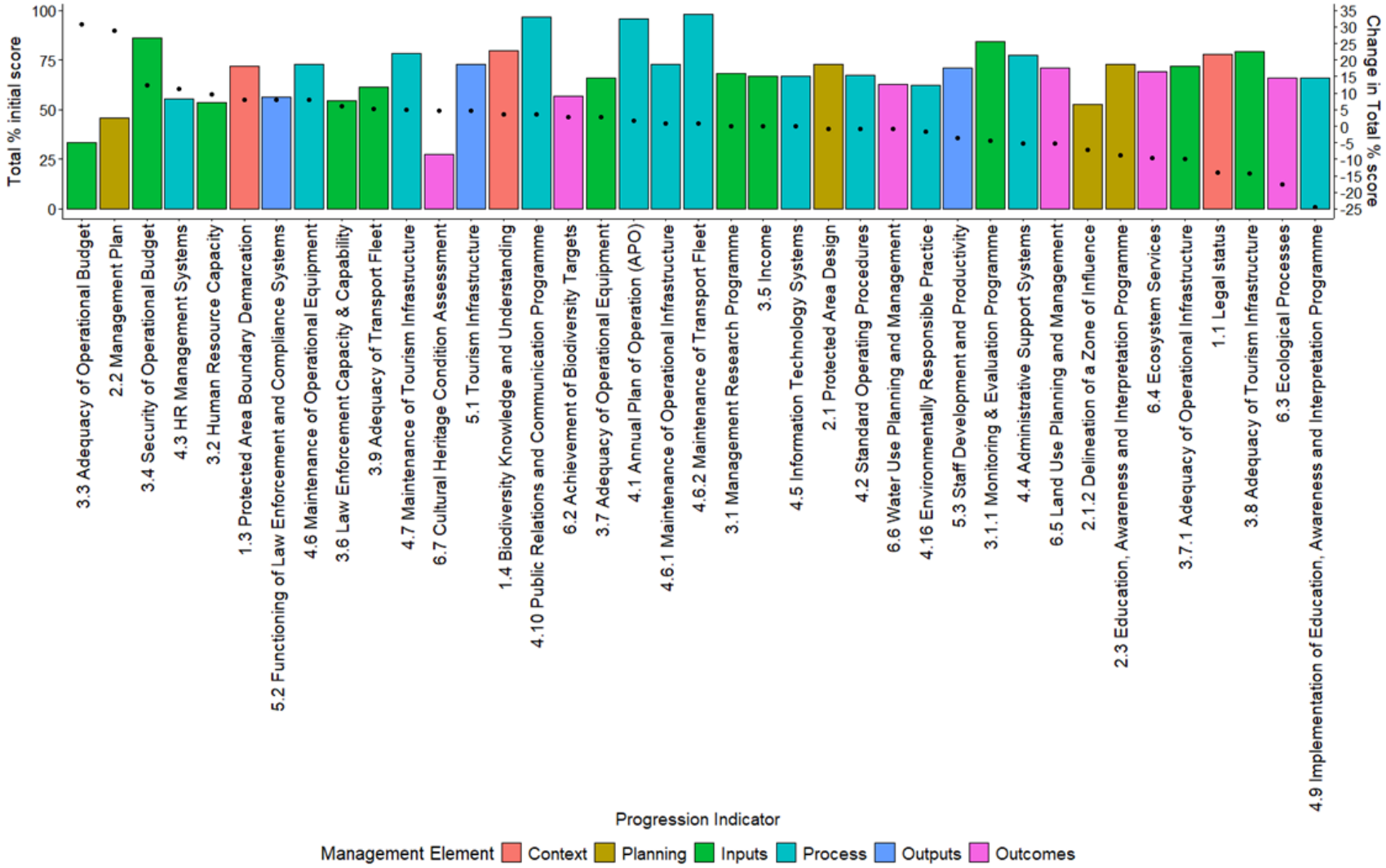

Figure 2.8 Change in progression indicators (PI) between before (2015) and after (2022) assessments. Where the Total score (%) per indicator initial score is represented by the bars in the plot (left x-axis) and the dots represent the change in the Total score (%) per indicator between assessments (right x-axis). Note that the right x-axis starts at a value of negative 25.

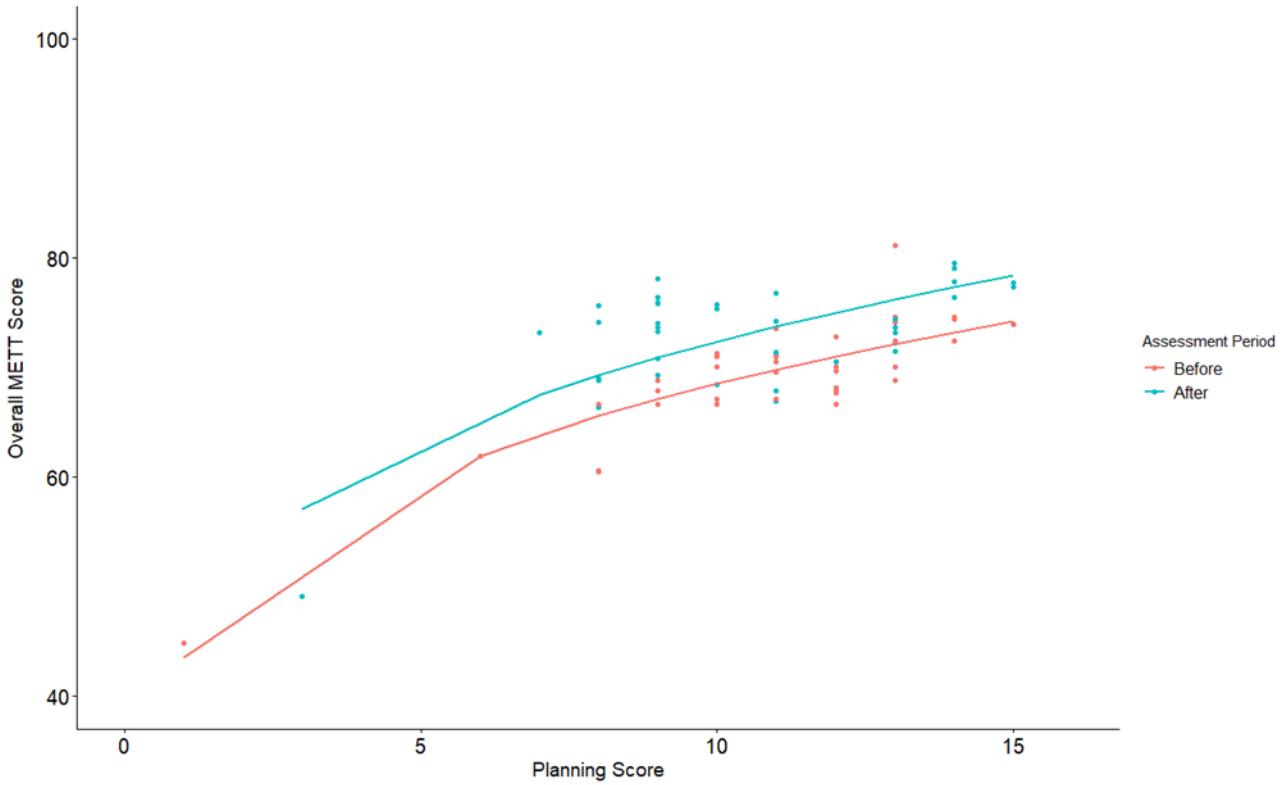

Figure 2.9 The relationship and best fit lines between the management element 'Planning' and assessment period in years with overall METT Score before (2015) and after (2022) application of a decision support framework. The 'Planning' element score is reflected on the x-axis. Assessment period and 'Planning' are the main influencers of the overall METT Score.

2.4 Discussion

Protected area management effectiveness improved significantly from assessments undertaken before application of the Conservation Standards to assessments undertaken after application of the decision support framework, with 76% of PAs improving their METT scores and the average METT score increasing from 69% to 73%. Factors significantly positively influencing scores were time between assessments, the management element 'Planning', the component of successful nature conservation 'Sound design and planning' and the indicator 'Management Plan'. Outcome indicators 'biodiversity targets' and 'ecological processes' also significantly influenced scores. The significant overall improvement in management effectiveness can be attributed to indicators associated with management planning, human resource capacity, communications, budget, and human resource management systems and information. These are identified by global studies to be strongly correlated with management effectiveness; Input indicators having the strongest correlation (Leverington *et al*., 2010; Dudley *et al*., 2007; Gill *et al.,* 2017).

Producing PA management plans and developing planning tools to meet indicator requirements for positive METT-SA results can lead to false assurances of effective management. The time lag between action and ecological response can also obscure strategy ineffectiveness (Parrish, Braun & Unnasch, 2003; Kapos *et al*., 2008; Coad *et al*., 2015; Geldmann *et al*., 2015). Improving METT-

SA scores did not translate into a positive conservation outcome, the average METT-SA score reported here being 73%, leaving much for management to do. Geldmann *et al*. (2015) found a significant positive correlation between the METT score and time (in years) between assessments, suggesting that implementation of management interventions improves management effectiveness. Such a positive trend in management effectiveness would suggest progress towards conservation outcomes (Hockings, 2003; Coad *et al*., 2015). However, results of this study suggest that despite the significant improvement in METT scores, specifically the significant improvement in the Inputs management element coupled with the positive correlation between METT Score and the Planning management element, there was a significant decline in conservation outcomes, specifically, 'ecological processes' and 'ecosystem services' indicators. This suggests that conservation outcomes are often not being achieved. The results of this study suggest planning needs to shift to implementation and the tracking thereof.

Despite human and financial resources having improved over time (Table S2.7; Fig. S2.4), these have not kept abreast with increasing anthropogenic pressures and threats (Smit, Maze & van Wilgen, 2024). According to the indicator ranking, there is budget only for regular operations with a reliance on external funding while human resource capacity is sufficient for achieving only critical management objectives (METT-SA Ver. 1.0.0) (Table S2.3). Staff productivity levels were found to be at 92%, indicating that productivity targets are being met as indicated in staff performance reviews (Table S2.3), yet Outcomes indicators declined. Global studies report capacity shortfalls (staffing and budget inputs) as predictors of conservation outcomes (Coad *et al*., 2019; Gill *et al*., 2017) and have found management effectiveness to be correlated with human and financial resources (Carbutt & Goodman, 2013; Coad *et al*., 2019; Geldmann *et al*., 2018; Powlen, Gavin & Jones, 2021). The significant improvement in management element Inputs and Outputs for this study suggests that PA management systems and processes exist and are adequate for critical activities, but insufficient to improve positive conservation outcomes.

The reason for the decline in Outcome indicators is inconclusive and requires an analysis of site level monitoring data to test qualitative Outcome indicator ratings. Studies have found that the default qualitative nature of the METT methodology and the tool's vulnerability to disparity in results reflect mostly perceptions of PA conditions (Carbutt & Goodman, 2013; Cook, Carter & Hockings, 2014; Stolton *et al*., 2019). While aspects related to external factors affecting PAs require understanding, they may not be within the ambit of PA management to influence (Geldmann *et al.,* 2013; 2019). For example, in South Africa, threat reduction efforts such as eradication and control of invasive alien plant species require continuous sustained effort at unsustainable costs (Fill *et al*., 2017). In addition, efforts are reliant upon often-interrupted workforces due to the practice of awarding contracts piecemeal for invasive alien plant clearing operations (Shackleton *et al*., 2016) whilst donor funder parameters may hamper the flexibility managers require to respond in the right place with the appropriate resources (van Wilgen & Wannenburgh, 2016; Nsikani & Geerts, 2024). In other cases,

policy may promote safety considerations over ecological requirements, for example, inadvertently converting fire as an ecological process simulation tool into a reactive threat reduction strategy for safety of infrastructure and human settlements (Kraaij & van Wilgen, 2014). In this manner, strategies become ineffective and positive conservation outcomes are not achieved. Lastly, management objectives and associated medium to long- term plans and threat mitigation strategies may be misaligned (Pullin & Knight, 2005; Kapos *et al*., 2008; Margoluis *et al*., 2013; Salafsky *et al.,* 2022), or management interventions may not be adequately implemented (McGeoch *et al*., 2010), as suggested by the results of this study.

The improvement in overall METT-SA scores, a positive result, should thus be interpreted with caution as these improvements may not reflect biodiversity objectives or outcomes (Leverington *et al*., 2010; Stolton *et al.,* 2019). A focus on an overall management effectiveness score may oversimplify complex issues (Hockings, Leverington & Cook, 2015) or mask critical differences in specific aspects of management (Coad *et al*., 2015). The consideration of individual indicators is essential in the application of the tool (Stolton *et al*., 2019) as demonstrated by the significant improvement in management elements Inputs and Outputs. For example, only one METT-SA indicator links implementation of the PA management plan to staff performance agreements: PA management plan implementation must be reflected as a staff performance key result area. Therefore, an inadequate management plan combined with poorly articulated staff performance targets may lead to deficiencies in PA management implementation, rendering any management intervention ineffective. In addition, compliance indicator improvement suggests false improvement in METT Score because these indicators simply indicate the existence of a plan, register or policy (Table S2.6).

The management element ‘Planning’ (Hockings, 2003) and the IUCN component of successful nature conservation ‘Sound design and planning’ (IUCN & WCPA, 2017) accounted for 72% and 66% of variation in METT-SA scores respectively, while the indicator ‘management plan’ accounted for 57% of the variation. Based on the hypothesis that action is linked to outcome (Cook, Hockings & Carter, 2010) the assumption that management effectiveness would improve following the application of a decision support framework, remains partly unanswered. Notably, the scope of this study did not include the degree to which plans drafted using the Conservation Standards were implemented. Additionally, the time between these approved plans and PAME assessment was less than four years, noting that there may not have been sufficient time for conservation outcomes to realise due to limited implementation time. Unless pertinent questions are asked about information that informs planning (Geldmann *et al*., 2021) and theories of change (Salafsky *et al*., 2022), and management plan implementation is assessed against PA objectives (Hockings, Leverington & Cook, 2015; Geldmann *et al*., 2021), compliance with the METT-SA ‘planning’ management element and the ‘management plan’ indicator is unlikely to give a true reflection of effectiveness or enable effectiveness since the indicator measures progress towards the existence of a plan.

Following adaptive management logic, understanding context and through planning, learning and review, the required management inputs, processes and outputs should eventually achieve outcomes based on the WCPA framework for PA management (Hockings, 2003; Hockings *et al*., 2006; Hockings, Leverington & Cook, 2015). This is only possible with sound planning, resourcing, implementation and governance. It is critical to draft PA management plans that contain explicit assumptions based on evidence and/or documenting evidence requirements during planning, implementation and management effectiveness assessment (Ervin, 2003a; Parrish, Braun & Unnasch, 2003; Kingsford & Biggs, 2012). Geldmann *et al*. (2021) propose that management indicators capture key aspects of management planning such as identified PA values, threats, and implementation tracking to improve outcomes.

2.5 Conclusion

PAME tools such as the METT-SA are necessary and useful to establish the foundation and ingredients for PA management. The tool, with its management elements following adaptive management theory, does not prompt adaptive management, but rather the ticking of a box deemed most applicable at the time of the assessment. Due to the statutory environment in which assessments occur, managers risk their decisions and actions being directed by indicators contained in the tool rather than planning and managing PAs adaptively in accordance with their unique contexts. Pursuing indicator compliance may come at the cost of sound PA management planning and implementation, monitoring and evaluation.

The study is inconclusive about the influence of the Conservation Standards on improved management effectiveness assessment results. The METT-SA is not sensitive to the quality of planning and neither should it be. The significant difference in scores between assessments before and after application of the decision support framework was attributed to time and the Planning management element, but the METT-SA considers only progress towards the existence of a PA management plan and associated planning tools rather than assessing the quality of a management plan or the process followed in drafting the plan. As such, METT-SA results may mask pitfalls associated with the management plan, such as misaligned strategies and subsequent misappropriation of resources, a strategy formulation concern highlighted by Parrish, Braun & Unnasch (2003) and Salzer & Salafsky (2006). The real benefit or utility of the Conservation Standards for improved PAME due to improved planning, may only become evident following a longer management plan implementation period and evaluation of progress towards PA management objectives and the condition of PA values. A future research avenue may for a particular PA measure trends in PAME and test the logic between PA management intent (PA vision, values, goals, threats and strategies), implementation (annual operational plans) and monitoring (monitoring plans) followed by the measurement of conservation outcomes.

The METT-SA results highlighted administrative and process gaps but did not drive a positive conservation outcome. Understanding PA context, planning, providing inputs and delivering outputs

improves METT-SA scores, but improved scores obscure the potential flaws in planning that render the strategy ineffective in mitigating threats and achieving positive conservation outcomes. The METT-SA contains only three outcome indicators specifically related to biodiversity and one outcome indicator specifically related to socio-economic aspects, so is unlikely to capture the complexity of ecological condition assessment. PA management authorities should adopt the four Components of successful nature conservation in PAs as conceptual foundation for PA management (IUCN & WCPA, 2017). The METT-SA can be distilled to ask only critical questions associated with planning, resourcing and governance. Progress towards the maintenance and restoration of PA values and achievement of PA goals should be the only measure of PA or conservation effectiveness.

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Supplementary Material:

Table S2.1. Years between protected area management effectiveness assessments using the Management Effectiveness Tracking Tool – South Africa (METT-SA) before and after application of a decision support tool. The average duration between assessments was seven years, apart from the Hexrivier Complex.

Protected Area Complex	**Year of Assessment (Before)**	**Year of Assessment (After)**
Knersvlakte Nature Reserve (NR)	2015	2022
Still Bay Marine Protected Area (MPA)	2015	2022
Waterval NR Complex	2015	2022
Grootwinterhoek NR Complex	2015	2022
De Mond NR Complex	2015	2022
De Hoop MPA	2015	2022
Rocherpan NR Complex	2015	2022
Hexrivier NR Complex	2018	2022
Brenton Blue Butterfly NR	2015	2022
Goukamma MPA	2015	2022
Anysberg NR	2015	2022
Cederberg NR Complex	2015	2022
Vrolijkheid NR Complex	2015	2022
Island and Rocks Complex	2015	2022
Penguin (Bird) Island NR Complex	2015	2022
Dassen Island NR	2015	2022
Riverlands NR Complex	2015	2022
Marloth NR Complex	2015	2022
Swartberg NR Complex	2015	2022
Betties Bay MPA	2015	2022
Goukamma NR Complex	2015	2022
Kammanassie NR	2015	2022
Grootvadersbosch NR Complex	2015	2022
Kogelberg NR Complex	2015	2022

Protected Area Complex	Year of Assessment (Before)	Year of Assessment (After)
Outeniqua NR Complex	2015	2022
Walker Bay NR Complex	2015	2022
Robberg MPA	2015	2022
Keurbooms River NR	2015	2022
De Hoop NR Complex	2015	2022
Dyer Island NR Complex	2015	2022
Robberg NR Complex	2015	2022
Geelkrans NR Complex	2015	2022
Gamkaberg NR Complex	2015	2022
Salmonsdam NR	2015	2022
Driftsands NR	2015	2022
Babilonstoring NR Complex	2015	2022
Hottentots Holland NR Complex	2015	2022
Limietberg NR Complex	2015	2022

Table S2.2. Evaluation of Management Effectiveness Tracking Tool – South Africa (METT-SA) datasets to establish appropriate timeframe for comparative analysis and selection METT-SA datasets to serve as 'before assessment'. Criteria for dataset selection included consistency in METT-SA management elements (e.g. the 'outcomes' element was introduced in a later version of METT-SA), the presence/absence of and wording of indicators, and detail of the criteria per indicator rating scale. The evaluation was applied to METT-SA datasets from 2011 to 2022.

Aspect	Method	Answer (Y/N)
1. Can I use 2011 METT-SA data? 2. Can I crosswalk indicators and associated indicator criteria to later versions of METT-SA and use all/some indicators to measure rate of change? (NOTE: METT-SA Version 1 applied for this assessment period)	1. Indicators were reviewed against indicators of METT-SA versions 2, 3 and 3a and the web-based tool. 2. Indicator criteria semantics were reviewed against METT-SA versions 2, 3 and 3a and the web-based tool 3. This was done to determine which year of assessment can be considered the 'first	1. METT-SA assesses five elements of management (i.e. 'Outcomes' is not listed). 2. There are specific indicators that could be cross walked but for those that could be cross-walked, indicator criteria semantics in essence ask the same question although semantics will solicit varying ratings, leading to a false impression of rate of change. 3. Some indicators amended from 'supplementary' and

Aspect	Method	Answer (Y/N)
	assessment' to determine change over time against the 'last assessment' (which used the web-based tool)	scored out of '1' to indicators with criteria scored out of '3', and vice versa, e.g. PA regulations/internal rules. 4. Some indicators add criteria within a criterion and disaggregate these into an additional indicator scored out of '1'. E.g. Boundary demarcation semantics amended to include boundary deviation, which was later split into two indicators, with a specific indicator for boundary deviation scored out of '1' (Boundary deviations). NO, cannot use dataset.
4. Can I use 2012, 2013, 2014 METT-SA data? 5. Can I crosswalk indicators and associated indicator criteria to later versions of METT-SA and use all/some indicators to measure rate of change? (NOTE: METT-SA Version 2 applied for these assessment periods)		1. METT-SA now assesses six elements of management (Outcomes introduced). 2. There are specific indicators that could be cross walked but for those that could be cross-walked, indicator criteria semantics are too dissimilar (wording, intention, comparability), leading to a false impression of rate of change. 3. Several indicators are disaggregated into additional indicators. NO, cannot use dataset.
6. Can I use 2015 METT-SA data? 7. Can I crosswalk indicators and associated indicator criteria to later versions of METT-SA and use all/some indicators to measure rate of change? (NOTE: METT-SA Version 3 applied for these assessment periods) (NOTE: Standard Operating Guideline (SOG) to facilitate		1. METT-SA assesses six elements of management. 2. Indicators are aligned in terms of rating out of '3' or '1'. 3. Minimal indicator semantics amendments exist, e.g. introduction of logical words such as 'Protected Area' internal rules. The intention remains the same, it is unlikely that rate of change will be influenced. 4. Indicator criteria semantics are tightened in the Web-based tool, intention remains the

Aspect	Method	Answer (Y/N)
standardised interpretation was in progress at this time, however, a stringent moderation across the organisation was implemented to improve credibility, consistency in indicator interpretation and ratings assigned)		same, unlikely that rate of change will be influenced. 5. Indicator 'Heritage knowledge' (out of '3') criteria changed. *Excluded, not comparable*. 6. Indicator 'Conservation Development Framework (CDF)' (out of '1') criteria changed. *Excluded, not comparable*. 7. Indicator 'Biodiversity management plan for heritage sites with biodiversity values' (out of '1') is not applicable to CapeNature protected areas. *Excluded, not comparable.* 8. Indicator 'Management Plans for Significant Heritage Assets' (out of '3') criteria changed. *Excluded, not comparable*. 9. Indicator 'Budget management' (out of '1') criteria changed. *Excluded, not comparable*. 10. Indicator 'Community Partners' (out of '1') is not applicable to CapeNature protected areas. *Excluded*. 11. Indicator 'Community Support' (out of '3') criteria changed. *Excluded, not comparable*. 12. Indicator 'Economic and Social Benefit Assessment' (out of '3') criteria changed. *Excluded, not comparable*. 13. Indicator 'Sustainable extractive use' (out of '1') criteria changed. *Excluded, not comparable*. YES, dataset can be used. Nine indicators excluded. 61 indicators remain for analysis

Table S2.3. Management Effectiveness Tracking Tool - South Africa (METT-SA) indicators grouped for analysis according to the IUCN World Commission on Protected Areas (WCPA) *Components of successful conservation* advocated by the IUCN Green List Standard for protected and conserved areas (IUCN & WCPA, 2017).

WCPA Management Element	Indicator ID	Indicator	Questions		Component of successful nature conservation
CONTEXT	1.1	Legal status	0	The site has no secure permanent conservation/ heritage legal status in terms of relevant legislation	Governance
			1	Some but not all properties managed as part of the site have been declared.	
			2	All properties managed as part of the site have been declared but not all title deeds have been endorsed yet.	
			3	All properties managed as part of the site have been declared and all title deeds have been endorsed	
	1.2	Protected Area Internal Rules Have internal rules for controlling use and activities in the site been gazetted	0	No	Governance
			1	Yes	
	1.3	Protected Area Boundary Demarcation	0	The boundary of the site is not known by the management authority or local residents/neighbouring land users.	Governance
			1	The boundary of the site is known by the management authority, but as it is not appropriately demarcated it is not known by local residents/neighbouring land users.	
			2	The boundary of the site is known by the management authority and demarcated to the extent that it is known by local residents/neighbouring land users.	

WCPA Management Element	Indicator ID	Indicator	Questions		Component of successful nature conservation
			3	The boundary of the site is known by the management authority, fully demarcated and is thus known by the local residents/neighbouring land users and the public	
	1.3.1	Boundary Deviations Have all boundary deviations been recorded in a legally binding document	0	No.	Governance
			1	Yes.	
	1.3.2	Servitude Register Has a register of all servitudes and the conditions relating thereto has been compiled	0	No.	Governance
			1	Yes.	
	1.4	Biodiversity Knowledge and Understanding	0	No information is available on key species, habitats, ecosystems and invasive species of the site to inform management of biodiversity objectives.	Design and planning
			1	Information on key species, habitats, ecosystems and invasive species of the site is not sufficient to support the achievement of biodiversity objectives.	
			2	Information and the understanding thereof concerning key species, habitats, ecosystems and invasive species of the site is sufficient to support the achievement of biodiversity objectives, but additional information is in the process of being compiled.	
			3	Information and the understanding thereof concerning key species, habitats, ecosystems and invasive species of the site as compiled by scientific services supports the achievement of all biodiversity objectives.	
	1.5		0	No heritage survey has been undertaken.	*Excluded*

WCPA Management Element	Indicator ID	Indicator	Questions		Component of successful nature conservation
		Cultural Heritage Knowledge	1	An informal heritage survey has identified heritage assets, but further investigation by a team supported by SAHRA or the relevant heritage authority is required.	
			2	A formal heritage survey has inventorised heritage assets but they have not been listed on SAHRIS.	
			3	A formal heritage survey undertaken by a team in collaboration with communities and stakeholders has inventoried heritage assets, listed assets on SAHRIS and incorporated management requirements into the integrated management plan	
	1.5.1	Format of Data Is all data for 1.4 and 1.5 in a readily accessible and understandable format facilitating decision making by the site manager?	0	No	Management
			1	Yes	
	1.6	Risk Assessment Has a full risk or similar assessment, covering inter alia biodiversity, financial management, human resources, tourism, pressures and threats been undertaken for the site, within the time period required by the organisation, been conducted	0	No	Design and planning
			1	Yes	

WCPA Management Element	Indicator ID	Indicator	Questions		Component of successful nature conservation
PLANNING	2.1	Protected Area Design	0	Inadequacies in design mean that achieving major conservation objectives is not possible.	Design and planning
			1	Although there are inadequacies in the design, these inadequacies have been addressed by setting objectives accordingly, but more still needs to be done.	
			2	To a large extent, mitigating measures compensate for inadequacies in size and shape so that conservation objectives can be met.	
			3	The size and shape of the site is adequate in design to fully achieve the conservation objectives	
	2.1.1	Protected Area Expansion Plan Has a site expansion plan been set out in line with the expansion strategy of the organisation	0	No	Design and planning
			1	Yes	
	2.1.2	Delineation of a Zone of Influence	0	No zone of influence has been established.	Governance
			1	No zone of influence has been established, but the desktop delineation is complete and compatible land uses have been identified.	
			2	The zone of influence has been clearly delineated and discussions have been held with neighbouring landowners and have been documented.	
			3	The zone of influence and applicable buffering mechanisms have been clearly defined and guidelines for suitable land uses have been provided to be discussed between site management and neighbouring land owners for input into the municipal IDP, catchment and river plans.	

WCPA Management Element	Indicator ID	Indicator	Questions		Component of successful nature conservation
	2.1.3	Corridor Management Is there a plan for the management of corridors linking the site to key habitats outside of the site thereby mitigating fragmentation	0	No	Design and planning
			1	Yes	
	2.2	Management Plan	0	There is no management plan with measureable objectives for the site.	Management
			1	A management plan with measureable objectives is being prepared or has been prepared.	
			2	An updated management plan with measureable objectives approved by the Minister/MEC (as applicable) exists.	
			3	An updated, integrated management plan with measurable objectives and covering all aspects of site management (see insert) is approved by the Minister/MEC (as applicable)	
	2.2.1	Conservation Development Framework (CDF) Has a zoning system based on a sensitivity analysis indicating visitor use zones, and positioning and nature of operational and visitor infrastructure been compiled and included	0	No	*Excluded*
			1	Yes	

WCPA Management Element	Indicator ID	Indicator	Questions		Component of successful nature conservation
		into the Integrated Management Plan			
	2.3	Education, Awareness and Interpretation Programme	0	No education, awareness and interpretation programme is in place at site level.	Design and planning
			1	An education, awareness and interpretation programme for the site exists but is not yet approved or has not been updated.	
			2	There is an approved and updated education, awareness and interpretation programme for the site.	
			3	There is an approved and updated education, awareness and interpretation programme for the site and it is fully integrated into the management plan	
	2.4	Management Plans for Significant Cultural Heritage Assets	0	There is no heritage management plan.	*Excluded*
			1	The compilation of the heritage management plan has commenced.	
			2	The heritage management plan has been drafted by a team approved by the relevant heritage authority but has as yet not been approved by the relevant heritage authority.	
			3	The heritage management plan has been drawn up by a heritage practitioner and has been approved by the relevant heritage authority	
	2.5	Biodiversity Management Plan for Cultural Heritage Sites with Biodiversity	0	No	*Excluded*

WCPA Management Element	Indicator ID	Indicator	Questions		Component of successful nature conservation
		Value Is there a comprehensive plan dealing with all aspects of biodiversity?	1	Yes	
	2.6	Restoration of Degraded Areas Has a plan for the rehabilitation of areas of degraded biodiversity in the site has been compiled	0	No	Design and planning
			1	Yes	
	2.7	Collections Management / Curatorship of Heritage Artefacts Is there a collections management plan that makes adequate provision for curatorship, repository and management of fossils and artefacts	0	No	Management
			1	Yes	
INPUTS	3.1	Management Research Programme	0	Research needs have not been identified nor is any management focussed research work taking place.	Governance
			1	Research needs have been identified, but current research is not relevant to achieving the management objectives.	
			2	Research needs have been identified, but only critical management objective orientated research is being done.	

WCPA Management Element	Indicator ID	Indicator	Questions		Component of successful nature conservation
			3	Research needs have been identified and projects relevant to all management needs are being undertaken, enabling the monitoring of results of management actions against set objectives.	
	3.1.1	Monitoring & Evaluation Programme	0	Monitoring needs have not been identified, nor is any monitoring work taking place.	Governance
			1	Monitoring needs have been identified, but other than for ad hoc observation, no monitoring is carried out.	
			2	Monitoring needs have been identified, but only monitoring of critical management objectives is being done.	
			3	There is an established monitoring and evaluation programme which is fully implemented with site management participation and is used to guide adaptive management.	
	3.1.2	Relationship with Researchers Is there a sound established working relationship and regular liaison with researchers that leads to research results feeding into management decisions?	0	No.	Management
			1	Yes.	
	3.2	Human Resource Capacity	0	There is no human resource capacity.	Management
			1	There is an approved staff organogram but human resource capacity is not sufficient i.e. organogram is not sufficient or some posts are unfunded or vacant.	

WCPA Management Element	Indicator ID	Indicator	Questions		Component of successful nature conservation
			2	The approved organogram reflects the actual needs of management for achieving only critical management objectives and the human resource capacity meets the approved levels.	
			3	The approved organogram reflects the actual needs of management for effectively achieving all management objectives and the human resource capacity meets the approved levels.	
	3.3	Adequacy of Operational Budget	0	There is no operational budget for the site or no budget directly allocated to it.	Management
			1	The allocated operational budget is inadequate.	
			2	There is a budget for regular operations, but many innovations and initiatives are reliant on external funding.	
			3	The available budget is sufficient and meets the full management needs of the site without external funding.	
	3.4	Security of Operational Budget	0	There is no secure operational budget.	Management
			1	There is an operational budget, but it is only available on an ad hoc basis or the budget is not specific to the site which must depend on an allocation of funds from a centralised budget.	
			2	An operational budget, specific to the site, is secure and guaranteed on an annual cycle.	
			3	An operational budget, specific to the site, is secure and is guaranteed on a 3-5 year cycle.	
	3.4.1	Capital Budget Has adequate capital budget for replacing operational equipment,	0	No	Management
			1	Yes	

WCPA Management Element	Indicator ID	Indicator	Questions	Component of successful nature conservation
		infrastructure and vehicles been provided?		
	3.4.2	Budget Management Is the budget effectively managed to meet critical management needs in accordance with the annual plan of operations (APO)?	0 No 1 Yes	*Excluded*
	3.4.3	Delegation of Management of Budget Is the site manager responsible and accountable for budget management?	0 No 1 Yes	Management
	3.5	Income	0 Although fees are theoretically applied, there is no collection. 1 Income is derived, but it goes to a budget outside the organisation and is not used for site management. 2 Income is derived, but it goes to a central budget within the organisation and is not directly used for the management of the site 3 Income is retained within the organisation and is used solely for site management.	Management
	3.5.1	Fund Raising Are there skills and capacity in the organisation to raise external sources of	0 No 1 Yes	Management

WCPA Management Element	Indicator ID	Indicator	Questions		Component of successful nature conservation
		funding for specific projects?			
	3.6	Law Enforcement Capacity & Capability	0	There is no capacity/resources/support to enforce (arrest & prosecute) rules/regulations.	Management
			1	There are major deficiencies in capacity/resources/support to enforce internal rules/regulations (e.g. lack of skills, no patrol budget).	
			2	The capacity/resources/support to enforce rules/regulations are acceptable, but some deficiencies are evident.	
			3	The capacity/resources/support to enforce rules/regulations are excellent.	
	3.7	Adequacy of Operational Equipment	0	There is no operational equipment for management needs.	Management
			1	Operational equipment is inadequate for management needs.	
			2	Operational equipment is adequate for current management needs.	
			3	Operational equipment is optimal for current and future anticipated management needs	
	3.7.1	Adequacy of Operational Infrastructure	0	There is no operational infrastructure for management needs.	Management
			1	Operational infrastructure is inadequate for management needs.	
			2	Operational infrastructure is adequate for current management needs.	
			3	Operational infrastructure is optimal for current and future anticipated management needs	

WCPA Management Element	Indicator ID	Indicator	Questions		Component of successful nature conservation
	3.8	Adequacy of Tourism Infrastructure	0	There is no tourism infrastructure despite the identified need.	Management
			1	Tourism infrastructure is inadequate to manage the current volume of visitors.	
			2	Tourism infrastructure is adequate to manage the current volume of visitors.	
			3	Tourism infrastructure is optimal to manage the current and anticipated future volume of visitors.	
	3.8.1	Tourism Grading Accommodation has been accredited with a recognised tourism grading standard.	0	No	Management
			1	Yes	
	3.9	Adequacy of Transport Fleet	0	There is no fleet available despite the identified need.	Management
			1	Vehicles are available but the number and/or type are unsuitable and inadequate for management needs.	
			2	There are sufficient suitable vehicles available to carry out critical management activities.	
			3	The fleet is totally appropriate and sufficient for all management needs	
	3.1	Health and Safety Has an audit certified that site management complies with and implements the Occupational Health and Safety Act?	0	No	Management
			1	Yes	
	3.11		0	No	Management

WCPA Management Element	Indicator ID	Indicator	Questions		Component of successful nature conservation
		Staff Housing Is there a policy with standards for staff housing?	1	Yes	
PROCESS	4.1	Annual Plan of Operation (APO)	0	No approved/standardised APO exists.	Management
			1	An APO exists but activities are not linked the to the management plan targets for the site.	
			2	An APO exists and actions are linked to the management plan targets for the site.	
			3	An approved APO exists and actions are linked to the management plan targets for the site	
	4.2	Standard Operating Procedures	0	There are no standard operating procedures.	Management
			1	Some standard operating procedures are in place and are being implemented.	
			2	Standard operating procedures pertaining to critical management activities are in place and are being implemented and updated. Other procedures are being designed.	
			3	Relevant standard operating procedures pertaining to all management activities are in place and are regularly updated to ensure best practice	
	4.3	HR Management Systems	0	There are no HR management and staff development systems.	Management
			1	HR management and staff development systems are poor and constrain effectiveness.	
			2	HR management and staff development systems are adequate and contribute to management effectiveness.	
			3	HR management and staff development systems are excellent and fully support management effectiveness.	

WCPA Management Element	Indicator ID	Indicator	Questions		Component of successful nature conservation
	4.4	Administrative Support Systems	0	There are no administrative support systems.	Management
			1	Administrative support systems are poor and constrain effectiveness.	
			2	Administrative support systems are adequate and contribute to management effectiveness.	
			3	Administrative support systems are excellent and fully support management effectiveness.	
	4.5	Information Technology Systems	0	Information technology systems are not in place and this significantly undermines management effectiveness.	Management
			1	Information technology systems are poor and limit management effectiveness.	
			2	Information technology systems are adequate and contribute to management effectiveness.	
			3	Information technology systems are excellent and fully support management effectiveness. All electronic data are backed up on a routine basis, stored according to organisational standards and are easy to access.	
	4.6	Maintenance of Operational Equipment	0	No maintenance of operational equipment is taking place.	Management
			1	There is no maintenance schedule, but ad hoc maintenance is taking place.	
			2	There is a maintenance schedule and all critical operational equipment is being maintained and meeting set standards.	
			3	There is a maintenance schedule and all operational equipment is being maintained and meeting the set standards	
	4.6.1		0	No operational infrastructure maintenance is taking place.	Management

WCPA Management Element	Indicator ID	Indicator	Questions		Component of successful nature conservation
		Maintenance of Operational Infrastructure	1	There is no maintenance schedule, but some ad hoc maintenance is taking place.	
			2	There is a maintenance schedule and all critical operational infrastructure is being maintained and meeting set standards.	
			3	There is a maintenance schedule and all operational infrastructure is being maintained and meeting the set standards.	
	4.6.2	Maintenance of Transport Fleet	0	There is no maintenance taking place.	Management
			1	There is a no maintenance schedule, but ad hoc maintenance is taking place.	
			2	There is a maintenance schedule and all critical assets of the transport fleet are being maintained and meeting set standards.	
			3	There is a maintenance schedule and the entire transport fleet is being maintained and meeting the set standards.	
	4.7	Maintenance of Tourism Infrastructure	0	There is no maintenance or upgrading of tourism infrastructure taking place.	Management
			1	There is no maintenance schedule, but ad hoc maintenance is taking place.	
			2	There is a maintenance schedule and all critical tourism infrastructure is being maintained and meeting set standards.	
			3	There is a maintenance schedule and all tourism infrastructure is being maintained and meeting the set standards.	
	4.8	Insurance Are operational	0	No	Management

WCPA Management Element	Indicator ID	Indicator	Questions		Component of successful nature conservation
		equipment, infrastructure and vehicles covered by adequate insurance?	1	Yes	
	4.9	Implementation of Education, Awareness and Interpretation Programme	0	There is no education, awareness and interpretation taking place.	Management
			1	There is limited ad hoc implementation of the education, awareness and interpretation programme.	
			2	The education, awareness and interpretation programme is being implemented.	
			3	The education, awareness and interpretation programme is fully linked to the objectives and needs of the site and is being fully implemented.	
	4.10	Public Relations and Communication Programme	0	There is no public relations and communication programme.	Governance
			1	There is some ad hoc public relations and communication.	
			2	There is a formal public relations and communication programme.	
			3	There is a wide ranging multi media public relations and communication programme keeping the general public and internal role players informed of important aspects of the site.	
	4.11	Community Liaison Structure Is there a functioning and formalised community liaison structure of local representatives and	0	No	Governance
			1	Yes	

WCPA Management Element	Indicator ID	Indicator	Questions	Component of successful nature conservation
		specialists that provides input to site management?		
	4.12	Sustainable Extractive Use Have standard operating procedures been set for the sustainable extractive use of biotic and abiotic resources	0 No 1 Yes	*Excluded*
	4.13	Management of Hazardous Substances Is a formal legally compliant programme with functional infrastructure for the management of hazardous substances (flammable and non-flammable) in place?	0 No 1 Yes	Management
	4.14	Community Partners Is there is a formal representative structure for community partners to participate in decision making according to a legally binding co-management agreement?	0 No 1 Yes	*Excluded*

WCPA Management Element	Indicator ID	Indicator	Questions		Component of successful nature conservation
	4.15	Commercial Tourism Is there appropiate interaction and co-operation between managers and tourism operators/concessionaires to enhance visitor experiences, protect values and resolve conflicts?	0	No	Governance
			1	Yes	
	4.16	Environmentally Responsible Practice	0	There are no environmentally responsible practices in place.	Design and planning
			1	Planning for instituting environmentally responsible practices has commenced.	
			2	Some environmentally responsible practices have commenced and plans exist to implement all aspects of environmentally responsible practice.	
			3	The site has been accredited with a recognised green standard.	
OUTPUTS	5.1	Tourism Infrastructure	0	Visitor impacts are resulting in severe degradation of the environment leading to loss of biodiversity.	Management
			1	Visitor impacts are not mitigated by the design of the tourism infrastructure which could result in degradation of the environment.	
			2	Visitor impacts which could result from current levels of visitation are fully mitigated by the design of the tourism infrastructure.	

WCPA Management Element	Indicator ID	Indicator	Questions		Component of successful nature conservation
			3	Visitor impacts which could result from current and anticipated levels of visitation are fully mitigated by the design of the tourism infrastructure.	
	5.2	Functioning of Law Enforcement and Compliance Systems	0	There are no protection systems or mechanisms for controlling legitimate and illegitimate access or activities in the site.	Management
			1	Protection systems or mechanisms for controlling legitimate and illegitimate access or activities in the site exist, but they are inadequate or are not being implemented.	
			2	Protection systems or mechanisms for controlling current levels of legitimate and illegitimate access or activities in the site are being implemented and there is a level of success	
			3	Protection systems or mechanisms for controlling current and anticipated levels of legitimate and illegitimate access or activities in the site are fully implemented. The success has been verified by a relevant site integrity audit.	
	5.2.1	Integrated Compliance Plan Does the site have an integrated compliance plan?	0	No	Management
			1	Yes	
	5.3	Staff Development and Productivity	0	Staff lack the basic skills to effectively achieve their productivity targets or no productivity targets have been set.	Management

WCPA Management Element	Indicator ID	Indicator	Questions		Component of successful nature conservation
			1	Basic training has improved productivity and effectiveness, but further development is required to meet productivity targets as indicated in staff performance reviews.	
			2	Staff productivity is meeting productivity targets as indicated in staff performance reviews.	
			3	Staff are well skilled for their duties and staff productivity targets are often exceeded as indicated in staff performance reviews.	
	5.4	Linking of Management Plan to Key Performance Areas Is the implementation of the management plan linked to the key performance areas of the site manager?	0	No	Management
			1	Yes	
	5.5	Community Support	0	There is antagonism towards the site.	*Excluded*
			1	There is no antagonism towards the site, but little actual support or assistance.	
			2	Community members assist and support the site with some site management tasks, fundraising, and provision of information.	
			3	There are a wide range of projects supported by communtity members that assist and support site management and contribute significantly to increased site management effectiveness.	

WCPA Management Element	Indicator ID	Indicator	Questions		Component of successful nature conservation
OUTCOMES	6.1	Economic and Social Benefit Assessment	0	The impact of the site on the local or regional economy or provision of social benefits to communities has not been assessed.	*Excluded*
			1	The existence of the site has neither damaged nor benefited the local or regional economy, but has created some employment opportunities for communities.	
			2	An assessment has shown that there is some flow of broader economic and social benefits to local communities from the existence of the site.	
			3	A formal review/audit has shown that the site delivers quantifiable long term stimuli to the regional (and possibly the national) economy and delivers a broad range of long term quantifiable community benefits that improve the livelihood strategies and resilience in the lives of communities.	
	6.2	Achievement of Biodiversity Targets	0	Biodiversity targets have not been set.	Conservation outcomes
			1	Biodiversity targets have been set and are being partially met .	
			2	All critical biodiversity targets are being met or are on track to being met .	
			3	A structured and scientific biodiversity condition assessment as part of the monitoring programmes has shown that the management of biodiversity is meeting all set targets.	
	6.3	Ecological Processes	0	Ecological processes are not being maintained with the result that ecological integrity and biodiversity are being compromised.	Conservation outcomes

WCPA Management Element	Indicator ID	Indicator	Questions		Component of successful nature conservation
			1	Ecological processes are only partially maintained with some ecological integrity and biodiversity being compromised.	
			2	Ecological processes are being adequately maintained/augmented by process simulation. Biodiversity is not being compromised.	
			3	A scientifically based assessment has shown that ecological processes are being effectively maintained/augmented with the result that ecological integrity and biodiversity are not being compromised.	
	6.4	Ecosystem Services	0	Ecological processes and systems are not being maintained resulting in no ecosystem service benefits to the site and neighbouring land users/communities.	Conservation outcomes
			1	Ecological processes and systems are being partially maintained resulting in the provision of limited ecosystem service benefits to the site and neighbouring land users/communities.	
			2	Ecological processes and systems are being adequately maintained resulting in the provision of ecosystem service benefits to the site and neighbouring land users/communities.	
			3	A structured and scientific measurement and monitoring system has shown that ecological processes and systems are being effectively maintained resulting in the provision of ecosystem service benefits to the site and neighbouring land users/communities	
	6.5		0	Land use planning does not take into account the needs of the site and is detrimental to the site.	Design and planning

WCPA Management Element	Indicator ID	Indicator	Questions		Component of successful nature conservation
		Land Use Planning and Management Outside the Protected Area	1	Land use planning does not take the needs of the site into account, but it is not detrimental to the site.	
			2	Land use planning partially takes the long term needs of the site into account. There is some cooperation from industries such as agriculture, forestry and mining.	
			3	There is a bilateral relationship between any relevant biodiversity plan and/or the applicable aspects of the IDP of the local municipality and the planning and management of the site. There is formal agreement with industries within the zone of influence	
	6.6	Water Use Planning and Management Operations Influencing the Protected Area	0	Water use planning and the water needs in terms of quantity and quality are detrimental to the site.	Design and planning
			1	Water use management exercises in the buffer zone/planning domain do not provide the water needs of the site, but it is not detrimental to the site.	
			2	Water use planning and management partially takes into account the long term needs of the site.	
			3	Catchment and river plans and water management fully take the water needs of the site into account and the water quality meets required standards as set out by the relevant authority.	
	6.7	Cultural Heritage Condition Assessment	0	No heritage assessment has taken place.	Conservation outcomes
			1	Some heritage assets and values are being maintained as required in the management plan or heritage management plan.	

WCPA Management Element	Indicator ID	Indicator	Questions	Component of successful nature conservation
			2 Heritage assets and values are being are being managed as required in the management plan or heritage management plan.	
			3 A structured assessment conducted by an accredited heritage practitioner, has shown that the management of heritage assets and values are meeting the set management objectives.	

Table S2.4. The difference between assessments before (2015) and after (2022) the application of a decision support framework for indicators grouped as components of successful nature conservation, where df is the degrees of freedom, n is the sample size. In the conclusion column = shows no significant difference between before and after scores, significant increase (^) in last score and a significant decline (v) in the last score.

Component of Successful Nature Conservation	Statistic	df	*P* value	Conclusion
Paired T-tests				
METT-SA score (All)	-4.16	37	< 0.001	^
METT-SA score progressive indicators (PI)	-1.18	37	0.244	=
METT-SA score compliance indicators (CI)	-14.99	37	< 0.001	^
Sound Design and Planning progressive indicators (PI)	1.93	37	0.061	=
Effective Management progressive indicators (PI)	-3.72	37	< 0.001	^
Successful Conservation Outcomes progressive indicators (PI)	2.62	37	0.006	v
Wilcoxon paired test	Statistic	n	*P* value	Conclusion
Good Governance progressive indicators (PI)	328.50	38	0.226	=
Good Governance compliance indicators (CI)	58.00	38	0.019	^
Sound Design and Planning compliance indicators (CI)	20.00	38	0.821	=
Effective Management compliance indicators (CI)	25.00	38	< 0.001	^

Table S2.5. Results for the paired t-tests and the Wilcoxon test for paired samples to test the significance between assessments before (2015) and after (2022) the application of a decision support framework, where df is the degrees of freedom. In the conclusion column = shows no significant difference between assessment scores, significant increase (^) in last score and a significant decline (v) in the last score.

Management Element	Statistic	df	p.value	Conclusion
Paired T-tests				

Management Element	Statistic	df	p.value	Conclusion
Planning (All)	1.22	37	0.231	=
Inputs (All)	-8.50	37	< 0.001	^
Inputs progressive indicators (PI)	-3.22	37	0.001	^
Process (All)	0.76	37	0.450	=
Process progressive indicators (PI)	0.87	37	0.195	=
Outcomes (All)	3.56	37	0.001	v
Outcomes progressive indicators (PI)	3.56	37	0.001	v
Wilcoxon paired test	Statistic	n	p.value	Conclusion
Context (All)	106.0	38	0.318	=
Context progressive indicators (PI)	203.0	38	0.730	=
Context compliance indicators (CI)	7.0	38	0.001	^
Planning progressive indicators (PI)	318.5	38	0.621	=
Planning compliance indicators (CI)	614.5	38	< 0.001	v
Inputs compliance indicators (CI)	3.0	38	< 0.001	^
Process compliance indicators (CI)	111.0	38	0.882	=
Outputs (All)	72.5	38	< 0.001	^
Outputs progressive indicators (PI)	58.0	38	0.223	=
Outputs compliance indicators (CI)	29.0	38	< 0.001	^
Outcomes compliance indicators (CI)	-	-	-	

Table S2.6. Change in the 22 compliance indicators (CI) between assessments undertaken before (2015) and after (2022) application of a decision support tool.

Compliance Indicator (CI)	Score (%) Before	Score (%) After
1.2 Protected Area Internal Rules	100	100

Compliance Indicator (CI)	Score (%) Before	Score (%) After
1.3.1 Boundary Deviations	N/A	94
1.3.2 Servitude Register	60	96
1.5.1 Format of Data	97	100
1.6 Risk Assessment	95	97
2.1.1 Protected Area Expansion Plan	97	100
2.1.3 Corridor Management	97	100
2.6 Restoration of Degraded Areas	94	94
2.7 Collections Management / Curatorship of Heritage Artefacts	100	94
3.1.2 Relationship with Researchers	100	100
3.4.1 Capital Budget	5	66
3.4.3 Delegation of Management of Budget	97	100
3.5.1 Fund Raising	100	100
3.8.1 Tourism Grading	13	13
3.1 Health and Safety	0	63
3.11 Staff Housing	3	100
4.8 Insurance	100	100
4.11 Community Liaison Structure	84	89
4.13 Management of Hazardous Substances	87	94
4.15 Commercial Tourism	80	94
5.2.1 Integrated Compliance Plan	21	100
5.4 Linking of Management Plan to Key Performance Areas	95	97

Table S2.7. Change in the 39 progression indicators (PI) between assessments undertaken before (2015) and after (2022) application of a decision support tool.

Progression Indicator (PI)	Score (%) Before	Score (%) After
1.1 Legal status	78	64
1.3 Protected Area Boundary Demarcation	72	80
1.4 Biodiversity Knowledge and Understanding	80	83
2.1 Protected Area Design	73	72

Progression Indicator (PI)	Score (%) Before	Score (%) After
2.1.2 Delineation of a Zone of Influence	53	46
2.2 Management Plan	46	75
2.3 Education, Awareness and Interpretation Programme	73	64
3.1 Management Research Programme	68	68
3.1.1 Monitoring & Evaluation Programme	84	80
3.2 Human Resource Capacity	54	63
3.3 Adequacy of Operational Budget	33	64
3.4 Security of Operational Budget	86	98
3.5 Income	67	67
3.6 Law Enforcement Capacity & Capability	54	61
3.7 Adequacy of Operational Equipment	66	68
3.7.1 Adequacy of Operational Infrastructure	72	62
3.8 Adequacy of Tourism Infrastructure	79	65
3.9 Adequacy of Transport Fleet	61	67
4.1 Annual Plan of Operation (APO)	96	97
4.2 Standard Operating Procedures	68	67
4.3 HR Management Systems	55	67
4.4 Administrative Support Systems	77	72
4.5 Information Technology Systems	67	67
4.6 Maintenance of Operational Equipment	73	81
4.6.1 Maintenance of Operational Infrastructure	73	74
4.6.2 Maintenance of Transport Fleet	98	99
4.7 Maintenance of Tourism Infrastructure	78	83
4.9 Implementation of Education, Awareness and Interpretation Programme	66	41
4.10 Public Relations and Communication Programme	96	100
4.16 Environmentally Responsible Practice	62	61
5.1 Tourism Infrastructure	73	77
5.2 Functioning of Law Enforcement and Compliance Systems	56	64
5.3 Staff Development and Productivity	71	68

Progression Indicator (PI)	Score (%) Before	Score (%) After
6.2 Achievement of Biodiversity Targets	57	60
6.3 Ecological Processes	66	48
6.4 Ecosystem Services	69	60
6.5 Land Use Planning and Management Outside the Protected Area	71	66
6.6 Water Use Planning and Management Operations Influencing the Protected Area	63	62
6.7 Cultural Heritage Condition Assessment	28	32

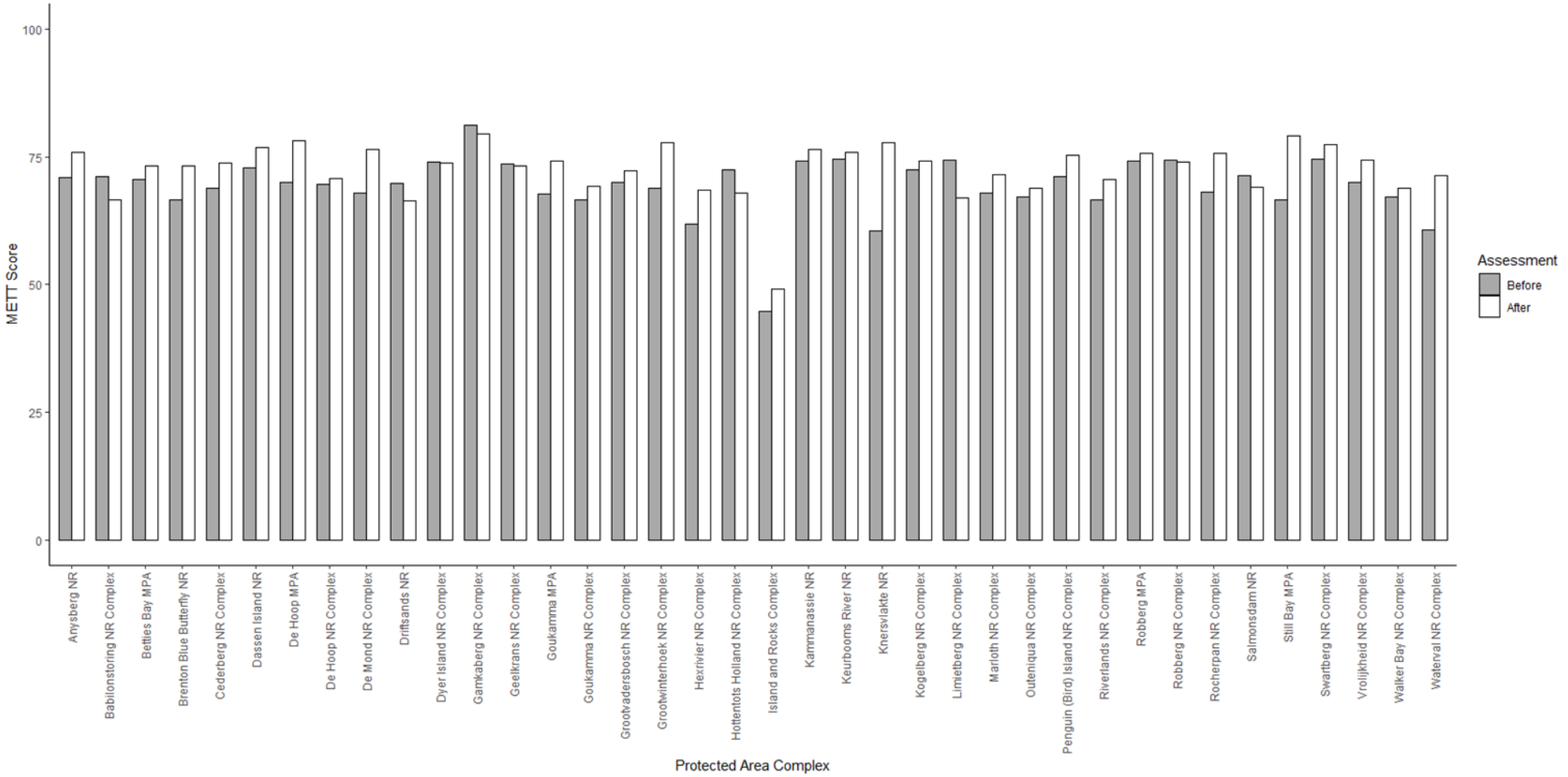

Figure S2.1 An overview of Management Effectiveness Tracking Tool – South Africa (METT-SA) Score per protected area complex for assessments undertaken before (2015) and after (2022) the application of a decision support framework.

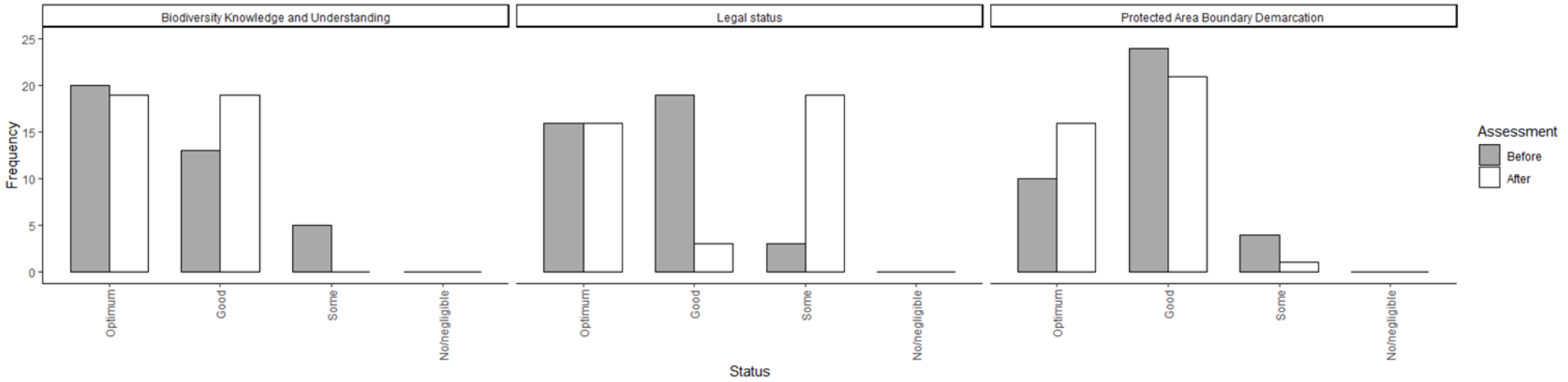

Figure S2.2 A comparison of the frequency for progressive indicators (PI) in the 'Context' management element before (2015) and after (2022) application of a decision support framework. 'Optimum' reflects indicators that are approaching optimum status, 'Good' reflects indicators that show good progress but there is room for improvement, 'Some' reflects indicators where there has been some progress and 'No/negligible' reflects indicators where there has been no or negligible progress.

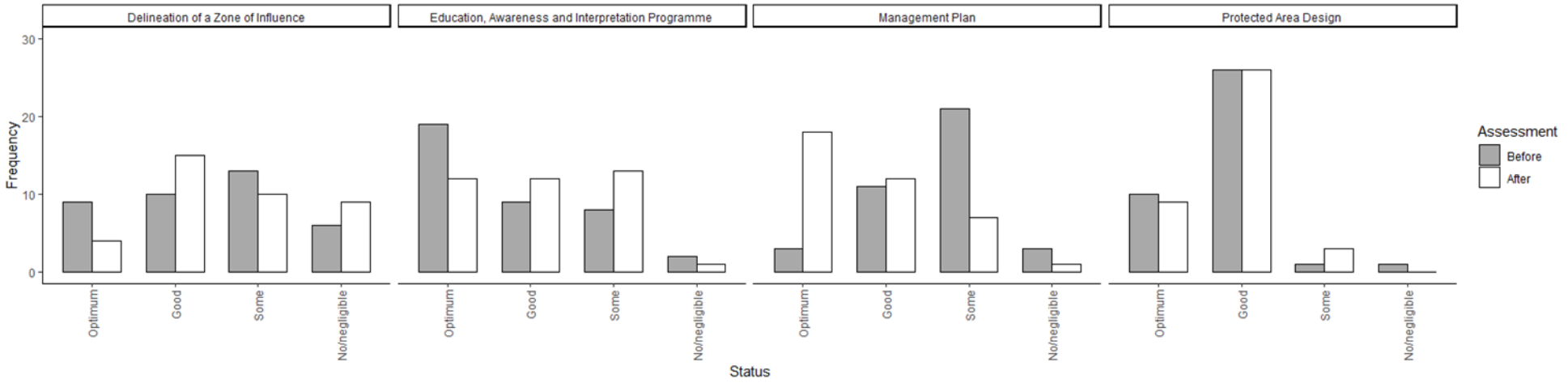

Figure S2.3 A comparison of the frequency for progressive indicators (PI) in the 'Planning' management element before (2015) and after (2022) application of a decision support framework. 'Optimum' reflects indicators that are approaching optimum status, 'Good' reflects indicators that have had good progress but there is room for improvement, 'Some' reflects indicators where there has been some progress and 'No/negligible' reflects indicators where there has been no or negligible progress.

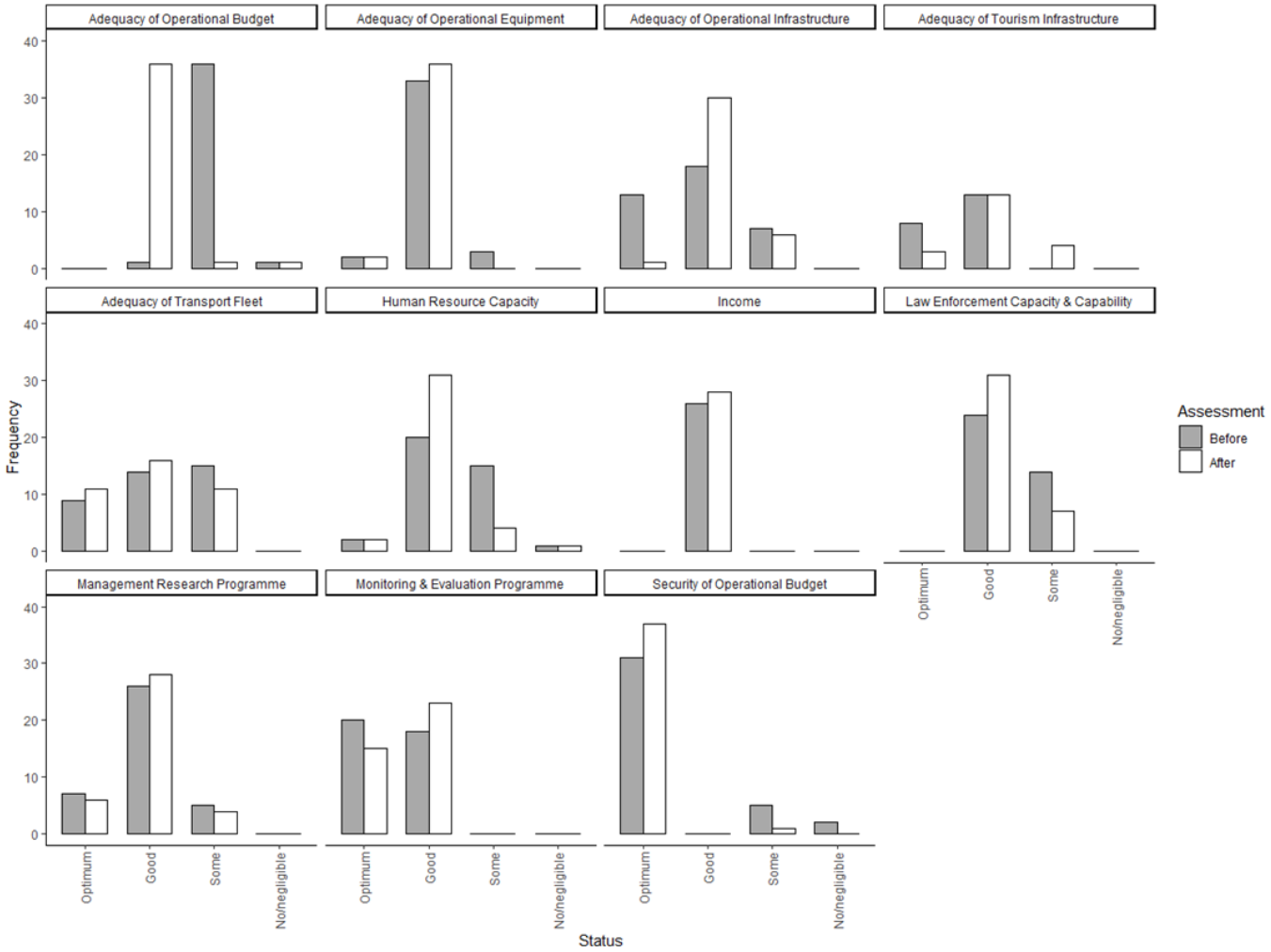

Figure S2.4 A comparison of the frequency for progressive indicators (PI) in the Inputs management element before (2015) and after (2022) application of a decision support framework. 'Optimum' reflects indicators that are approaching optimum status, 'Good' reflects indicators that have had good progress but there is room for improvement, 'Some' reflects indicators where there has been some progress and 'No/negligible' reflects indicators where there has been no or negligible progress.

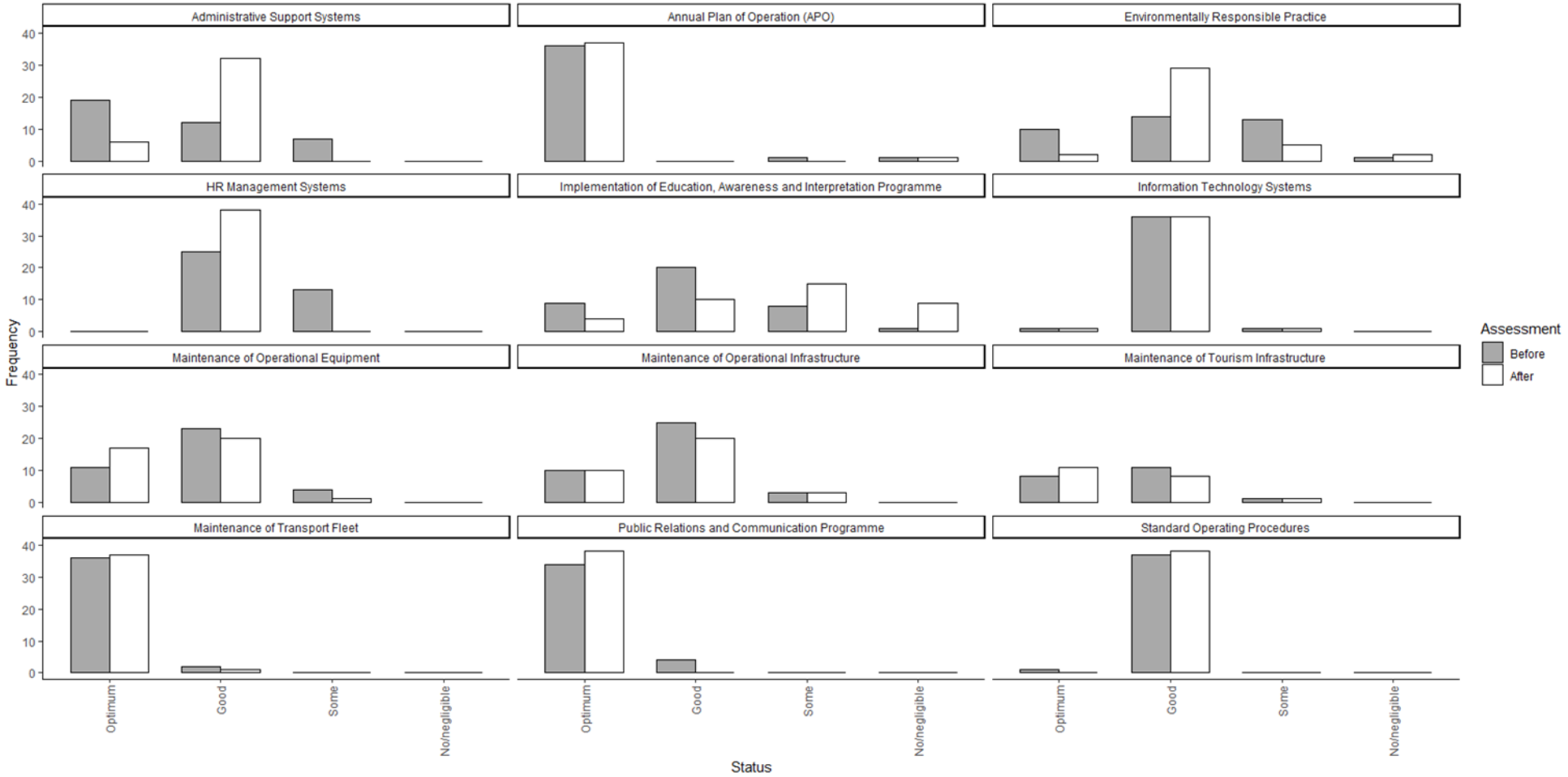

Figure S2.5 A comparison of the frequency for progressive indicators (PI) in the 'Process' management element before (2015) and after (2022) application of a decision support framework. 'Optimum' reflects indicators that are approaching optimum status, 'Good' reflects indicators that have had good progress but there is room for improvement, 'Some' reflects indicators where there has been some progress and 'No/negligible' reflects indicators where there has been no or negligible progress.

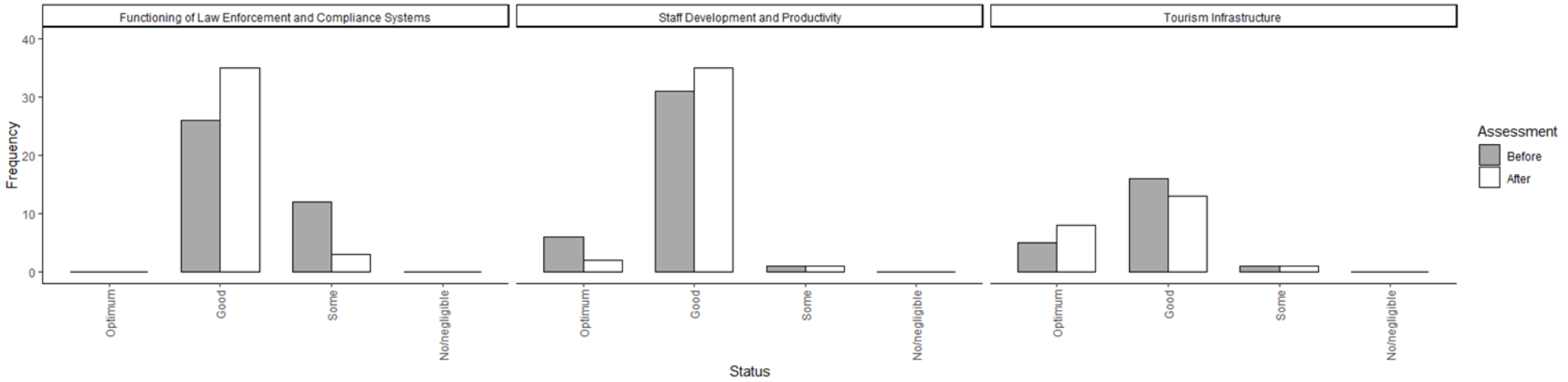

Figure S2.6 A comparison of the frequency for progressive indicators (PI) in the 'Outputs' management element before (2015) and after (2022) application of a decision support framework. 'Optimum' reflects indicators that are approaching optimum status, 'Good' reflects indicators that have had good progress but there is room for improvement, 'Some' reflects indicators where there has been some progress and 'No/negligible' reflects indicators where there has been no or negligible progress.

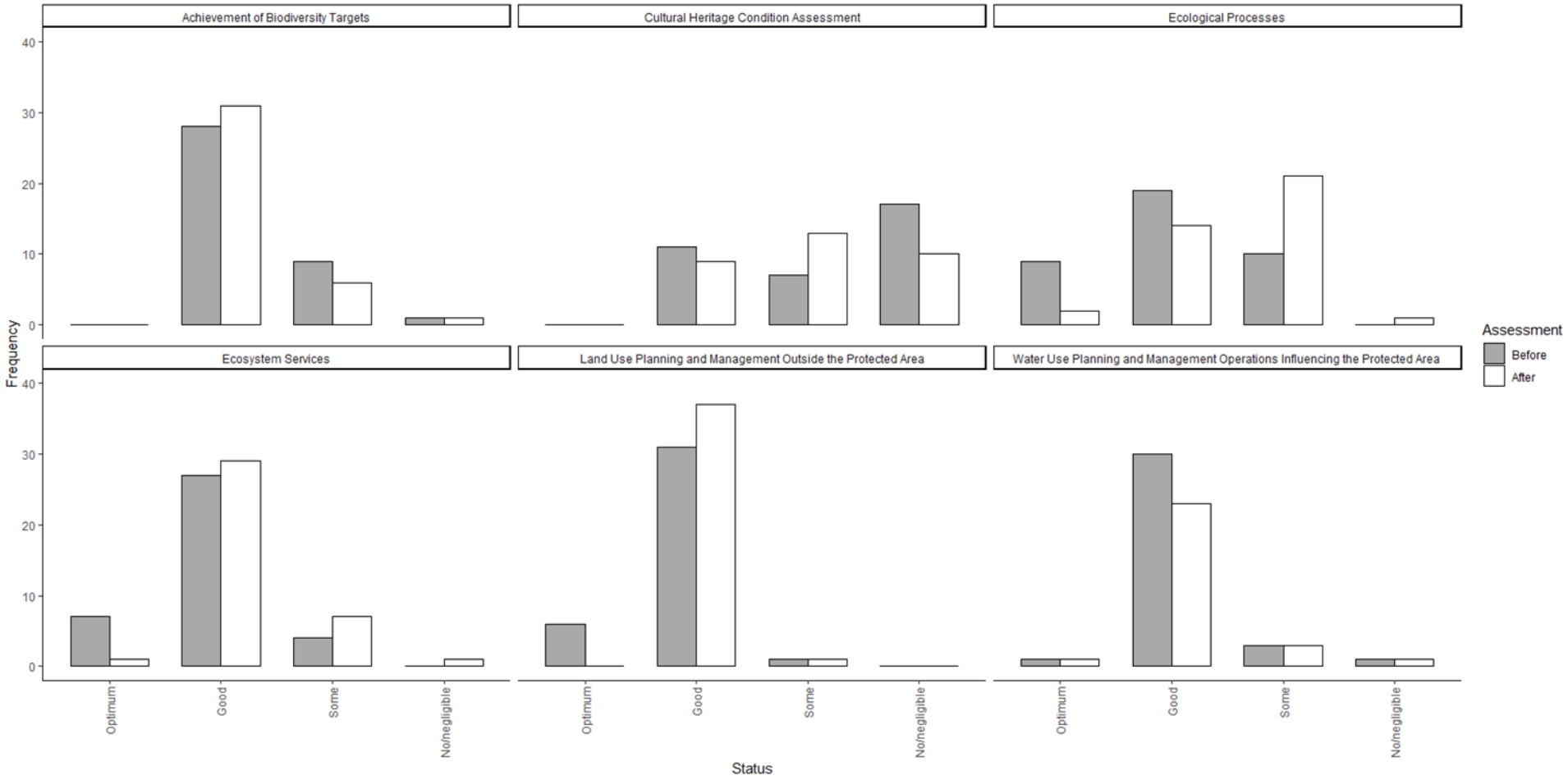

Figure S2.7 A comparison of the frequency for progressive indicators (PI) in the 'Outcomes' management element before (2015) and after (2022) application of a decision support framework. 'Optimum' reflects indicators that are approaching optimum status, 'Good' reflects indicators that have had good progress but there is room for improvement, 'Some' reflects indicators where there has been some progress and 'No/negligible' reflects indicators where there has been no or negligible progress.

CHAPTER 3: TURNING THE WHEEL OR MOVING FORWARDS? USING EVIDENCE AND A DECISION SUPPORT FRAMEWORK FOR EFFECTIVE PROTECTED AREA MANAGEMENT

Abstract

Protected areas (PAs) must ensure that biodiversity is adequately represented and persists over the long term, but PAs exist in complex social-ecological systems requiring site specific interventions according to their unique biological and social characteristics and pressures. Informed objective setting for sound PA management decisions is necessary for the underpinning PA attributes to fluctuate within acceptable thresholds. A paucity of evidence-informed policy or practice may result in poor decision making leading to biodiversity loss. The application of a decision support framework to PA management planning can however enhance management effectiveness through systematic planning and the targeted use of evidence at the foundational stages of planning. To understand how practitioners use evidence in PA management planning and the contribution of a decision support framework to PA management planning, I investigated perceptions of conservation practitioners in a biodiversity hotspot, South Africa. Practitioners sourced site-specific evidence as a point of departure and accessed evidence in multiple ways, but mostly by generating and analysing data and collaborating with experts. Monitoring programmes were perceived to generate sufficient evidence to measure the condition of biodiversity attributes but provide limited insights to human well-being benefits of PAs. Evidence generated by PA management effectiveness assessment was deemed to have limited potential for conservation outcomes measurement. The application of a decision support framework can improve management effectiveness by emphasising foundations of the planning process, framing management issues, articulating goals, and promoting the use of evidence by recognising the condition of PA attributes and the conservation situation. The framework has introduced a globally recognised standard that allows for comparative analyses across PAs with similar contexts. The framework facilitated an early introduction of evidence and measures of success coupled with wider collaboration and stakeholder participation. At the onset of planning, adaptive management capability can thus be developed and conservation outcomes thinking prompted. Based on practitioner's reliance on analysed data reported in this study, it is essential that biodiversity observations, surveillance and integrated monitoring programmes are robust and responsive to PA attributes, threats and anthropogenic influences. These can be enabled with the application of a decision support framework to management planning.

3.1 Introduction

Protected areas (PAs) are considered cornerstones for biodiversity conservation (Margules & Pressey, 2000; Hockings, 2003; UNDP, SCBD & UNEP-WCMC, 2021). PAs also deliver a range of social, economic and environmental benefits to society (Hockings *et al*., 2009a; Worboys, 2015). To conserve the ecological and cultural attributes that underpin the significance of PAs and measure the impact of interventions, PA management planning requires defining PA values (those attributes that underpin the significance of the PA) and establishing thresholds of acceptable variation for these values (Parrish, Braun & Unnasch, 2003; Hockings *et al*., 2006; Kingsford & Biggs, 2012). PA management plans can be considered a series of hypotheses about the impact of a management intervention (Hockings, Leverington & Cook, 2015). However, conservation practitioners may place an over-reliance on experience-based information for management decisions – and they often lack evidence to assess these management decisions (Hockings, 2003; Pullin & Knight, 2005; Cook, Hockings & Carter, 2010). Such lack of evidence-informed policy or practice in conservation can lead to poor decision-making, inefficiency and failed interventions (Sutherland & Wordley, 2017; Dubois *et al*., 2019). Environmental management related research and results from scientific monitoring are still underutilised to inform management and decision-making (Walsh, Dicks & Sutherland, 2014; Gill *et al*., 2017).

A limited use of evidence may result in the failure of management actions to achieve desired outcomes (Cooke *et al*., 2017) and limit understanding of why performance may be poor (Ghoddousi, Loos & Kuemmerle, 2022). Sutherland & Wordley (2017) have coined the term 'evidence complacency' whereby practitioners not seeking or using evidence to inform decisions, may lead to failed implementation and inefficiencies. Assessments that measure protected area management effectiveness (PAME) using tools such as the management effectiveness tracking tool (METT) are required to be informed by site level monitoring and evaluation on the condition and trend in PA values, due to the qualitative nature of assessment using tools like the METT (Leverington *et al*., 2010; see Chapter 2). However, quantitative data about PAME is generally lacking (Carbutt & Goodman, 2013; Coad *et al*., 2015).

Practitioners have been found to rely more on evidence for the status of PA values and threats, and on experience to evaluate success of interventions (Cook, Hockings & Carter, 2010). Based on the assumption that action is linked to outcome, it is essential to understand what evidence practitioners use in their decisions to select actions, including choosing the decision not to act (Cook, Hockings & Carter, 2010). Evidence and decision making are complimentary since decisions need to be made about the selection of indicators to measure management success and PA value status (e.g., reliability and validity) and finding the right balance of qualitative versus quantitative indicators (Hockings *et al*., 2009a). Decisions also need to be made about what the evidence is suggesting to management (e.g., to adjust a management intervention or to seek an alternative intervention).

Importantly, there is differentiation between status monitoring (trends in PA values and ecological integrity) and effectiveness monitoring (impact of actions) (Salzer & Salafsky, 2006).

Systematic conservation planning and the associated setting aside of land for conservation assumes that legally proclaiming and demarcating an area as protected, will safeguard biodiversity against factors that threaten it (Margules & Pressey, 2000). However, legal status does not necessarily imply PA management success (Geldmann *et al*., 2019; Kiffner *et al*., 2020). PA management plans should facilitate representation and persistence of biodiversity over the long term and direct the range within which PA values may acceptably fluctuate (Biggs & Rogers, 2003; Hockings *et al*., 2006; Gillson *et al*., 2019). This requires the identification and selection of appropriate proxies for the measurement of species, ecosystems and processes, all of which requires the sourcing, gathering and using of evidence. The condition of PA values and adequacy of PA design (PA shape and size necessary for PA values to persist) and interventions to address inadequacies, are thus foundational to positive biodiversity outcomes (Parrish, Braun & Unnasch, 2003; Hockings *et al*., 2006; IUCN-WCPA, 2017; Hockings *et al*., 2019).

PAME assessments using tools such as the METT are useful to identify strengths and weaknesses in management and policy and help prioritise interventions to improve management and allocate resources (Goodman, 2003; Hockings, Leverington & Cook, 2015). The application of a decision support framework to the PA management planning process can facilitate the measurement of conservation outcomes over time, thereby complementing PAME assessment with quantitative evidence about these outcomes (Timko & Innes, 2009). PAs exist in complex social-ecological systems (Schwartz *et al.*, 2017) and differ in their biological and social characteristics, pressures and use, requiring site-specific interventions (Hockings *et al.*, 2006). Therefore, analysing the conservation situation and developing theories of change using decision support frameworks for a specific site can help, all of which require accessing, assessing, and applying appropriate evidence to planning and implementation evaluation (Salafsky *et al*., 2022). Decision support frameworks also bring together diverse expertise and stakeholders to navigate and plan within these complex social-ecological systems, as demonstrated by frameworks such as the Conservation Standards for the Practice of Conservation (hereafter the Conservation Standards) and Strategic Adaptive Management (Carr *et al*., 2017; Núñez-Regueiro *et al*., 2020; Roux *et al*., 2021; 2022).

Based on PAME assessment results using tools such as the Rapid Assessment and Prioritisation of Protected Area Management, management strengths in portions of the South African PA network have been found in PA management plans that contain specific biodiversity related objectives that are generally known by PA employees and consistent with policies (Ervin, 2003a; Goodman, 2003). However, inadequacies in research and data collection indicated an unlikely use of data to inform management planning (i.e. decision making), bringing into question the adequacy or integrity of PA objective setting and the ability to demonstrate effective and adaptive management (Ervin, 2003a).

Independent audits of a subset of South African PA management plans following PAME assessments that used the METT, adapted to suit local conditions (METT-South Africa), found PA management objectives to be vague (GRAA & DEA, 2015). This finding is not unique to PAs, also existing in restoration programmes (Ntshotsho, Reyers & Esler, 2011). As it relates to PAs, in some cases, qualitative PAME assessments using the METT-SA were not supplemented with quantitative evidence to support scores and thus used as the sole informant for PAME (Carbutt & Goodman, 2013). Best practice advocates that the METT should not be utilised as the sole PA management evaluation tool (Leverington *et al.*, 2010). Conservation agency led internal assessments aimed at investigating consistency within PA management plans, and between PA management plans and PAME assessment results, found gaps in management planning associated with the measurability of the achievement of PA objectives, while the articulated detail of PA values was lacking (Hayward, 2021a). Management planning required improvement to enable monitoring and evaluation for adaptive management capability (Hayward, 2021b). Others found that management plans sought to set targets for management to achieve as opposed to defining thresholds for PA values with an associated range for management to maintain and/or achieve (Biggs & Rogers, 2003; Gillson *et al.*, 2019). In response, conservation agencies either developed decision support frameworks such as the *Strategic Adaptive Management* (SAM) by South Africa National Parks (Biggs & Rogers, 2003; Biggs *et al*., 2011; Kingsford & Biggs, 2012) or adopted decision support frameworks (such as the *Conservation Standards for the Practice of Conservation*) adopted by the Western Cape Nature Conservation Board (CMP, 2013; Schwartz *et al*., 2017; CMP, 2020; Hayward, 2021a).

In the Western Cape, South Africa, management effectiveness of PAs improved significantly over time, although a positive conservation outcome was not evident (see Chapter 2). Despite significant improvement in management inputs and outputs, a significant decline in the management element 'Outcomes' was observed (see Chapter 2). Complying with METT-SA indicator requirements enables a policy framework for management to operate within, but practitioners risk their decisions and actions being directed by indicators contained in the tool rather than planning and managing PAs adaptively in accordance with their unique contexts. Pursuing indicator compliance may come at the cost of sound PA management planning and implementation, monitoring and evaluation. The importance of practitioner experience for planning and PAME assessment is well known (Pullin & Knight, 2005; Cook, Carter & Hockings, 2014), but similarly is the need for the use of evidence (Cook *et al*., 2017; Gillson *et al*., 2019).

Therefore, this study aims to explore a) the use of evidence by conservation practitioners, specifically related to source and type of evidence used and means of access to evidence; and b) the contribution of a decision support framework to promote evidence-based PA management planning within complex social-ecological systems.

3.2 Methods

3.2.1 Study area and protected area management

The Cape Floristic Region (CFR) encompasses a large portion of the south-western corner of South Africa and comprises unique biodiversity characterised by high concentrations of endemic plant taxa (Cowling *et al*., 2003). It is known internationally as a biodiversity hotspot of global significance (Myers *et al*., 2000). The biodiversity is comprised of complex and valuable coastal, lowland fynbos, midland and mountain fynbos, renosterveld, succulent karoo, mainland thicket and freshwater ecosystems (Mucina & Rutherford, 2011).

The CFR is mostly located in the Western Cape Province where there are three spheres of government responsible for PAs. SANParks is the national authority assigned for the management of national parks. The Western Cape Nature Conservation Board trading as CapeNature is the provincial nature conservation authority for the Western Cape Province and is assigned as a management authority for a selection of nature reserves, while local authorities are responsible for several nature reserves within their areas of jurisdiction (CapeNature, 2023).

Established under the Western Cape Biodiversity Act, 2021 (Act 6 of 2021) (Western Cape Government, 2021), CapeNature (hereafter ‘the conservation agency’) is responsible for the management of 38 statutory provincial PA complexes comprising 112 nature reserve parcels (Fig. 3.1). Management effectiveness of these nature reserves is assessed using the METT-SA (Cowan, Mpongoma & Britton, 2010; CapeNature, 2022).

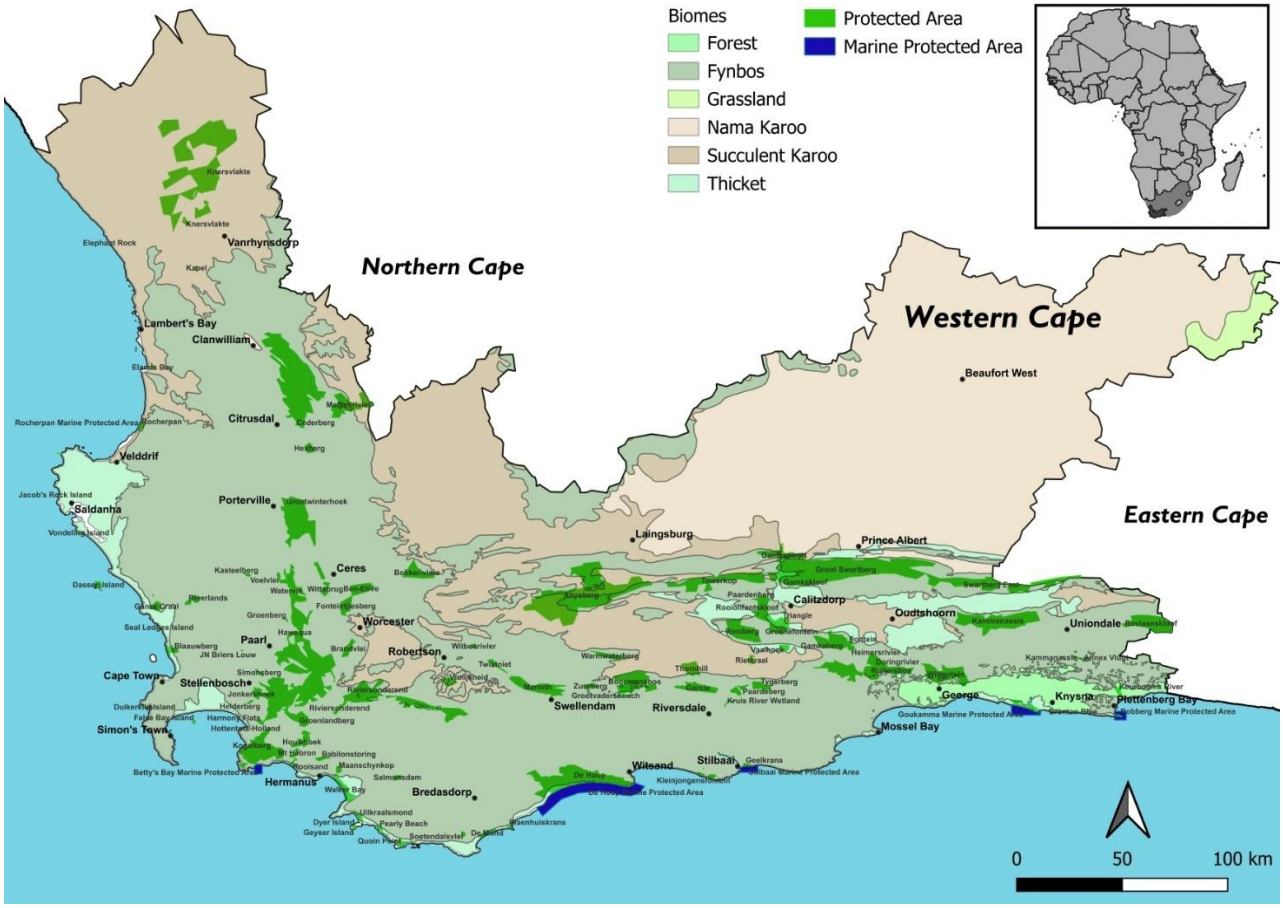

Figure 3.1 Map of the Western Cape Province, South Africa, depicting the biomes and protected areas that are the subject of this study and managed by the provincial conservation agency, CapeNature.

The conservation agency piloted and adopted The Conservation Standards for the Practice of Conservation (hereafter the 'Conservation Standards') decision support framework in 2017-2018 for the drafting of PA management plans (CMP, 2013; 2020; Hayward, 2021a). The Conservation Standards, designed on the principles of adaptive management and evidence-based conservation action, facilitates collaborative planning and stakeholder engagement. The framework outlines a systematic process that during the conceptualising and planning phases, emphasises the articulation of PA values and thresholds of acceptable variation for management to achieve or maintain, threats and understanding of the conservation situation, as foundation to strategy (CMP, 2020). Prior to 2017, managers or small planning teams drafted PA management plans without a formal decision support framework. Since 2018, the Conservation Standards were applied with the aim of producing PA management plans that reflected a management intent in the form of clearly articulated measurable PA goals and objectives, defined PA values with associated thresholds linked to goals, and alignment between management intent, implementation frameworks and monitoring (Hayward, 2021a). This study focusses on the use of evidence by practitioners for PA management planning and review and the contribution of the Conservation Standards.

3.2.2 Perception survey

Structured interviews were undertaken to explore practitioner perceptions in their use of evidence in the design and review of PA management plans (Shackleton *et al*., 2022). This included questions on source of evidence, the type of evidence sourced, and how evidence was accessed. To gain insight on practitioners' perceptions of PA management issues as a precursor to their use of evidence, interviews explored practitioner perceptions of PA context in the categories of key management issues, key threats and critical management activities (Stolton *et al*., 2007; Dudley *et al*., 2007; Cook, Hockings & Carter, 2010). Additionally, interviews sought perceptions on whether and why evidence was sought, as a basis to exploring the source, type and accessibility of evidence. Finally, interviews gathered perceptions on the contribution of evidence generated by monitoring programmes and PAME assessments using the METT-SA to inform conservation outcomes, the contribution of the Conservation Standards as a decision support framework, and practitioners' experience of the framework for PA management planning.

Purposive sampling (Babbie, 2021) was used to identify and select participants within the conservation agency based on their organisational functions ascribed to PA planning and management. Selection was further informed by their experience in the drafting of PA management plans both in the absence of, and with the application of, the Conservation Standards. Participants comprised practitioners in the functions of PA managers and ecologists who contributed to and/or practiced and/or facilitated PA management, planning, PAME assessments, and/or adaptive management. PA managers represented PAs from across the conservation agency's PA network. Sample size was limited to those managers who had participated in PA management planning both in the absence of and with the application of the Conservation Standards. Ecologists represented in the sample supported a range of PAs and associated landscapes across the conservation agency's area of jurisdiction and represented 67% of ecologists employed by the conservation agency. Biodiversity intelligence managers were represented in the sample and also labelled as 'ecologists' due to the ecological focus of their function (Table 3.1).

Table 3.1. An overview of the practitioners who participated in the research.

PRACTITIONER (SAMPLE SIZE)	FUNCTION	YEARS EXPERIENCE	GENDER
MANAGER (7)	Overall management of and accountability for the PA, coordination, planning and implementation of management activities and annual operations, project management, risk mitigation and management, eco-tourism, stakeholder and community engagement, law enforcement and compliance monitoring, environmental education and awareness, job creation.	15 to 26 Ave. 22	F: 2 M: 5

ECOLOGIST (8)	Provision of ecological decision support, contribute to and/or facilitate PA management planning and review and management effectiveness assessments, facilitate implementation of management actions, develop annual ecological monitoring programmes, lead ecological monitoring programme and protocol design and data analysis, and develop capability, provision of information, facilitate link between science and management (networking, research, etc.).	7 to 30 Ave. 18	F: 4 M: 4

A two-part questionnaire was used (Supp S3.1). The first part was designed to capture site-specific contextual information of management issues, threats and critical management activities as a precursor to practitioner perceptions of evidence source, type and accessibility, as mentioned above. The second part captured practitioners' perceptions on the source, type and means of access to evidence, including perceptions on the sufficiency of monitoring programmes generating evidence to evaluate the condition of PA values and the impact of management interventions, and perceptions on the contribution of the Conservation Standards decision support framework for management planning.

The questionnaire comprised closed Likert-scale questions to measure attitude, as it related to use of evidence and sufficiency of monitoring programmes, with open ended questions to allow for answer validation. Open ended questions explored practitioners' experience with and attitude towards, the Conservation Standards decision support framework. On questions about practitioner perceptions of the Conservation Standards, practitioners were asked to reflect on their experiences in drafting and using management plans created prior to the application of the Conservation Standards. Likert-scale 1-5 (1 never, 5 always) for questions 6 to 8 were aggregated into the categories of 'yes' and 'no' (Table S3.1). Likert scale 1-7 (1 strongly disagree, 7 strongly agree) for questions 9 to 12 and 18 and Likert-scale 1-6 (1 definitely not, 6 definitely) for questions 13 and 14 were aggregated into 'yes, 'maybe' and 'no' for ease of analysis (Table S3.1).

For content validity (Rattray & Jones, 2007) questionnaire items were generated based on the principles of PAME and objectives of the IUCN Green List Standard for protected and conserved areas (Hockings *et al*., 2006; IUCN & WCPA, 2017). Best practice advocated by the Conservation Standards was used to emphasise PA design and status of PA values as a foundation for biodiversity conservation outcomes (Juffe-Bignoli *et al*., 2014; CMP, 2020; Geldmann *et al*., 2021). These aspects were associated with the conceptual stages of management planning as they form the foundation of planning. Evidence type categories such as specific evidence (evidence specific to a PA or system), proximate evidence (evidence spatially or conceptually similar) and generic evidence (evidence about globally relevant systems or situations) used in the questionnaire were informed by

or adapted from the work of Pullin & Knight (2005), Cook, Hockings & Carter (2010) and Salafsky *et al*. (2022) (Tables S3.2, S3.3, S3.4). The ordering of questions followed the logic of the Conservation Standards' five-step management cycle, the focus of this research being Step 1 (Conceptualise/Assess) and Step 2 (Plan actions and monitoring) (CMP, 2013; 2020).

To guard against researcher and participant biases and to facilitate consistency in responses, the questionnaire posed some questions more than once in a different frame and introduced varying Likert-scales for closed questions (Babbie, 2021). To enable interviewer consistency in the posing of questions and guiding participants on the definition of terms used, guidance material was developed and used to guide respondents on the categorisation of evidence type as described above, evidence source and accessibility referred to in the questionnaire (Tables S3.2, S3.3, S3.4). Comprehensiveness of the questionnaire was tested through pilot interviews with a sub-sample of interviewees. No refinements were required.

3.2.3 Data collection

Participants were interviewed using the Microsoft 365 MS Teams online meeting desktop application. Interviews were conducted by the principal researcher over four months (from February to May 2023) following formal invitations to participants and their subsequent consent to participate. The duration of interviews was between 55 minutes and 90 minutes depending on responses to open questions. Upon invitation to participate and upon initiating interviews, participants were informed of their rights and the ethical integrity of the research (Ethics Approval Ref. 201007894/10/2022). Research participants were fluent in English thus interviews were conducted in the English language, voice recorded and transcribed for analysis. One participant declined the interview and elected to submit a written response to the questionnaire. For instances where responses refer to specific individuals by name, fictitious names have been applied.

3.2.4 Data analyses

Thematic content analysis was undertaken manually following listening to recordings and reading transcribed data. The 25 open ended questions were arranged into the following thematic areas to analyse perceptions for emerging themes and sentiments: 1) Protected area context in relation to key management issues, key threats and critical management activities; 2) The source, type and access to evidence for PA management planning; 3) Perceptions on sufficiency of monitoring programmes for conservation outcomes and effectiveness of actions; and 4) The contribution of the Conservation Standards. Further thematic analysis was then applied to these broad themes and qualitative data coded based on the principles of conservation biology (Meffe & Carroll, 1997) using ATLAS.ti (ATLAS.ti Scientific Software Development GmbH, 2023). ATLAS.ti was used to guide sentiment analysis and codes were assigned for frequency analysis of emerging themes.

Three-way contingency was applied to investigate the association between source of evidence and the frequency of evidence accessed by practitioners. A Woolf test using package 'DescTools' (Signorell, 2024) showed no significant three-way interaction between evidence source, frequency

of use and group. Assumptions for the Cochran-Mantel-Haenszel Test were met, and the test applied to investigate whether there was significant association between evidence source and frequency of access by practitioners. All statistical analyses were undertaken using R Statistical Software (v4.3.2 R Core Team, 2023)

3.3 Results

3.3.1 Key management issues, threats and critical management activities

PA budget was highlighted by 87% of practitioners as a key management issue, followed by human resources (80%). Practitioner responses made reference to constraints on PA operations due to resource inadequacy to fulfil operational requirements. Other responses alluded to the requirement to balance constrained resources between threat mitigation tasks and other priority tasks, noting that resources were often diverted away from biodiversity monitoring (Table S3.5.1).

Threats such as invasive alien species and natural systems modifications, largely in the form of inappropriate fire regimes, were mentioned by all practitioners (Table S3.5.2). This suggests that these threats are pervasive across the PA network. Threats associated with biological resource use was mentioned by 73% of practitioners, illegal harvesting and succulent plant poaching were specifically highlighted. Of the contributing factors to threats highlighted by practitioners, 21% raised concern about the relevance of nature conservation to the broader public and 28% expressed concern at limited knowledge and understanding of ecological processes and systems to enable them to apply adaptive management (Table S3.5.2).

As for critical management activities, the top activities highlighted by practitioners included invasive alien species control (67% of practitioners), fire management (40% of practitioners), law enforcement (53% of practitioners) and monitoring (40% of practitioners). Under the banner of ‘management’ as an activity (mentioned by 67% of practitioners), managers emphasised project management and project or plan implementation with specific reference to fire and invasive alien species, planning and logistics management. Ecologists highlighted management in broad terms as it pertained to PA goals, wildlife, ecosystems and cultural heritage generally (Table S3.5.3).

3.3.2 Evidence, source, type and accessibility

Practitioners use evidence in the development and review of PA management plans. There was no significant association between evidence source and frequency of access across practitioners for PA values viability assessment, threats assessment or for analysis of the conservation situation (Table 3.2). Practitioners used multiple sources of evidence with analysed data and expert opinion used more than 85% of the time for the selection of PA values and for threats assessment (Table 3.3; Fig. S3.1). Expert opinion and knowledge and experience were drawn upon more than 80% of the time for analysis of the conservation situation (Table 3.3; Fig. S3.1). Practitioners indicated the use all three types of evidence for PA management planning. Specific evidence was used 93% of the time, proximate evidence was used 80% of the time and generic evidence was used 57% of the

time (Fig. 3.2). Practitioners highlighted the use of evidence for credibility and integrity: '*Scientific fact needs to underpin decisions, we shouldn't be guessing… we should have a handle on what's there, what's happening and trends in species and ecosystems*. *We need scientifically sound information to base our planning on and we don't want to reinvent the wheel and we have to keep up to date with the relevant findings in terms of what is happening with our protected areas… we're a government entity. We have to be accountable… we are using taxpayers' money… we have staff, personnel... So it shouldn't be on someone's perception and personal thoughts and ideas. There has to be structure, there has to be a scientific brand, and it has to be acceptable in mainstream' (P11)*. Generic evidence was less frequently used due to the unique and distinctive characteristics of the CFR but deemed to offer useful benchmarks and contextual understanding across similar systems and/or threats e.g. freshwater systems and climate change effects (Table S3.6).

Practitioners accessed evidence in multiple ways, with 96% of practitioners indicating collaboration with experts and 87% indicating a preference for analysing existing data. Systematic reviews and evidence sourced by searching archives, files, libraries (hand search of resources) were least frequently accessed (33% and 47% respectively) (Fig. 3.3). Managers interpreted evidence for management planning and review to be maps, reports, species/ecosystem status, registers and lists, while ecologists interpreted evidence to be research results, literature and results of long-term monitoring projects (Table S3.7 and Table S3.8).

Practitioner attitudes on the ease of access to evidence ranged between being 'somewhat difficult and time consuming' to 'quick and easy' (Fig. 3.4). A higher proportion of managers were neutral on the subject at 43%, remaining responses equally split at 29% between 'somewhat difficult and time consuming' and 'somewhat quick and easy'. Ecologists were equally split at 25% between 'somewhat quick and easy' and 'quick and easy' while 38% felt access to evidence was 'somewhat difficult and time consuming' (Fig. 3.4). Based on transcript analysis, ecologists specifically highlighted limitations on time and capacity to keep up with reading publications and the efficiency of institutional knowledge management systems for quick access to evidence in a user-friendly format, whilst managers highlighted a need for easily understandable published literature and analysed data. Ease of access to evidence was also associated with experience: *It wouldn't be very difficult, but again for [John], who's 28 years old and he's just come out of Technikon [tertiary institution], it's going to be very difficult and time consuming. Whereas for me and [Steven] and the guys that have been in a bit long in the tooth that we kind of know what we're looking for... actually have that information at my fingertips and I think that's where institutional knowledge is important' (P4)* (Table S3.9).

3.3.3 Monitoring programmes and effectiveness of actions

Considering the use of evidence for management planning and review, 73% of practitioners perceived monitoring programmes to collect information to measure condition and trend of ecological PA values and 67% perceived monitoring programmes to collect information to measure the impact

of interventions (Fig. 3.5). In response to monitoring programmes collecting information to measure the condition and trend of cultural and human well-being values, practitioners were less confident, with 13% and 20% of practitioners respectively in agreement.

A practitioner sentiment analysis (ATLAS.ti Scientific Software Development GmbH, 2023) of monitoring programmes showed 14 instances of positive sentiment, seven instances of neutral sentiment and 19 instances negative sentiment (Table 3.4). Of the positive sentiments, 43% were associated with ecological monitoring bias, and 36% with institutional capability (Table 3.4). Although positive, some practitioners indicated an uncertainty in whether monitoring projects were consistently implemented across the relevant PAs (Table S3.10). For neutral sentiments, 71% were associated with institutional capability related to cultural heritage and human well-being values, in that capability was limited to measure these values. Furthermore, for neutral sentiments, 57% of practitioners highlighted a monitoring project output bias in that projects collected count data as opposed to trend and impact analysis data (Table 3.4; Table S3.10). For example, *'We measure the number of people that come and go… we only look at numbers when it comes to humans in the reserve [protected area]' (P4).* Of the negative sentiments, 63% were associated with institutional capability (Table 3.4), practitioners highlighting a requirement for more data analysis and a need for improved monitoring of cultural and human well-being values. Generally, these practitioners indicated improvement of monitoring approaches were required to better track the condition and trend of PA values for an evidence-based management response: '*Somewhat, invasive alien plant species and density information tell us something about interventions; other data can tell us about the state, but not necessarily whether we are doing a good job' (P12)*; '*I can prove that I've had interventions. I don't have to prove that I've got an answer…' (P3); 'We can spend more energy on human well-being and not only report on job creation and our [invasive] alien [plant] clearing contractors... needs some unpacking, but I agree we do that' (P8)* (Table S3.10).

On monitoring programmes measuring the effectiveness of actions, 27% of practitioners perceived monitoring programmes to do this (Fig. S3.2). As highlighted by a practitioner: '… *whether we are gathering Protea [indicator species] data or alien [invasive plant] density data or even various sorts of animal or plant surveillance data, the link back to take that evidence to change management, … is not strong enough and it's more due to probably a lack of monitoring rather than anything else; we need to be doing more monitoring…' (P12)*. Noting that PA goals are founded on the condition of PA values (PA value monitoring projects perceived by 73% of practitioners to give an indication of PA values condition as noted above), 53% of practitioners perceived evidence generated from monitoring programmes to measure the achievement of goals (Fig. S3.2).

Practitioners used a combination of qualitative and quantitative evidence for PA management. Practitioner perceptions trended towards quantitative evidence as the basis for management planning while for the achievement of goals, perceptions on evidence base were distributed between

qualitative and quantitative, leaning towards quantitative evidence. For the effectiveness of actions, perceptions trended between qualitative and quantitative evidence (Fig. 3.6).

When assessing PAME using the METT-SA, 60% of practitioners agreed that the assessment generates evidence that could evaluate conservation outcomes, 13% disagreed and 27% felt that maybe outcomes evaluation was possible using information generated by the assessment (Fig. S3.3). Practitioners highlighted the need to consider the PAME assessment holistically, linking management plan implementation to the assessment: '…*the information that we get from the METT-SA assessment can inform whether we are implementing the protected area management plan or we reaching our goals, etc. Not in all cases, but I think in most cases' (P13).* The qualitative nature of PAME assessment using the METT-SA was highlighted together with the limited number of outcomes indicators in the tool, while the strategic, organisational level design of the METT-SA and its apparent indicator bias towards the conservation agency as opposed to the specific PA, was highlighted: '*Indicators are not adequate to show whether there really has been improvement [at PA level]… might show improvement on management action, but it does not mean there's been improvement on the ground' (P8).* (Table S3.11).

3.3.4 The contribution of the Conservation Standards for the Practice of Conservation as a decision support framework

Practitioner sentiment towards the contribution of the Conservation Standards, in relation to the use of evidence and benefit of the framework, was positive (79%; Table 3.5). Beneficial changes highlighted were associated with practitioners considering evidence, engaging stakeholders and experts at the onset of planning, and the onboarding of an international standard with a comparative analysis power across PAs with similar contexts. Negative sentiments were associated with caution against the framework being too structured and leading to potential for the PA management planning process to overlook important management aspects: '…*you were so structured that you might have overlooked what's outside of that structure... I had to be forceful for the marine stuff to be considered' (P6)*. Other negative sentiments highlighted the application of the Conservation Standards to the management planning process as cumbersome and lengthy, and potentially too high level for planning participants, noting that the decision support framework was however, acceptable (Table 3.5).

In total 69% of practitioners felt management intent of these PA plans were evident prior to the application of the Conservation Standards (Table 3.6). Practitioners indicated that plans prior to the Conservation Standards were more protected area-centric with a puristic approach to nature conservation within fences as opposed to the broader consideration for human well-being aspects and a landscape approach to conservation as prompted by the Conservation Standards and the Global Biodiversity Framework (CMP, 2020; UNDP, SCBD & UNEP-WCMC, 2021): '*there were clear strategic management intentions, but I think they again they're focused more on reserve [PA]… I think that's historically how it was… conservation, fences and doing pure conservation' (P1)*. Plans

were considered '*highly variable' (P8)* and a '*one-man plan' (P10)* with '*formalised monitoring and evaluation lacking' (P5)*; '*…it was kind of like an expert opinions idea that this is where we need to be focusing and that's what the actions were aimed at, with the open standards [Conservation Standards] actually guided you to come up with those' (P2)*. Notably, these plans were considered more direct in terms of their implementation frameworks but were limited in adaptive management feedback capability and thus considered '*not entirely off the mark, just limited and adaptive feedback not formally part of it... harder to tell if they were achieving outcomes even though quite specific and direct' (P12)* (Table 3.6, Table S3.12.1).

Following the application of the Conservation Standards, 85% of responses reflected a positive sentiment on a clear strategic PA management intent contained in PA management plans (Table 3.6, Table S3.12.2). Managers highlighted that the application of the Conservation Standards led to an expansion in thinking and clarity in directing action towards prioritisation, conservation outcomes and adaptive management capability. '*the old management plans, you were focused on achieving outcomes within specific areas… When now, with the Conservation Standards, it's much broader… You're depending on your partners; you're depending on everybody bringing their parts together for that outcome to be achieved' (P3)*; '*Yes, strategies clear, linked to clear objectives that are more measurable…' (P8)*.

Practitioners indicated that the new plans needed to be condensed and had not yet been fully implemented, and that monitoring, PA management plan review and adaptation was now necessary: *'We're still very much in a planning / implementation phase. We need to move along now and do the actual assessment and review and adaptation' (P10)*; '*hugely improved; but not doing enough monitoring, or the right kind of monitoring and putting enough effort into it. Constantly looking at our impact - still need to do that to give effect to the plans; on the right track but implementation not done yet' (P12)* (Table S3.12.2).

The Conservation Standards were considered to have improved the strategic direction of plans. A respondent highlighted that the Conservation Standards' language and terminology was not well understood by PA managers and field staff, noting that plans needed to be practical and understandable for implementation: '*The language/terminology used in of the Conservation Standards process is foreign to managers and staff. They do not understand it and if they do not understand the language then they will not read the document' (P12)*. Similar sentiments about terminology were shared by others (Table S.12.2).

Table 3.2. Association between evidence source and frequency of access by practitioners in their selection of protected area (PA) values, analysis of PA value viability, assessment of threats and analysis of the conservation situation during the foundational stage of PA management planning. P value from a Cochran-Mantel-Haenszel test and df is the degrees of freedom.

Cochran-Mantel-Haenszel test	M^2	df	*P*
Protected area values	0.672	6	0.995
Protected area values viability assessment	1.57	6	0.995
Threats assessment	0.17	6	1.000
Analysis of the conservation situation	0.96	6	0.987

Table 3.3. Source of evidence used by practitioners during the conceptual stage of the protected area (PA) management planning process as it related to the selection of PA values, PA values viability assessment, threats assessment and analysis of the conservation situation.

	Selection of PA values (%)		*PA values viability assessment (%)*		*Threats assessment (%)*		*Analysis of the conservation situation (%)*	
	Yes	No	Yes	No	Yes	No	Yes	No
Management plan (old)	86	14	50	50	70	30	47	53
Grey literature	67	33	37	63	57	43	60	40
Peer reviewed literature	73	27	50	50	57	43	40	60
Raw data	50	50	43	57	73	27	40	60
Analysed data	87	13	73	27	93	7	61	39
Expert opinion	93	7	70	30	97	3	83	17
Knowledge and experience	57	43	57	43	77	23	87	13

Table 3.4. Emerging themes regarding sentiments (n) toward monitoring programmes collecting information on the condition and trend of ecological, cultural and human well-being protected area (PA) values. Sentiments were associated with themes such as ‘institutional capability’, ‘accessibility of information’ and biases in monitoring programmes. ‘Uncertainty’ related to practitioners’ alluding to the consistency of implementation of monitoring projects and knowledge of what should be monitored.

Sentiment	Institutional Capability (%)	Accessibility of Information (%)	Ecological Monitoring Bias (%)	Output Bias (%)	Uncertainty (%)
Positive (n=14)	36	7	43	7	14
Neutral (n=7)	71	14	-	57	7
Negative (n=19)	63	16	11	5	-

Table 3.5. Practitioner sentiment about the contribution of the Conservation Standards for the Practice of Conservation decision support framework to protected area (PA) management planning in relation to use of evidence and benefit to the planning process. Based on 55 responses derived from four open questions. Managers are denoted by ‘M’ and ecologists by ‘E’. The number

followed by ‘P’ denotes the practitioner and the number followed by ‘E’ or ‘M’ denotes the quotation number.

Sentiment (n=55)	Frequency (%)	Samples of quotation content
Positive	79	*…enlightening… one of the first plans I'd written where you look at the evidence and determine is this something that we really need to be concerned about or is it something that's less concerning. In that sense it prioritises it (P2M-3).* *…robust process… looks at different evidence… workshop style… by far better than previous attempts to do management... that was very much based on gut feeling and old knowledge and legacy information, Conservation Standards is more structured… forces you to look at evidence, qualitative and quantitative (P10E-10).* *Brings in evidence, that whole suite from the local indigenous leader to a PhD published paper... It's comprehensive and the wide scope evidence that it brings in (P11E-11).* *We're bringing ourselves in line with international standards and we are setting a standard (P1M-17).* *Stakeholder involvement from the onset and clear objectives being set (P5M-20).* *It allows you to track (P13E-27).* *Conservation Standards can work well in cases where there is a lot of conflict amongst stakeholders (to reach consensus and agree on issues). For most of our PAs we know what needs to happen, we just need dedicated funding and resources to implement required actions. (P15E-29).* *It highlighted specific areas that we needed to focus on that I don't think would have been focused on in the old way because it wouldn't have brought it out like the Open [Conservation] Standards did (P2M-32).* *I think it has cemented a standard process. It has definitely made it more inclusive… It’s [the process] identified strengths and weaknesses. … it's fulfilling our mandate in terms of how we have to engage [stakeholders] (P11E-25).* *Definitely changed because it used to be between the [PA] fences and inwards. That's definitely changed the look from fences outwards… and also looking at international aspects… more inclusive process (P3M-33).* *There is an evaluation process at the end of five years that wasn’t in the previous plans. You would write a plan and five years later you would write another plan. I don't think there was a lot of reflection on whether you had achieved the outcomes (P4M-34).* *Planning more robust, scientifically defensible (P10E-39).* *Main change was the stakeholder engagement… from the beginning… And focusing on having the data before we plan*

Sentiment (n=55)	Frequency (%)	Samples of quotation content
		so that we know what to focus on and what we need to plan for (P14-E-43). *It opens you to questioning. It opens you to the amount of involvement in terms of participation of the broader community and public… increases public buying into the process (P9-E53).*
Neutral	16	*If done correctly, evidence brought in at the beginning when developing goals and strategies, and again mid-cycle when time to review and adapt (P8E-8).* *Available evidence was used in the past in management planning. It is nothing new (P15E-15).* *Current [Conservation Standards] plans lead you there, but doesn't spell out detail always. The next level is missing (P6M-36).* *The way that [the framework] is relayed to [those] participating has various levels that [must] be taken into consideration… that's the only thing that would have to change would be the level of facilitation for the various groups that participate (P3M-48).*
Negative	5	*It is very focused on certain criteria... weary of missing important management aspects because it was so focused on specific management criteria... (P6M-6).* *Cumbersome (process). The basic SAM (strategic adaptive management) process followed is acceptable, but one gets bogged down into too much of a detailed process (P15E-59)*

Table 3.6. Sentiment analysis of protected area (PA) management intent prior to and after the application of the Conservation Standards for the Practice of Conservation decision support framework.

Sentiment (n=15)	Sentiment frequency (%) before	Sentiment frequency (%) after
Positive	69	85
Neutral	23	15
Negative	8	0

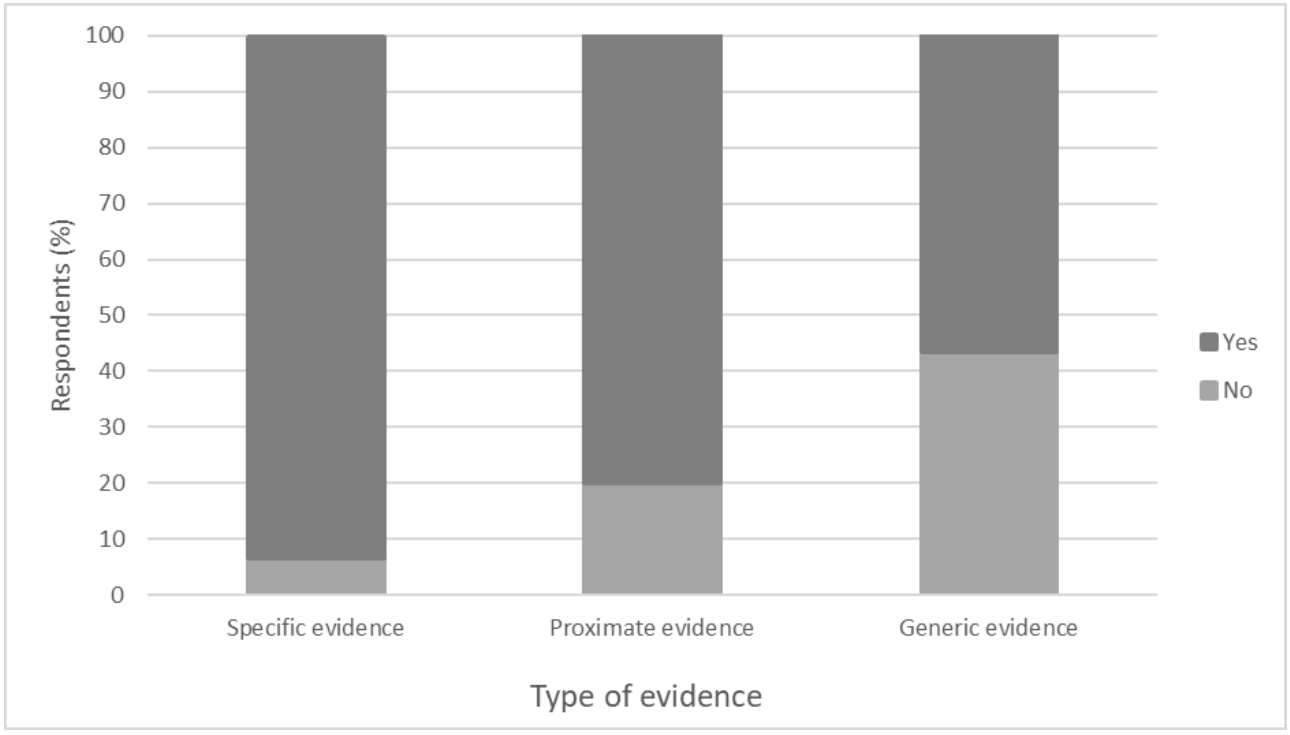

Figure 3.2 Type of evidence used by practitioners during the protected area (PA) management planning process. Specific evidence (evidence from the specific PA or ecosystem or species or cultural aspect of interest) is sourced frequently, followed by proximate evidence (evidence from a spatially or conceptually similar situations) and generic evidence (evidence from globally relevant or similar systems or situations or programs).

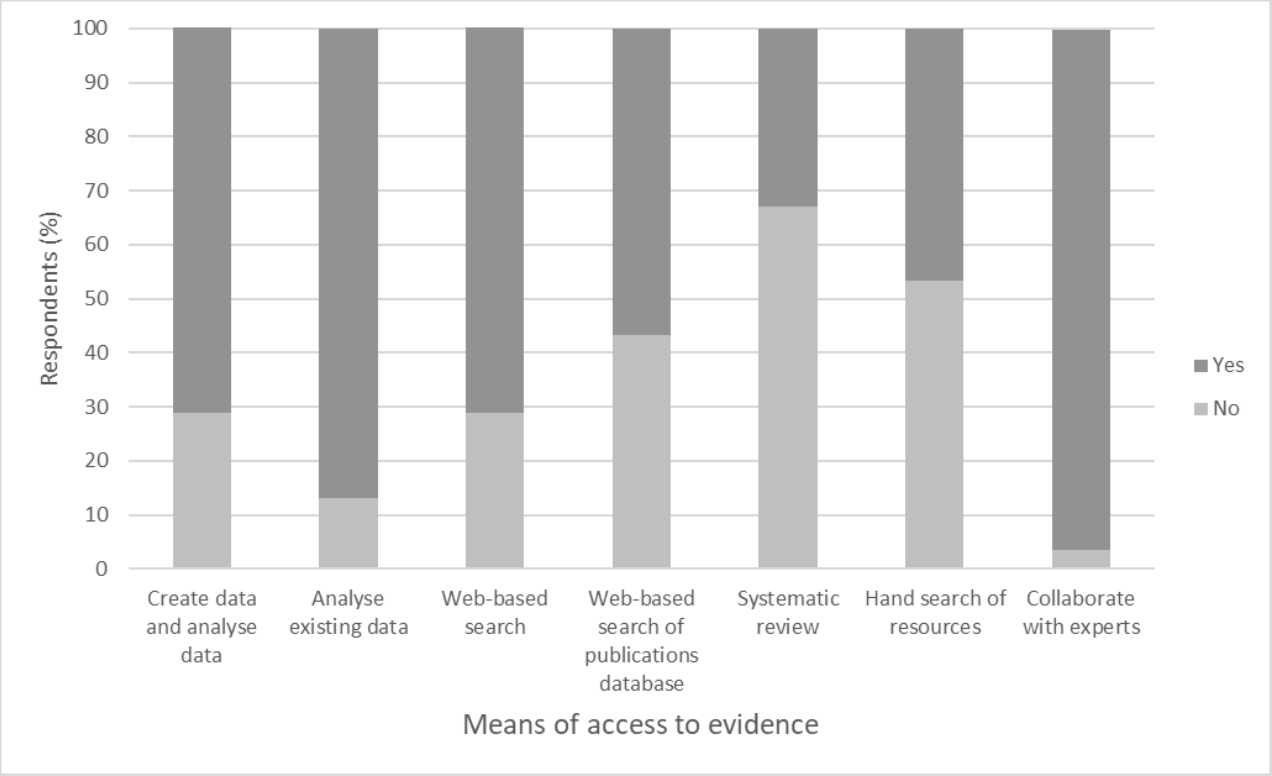

Figure 3.3 Frequency analysis of how practitioners access evidence. Practitioners access evidence in multiple ways, the collaboration with experts being most frequent, followed by analysis of existing data, creating and analysing data and web-based searches for evidence.

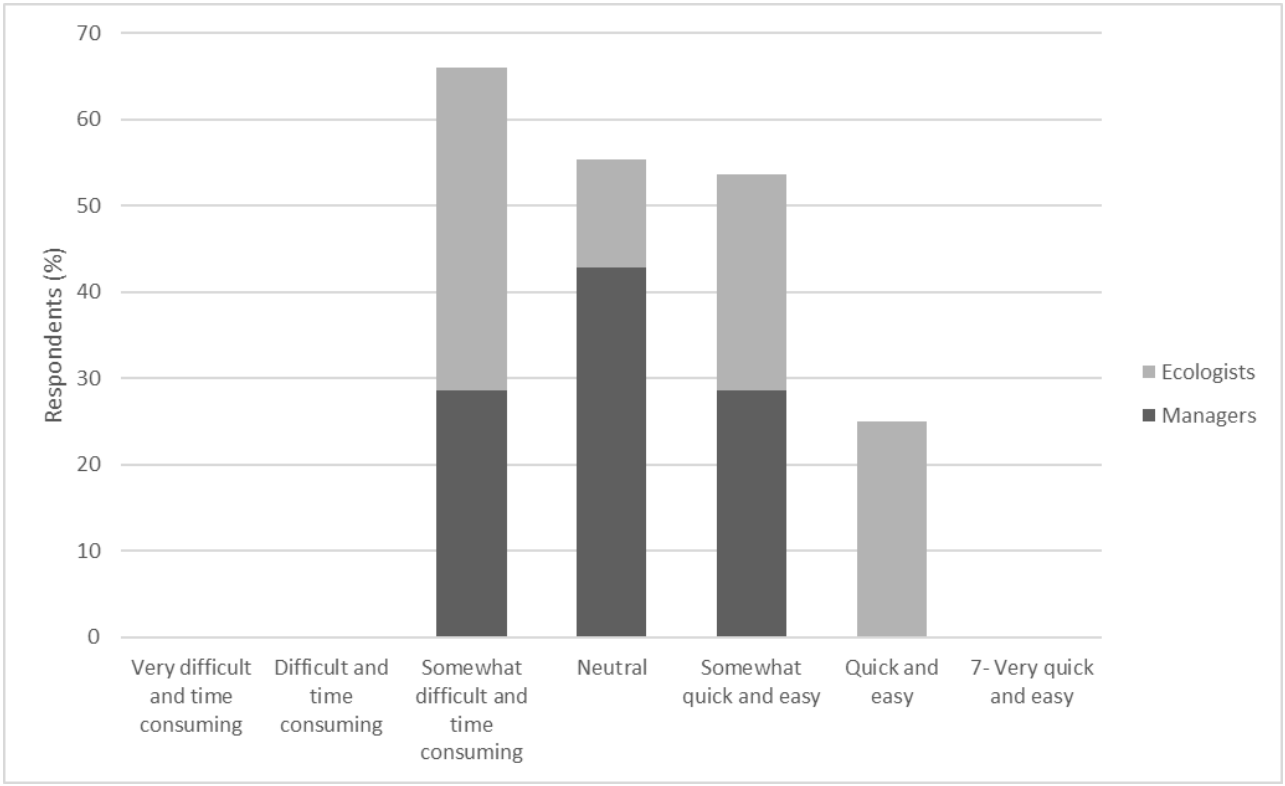

Figure 3.4 Practitioners' perceptions on the ease of access to evidence. 'Ecologists' are defined as a practitioner in the employ of the Conservation Agency whose function includes the provision of ecological decision support, contribute to and/or facilitate protected areas (PA) management planning and review and management effectiveness assessments, facilitate implementation of management actions, develop annual ecological monitoring programmes, lead ecological monitoring programme and protocol design and data analysis, and develop capability, provision of information, facilitate link between science and management (networking, research, etc.). 'Managers' are defined as a practitioner in the employ of the Conservation Agency whose function includes overall management of and accountability for the PA, coordination, planning and implementation of management activities and annual operations, project management, risk mitigation and management, eco-tourism, stakeholder and community engagement, law enforcement and compliance monitoring, environmental education and awareness, job creation

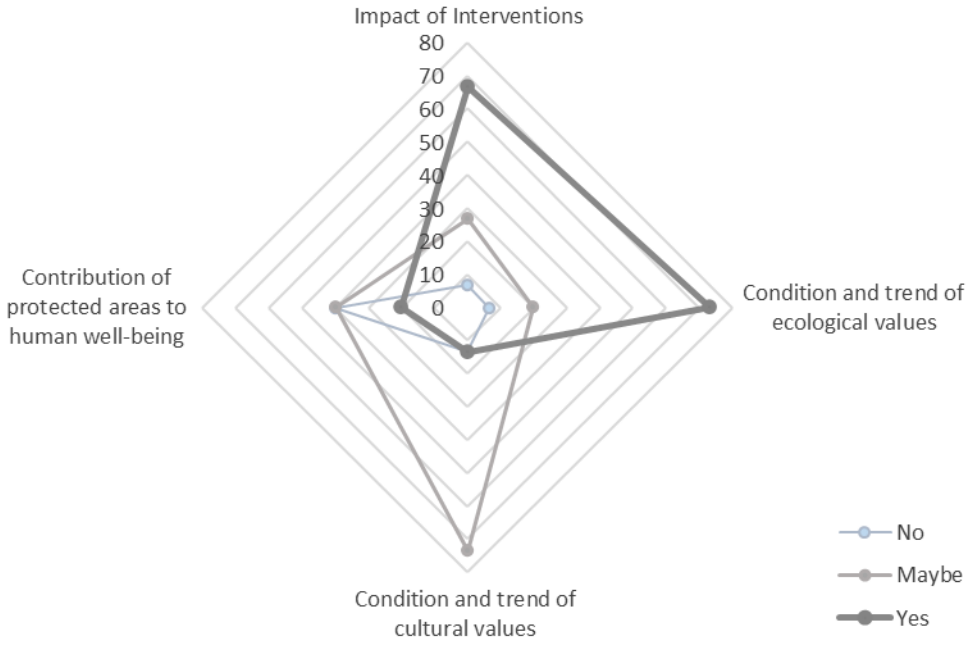

Figure 3.5 Practitioner perceptions (%) on monitoring programmes collecting information to measure condition and trend of protected area (PA) values (ecological, cultural and human well-being values) and impact of interventions.

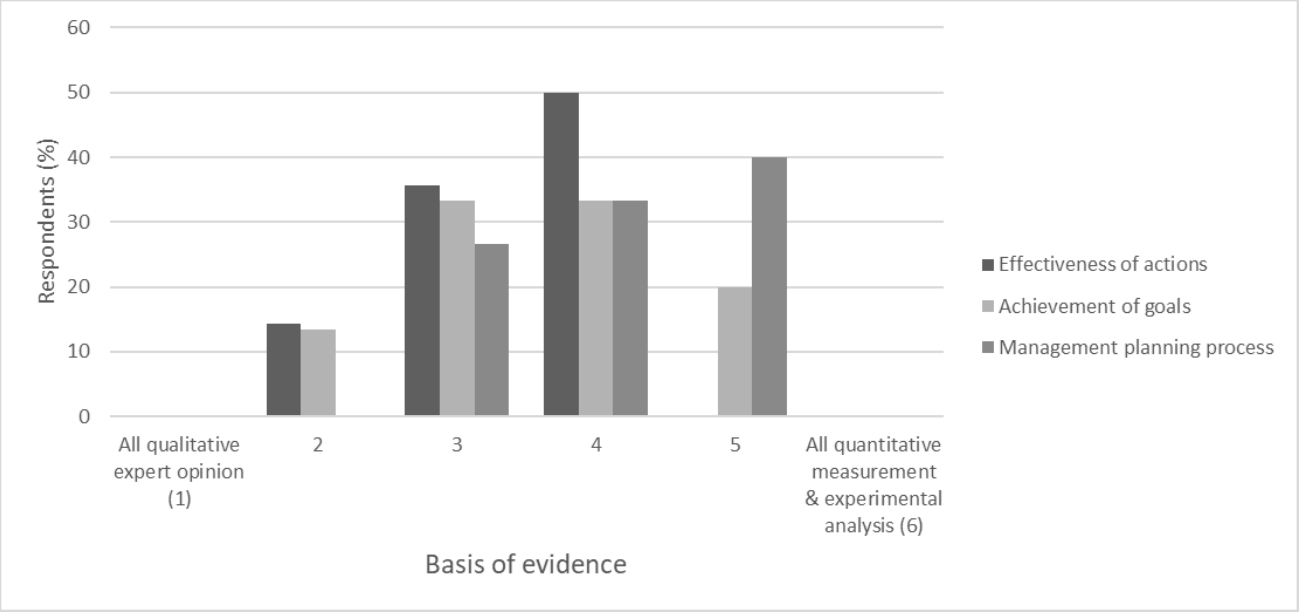

Figure 3.6 On a scale of 1 to 6, practitioners' perception of evidence-based information used for protected area (PA) management, '1' being all qualitative expert opinion and '6' being all quantitative and experimental analysis.

3.4 Discussion

3.4.1 The use of evidence in practice

Practitioners used multiple sources of evidence and accessed evidence in a variety of ways, noting that limitations exist in terms of format, the requirement for it being analysed, interpreted and made relevant to management. This is not a unique finding in the practice of conservation or PA management (see for example Esler *et al*., 2010; Cook *et al*., 2012). Roux *et al*. (2006) advocate a 'co-production of knowledge' approach, the collaborative learning by experts and implementers (or 'users'); the production of evidence thus viewed as a process of learning and enabling adaptive management. The current study highlights the regard placed by practitioners on evidence for credibility and integrity of planning and management. Their reliance on expert opinion and analysed data, coupled with accessing evidence by means of collaborating with experts may allude to an institutional aptitude for the co-production of knowledge. Although confident with evidence generated for understanding the condition of ecological PA values, practitioners were not confident about the evidence generated to understand the effectiveness of their management interventions. In response, the co-production of knowledge, i.e. the learning capacity and adaptive management capability by conservation organisations, specifically those publicly administered, can be enhanced by agency research (Roux *et al*., 2015) and the co-production of PA management plans and application of adaptive management (Roux *et al*., 2021; 2022).

The emphasis on analysed data and expert opinion as primary evidence sources about biodiversity and threats is common practice by practitioners (Pullin & Knight, 2005; Cook *et al*., 2012). However, as it relates to analysing the PA conservation situation, the heavy reliance on expert opinion, knowledge and experience (Table S3.2) over other sources indicates that managing for biodiversity conservation within complex social-ecological systems depends upon a range of expertise and knowledge, social and environmental, sciences or knowledge.

Studies have found that the diverse range of expertise and knowledge are not normally carried by conservation practitioners and/or not well researched or well-integrated (Núñez-Regueiro *et al*., 2020). Effective PA management requires an understanding of the drivers of anthropogenic pressures to reduce these pressures while at the same time achieve human well-being and improved biodiversity condition (Zafra-Calvo & Geldmann, 2020). The results of the current study highlighted gaps associated with measuring the contribution of PAs to human well-being and associated institutional capability to formulate appropriate measures to demonstrate impact. The requirement for interdisciplinary engagement for effective PA management and drawing upon wide stakeholder networks to ingrate social and other sciences and knowledge are thus crucial for conservation success. Despite the gaps associated with measuring human well-being impact for the current study (see Table S3.10), the application of the Conservation Standards introduced consideration for the social-ecological context and created a platform to identify knowledge requirements and foster interactions with a wider range of stakeholders and/or experts.

Based on practitioner preferences for collaboration with experts and creating and analysing data, the existence of good biodiversity information in the CFR can be inferred. This is contrary to other global biodiversity hotspots where biodiversity information gaps still exist and barriers include language and resource limitations (Giehl *et al.*, 2017; Schmitz *et al*., 2023). Based on practitioner perceptions for the current study, the application of the Conservation Standards to management planning introduced evidence and collaboration with experts at the onset of planning. This was coupled with an early identification of PA values and indicators to monitor progress towards goals. Results do not imply that management planning prior to the Conservation Standards did not utilise evidence, only that evidence may not have easily inferred the condition of PAs in response to changing PA contexts and anthropogenic pressures and threats.

Evidence complacency (Sutherland & Wordley, 2017) was not found to be apparent in the conservation agency based on the results of the current study. However, limitations such as ecological monitoring bias in the form of a disproportionate focus on specific species or ecosystems or threats as opposed to equally important cultural and human well-being attributes of PAs exist. Human well-being or other benefits derived from PA's are necessary for measuring PAME and progress towards CBD targets for equitably managed PAs (Zafra-Calvo *et al*., 2019). As passionately as biodiversity outcomes are advocated as indicators for PA conservation effectiveness (Geldmann *et al.*, 2021; see Chapter 2), so should social outcomes and social-ecological interactions be advocated as part and parcel of PA management and impact evaluation programmes (Zafra-Calvo & Geldmann, 2020; Ghoddousi, Loos & Kuemmerle, 2022).

3.4.2 Evidence and knowing and doing

Practitioner perceptions, that monitoring programmes collect information on condition and trend of ecological PA values and impact of interventions, suggests a reliance on empirical evidence. Barriers such as language may not exist for practitioners in the context of the current study, but scientific literacy as a factor is unknown (Ntshotsho *et al*., 2015; Giehl *et al.*, 2017). Sources of evidence highlighted in the current study suggest that the gap between the existence of scientific evidence and its use by management at the local scale may not be as vast as perceived, similar to findings by Esler *et al.* (2010) and Cook *et al*. (2012). Rather than limitations on evidence, barriers may well lean toward limitations in management plan implementation and associated limitation on the visibility of results in field (Foxcroft *et al*., 2020; see Chapter 2). These limitations may create an impression that the available and accessible evidence is not considered. Based on results (see Tables S3.7 and S3.8), managers and ecologists in the context of the current study may also have differing impressions of a 'result' and/or timeframes for these 'results' to manifest. For example, transcript analysis suggests that managers have a short-term outlook in response to their needs (the result expected from evidence being the 'what', 'where' and 'how' to implement, like the findings of Cook *et al*. (2012)) as opposed to ecologists who have a long-term view and need (the result expected being 'change in the system') (see Table S3.7). The short-term outlook by managers could be

attributed to the nature of publicly administered PA management, decision-making governed by annual operational and financial planning cycles and available resources while ecologists may view PA management issues in broad terms, for example, 'PA management' or 'wildlife management' (see Table S3.5.3).

The divide between management and science highlighted by Roux *et al*. (2006) may thus lie in the timeframes that managers require evidence to decide and act. For example, in Australia, PA managers prioritised evidence for day-to-day management decisions over other sources (Cook *et al*., 2012). Results of the current study indicates that managers draw on evidence such as maps, reports, species or ecosystem status, registers and lists for decision making, coined as 'basic data' by Salafsky *et al*. (2019). This could be attributed to the short-term planning and operational environment within which managers must operate. Ecologists in the context of this study, related to evidence in the form of long-term monitoring results, research and literature, coined as 'primary studies' by Salafsky *et al*. (2019). The strength of the evidence to inform management decisions thus depends on upon how well and how timeously 'primary studies' translate and integrate stepwise year on year, into the 'basic data' and short-term planning and management requirements that govern managers who must make decisions.

Ultimately, practitioners should want to know 'how the biodiversity is doing' (Parrish, Braun & Unnasch, 2003) and the contribution of PAs to human well-being (Zafra-Calvo *et al*., 2019; Zafra-Calvo & Geldmann, 2020; Mann-Lang *et al*., 2021; Ghoddousi, Loos & Kuemmerle, 2022). Practitioners in the context of this study are thus dependent on the regular feedback loops promoted by adaptive management over time, to ensure that short-term management activities remain on track year on year to result in positive outcomes over the long term. Decision making rationale and monitoring programmes thus need to survive policy and staff turnover while protected area management planning must be based on long term theory of change.

3.4.3 Decision support frameworks and adaptive management capability

The current study demonstrates that the application of a decision support framework as a standard, can help improve management effectiveness by placing emphasis on the PA management planning process, the information or evidence used to inform planning, framing management issues, establishing measures of success, and ecological integrity. The basis of the evidence for the entire management planning process in this study leaned towards quantitative measurement, the evidence base for effectiveness of actions leaned towards qualitative, and the achievement of goals ranged between quantitative and qualitative evidence (Fig. 3.6). This confirms that the adequacy of biodiversity observations, surveillance and monitoring programmes are an essential first step to establishing the basis for PA management, i.e. the selection of PA values, assessing their viability, analysing threats and the conservation situation, and developing outcomes monitoring (Parrish, Braun & Unnasch, 2003). Those practitioners who perceived evidence generated from monitoring programmes to measure the achievement of goals had low confidence about monitoring

programmes measuring the effectiveness of management intervention. The selection of indicators thus requires careful consideration (Margolius *et al*., 2013), the realities of conservation practice often being challenged by limited impact indicators, broad and/or merged goals that are difficult to measure, inconsistent monitoring, and the selection of too many indicators to monitor (Hockings *et al.*, 2009b; Timko & Innes, 2009; Ntshotsho, Reyers & Esler, 2011).

Recognising that evidence-based approaches for measuring intervention success are challenging and since PA managers do not operate in controlled environments where intervention application can be tested (Gillson *et al.*, 2019), sourcing and accessing multiple sources and types of evidence is necessary under the banner of adaptive management, including the utilisation of best available knowledge in the form of expert opinion (Salafsky *et al*., 2019). Decisions about the selection of indicators to measure management success and condition of PA values, finding balance between qualitative and quantitative indicators (Hockings *et al*., 2009a), and making decisions about when to adjust a management intervention or to seek an alternative intervention is difficult (Salzer & Salafsky, 2006). The evidence may not always be readily available within the timeframe practitioners need to act (Cook *et al.*, 2012). Thus, for practitioners to be certain about acting in complex and uncertain circumstances, the Conservation Standards decision support framework appears to have created certainty about deciding and confidence in the known, versus the unknown, by directing information requirements, the use of evidence and highlighting knowledge and/or monitoring gaps and options to address these gaps.

It is essential that biodiversity observations, surveillance and monitoring programmes are robust, responsive to PA value attributes, and fit for purpose due to the reliance practitioners place on analysed data as reported in this study. The reliance placed on expert opinion suggests scope for ongoing pursuance of and maintenance of sound partnerships, networking and collaboration between the scientific community and practitioners and key stakeholders. These platforms exist and are available to practitioners (Foxcroft *et al.*, 2020). Mismatched monitoring programmes or mismatched indicators against PA values, management interventions and objectives may render planning and outcomes evaluation ineffective. The benefit of a decision support framework is that it introduces comparative analysis power and promotes consistency and a common lexicon, coupled with collaboration (Schwartz *et al.*, 2017; Redford *et al*., 2018). Therefore, PAs with similar attributes, similar threats and similar management issues can apply similar indicators, creating scope for comparative analysis and impact evaluation at landscape (Melzer, Ezzy & Hines, 2019). For this study, the introduction of the Conservation Standards established PA values and thresholds for variation and practitioners perceived these to provide information on the condition of ecological PA values and impact of intervention. Analysis of these data is however required to provide insights into the adequacy of monitoring projects to serve this purpose. Results also indicated that practitioners feel that comparative analysis across PAs with similar contexts, is now possible.

There is risk of a management intervention focusing solely on one or two prevalent and destructive threats at the cost of the big picture (Parrish, Braun & Unnasch, 2003) while non-linear causal links between intervention and outcome also exist (Geldmann *et al*. 2013; Geldmann *et al*. 2019, Wauchope *et al*. 2022). For this study, all practitioners perceived invasive alien plant species to be a threat, management issues associated therewith being project management, financing and human resourcing. The control of invasive alien plant species requires monitoring programmes to respond to threat reduction and ecological integrity. The evidence generated may then infer failure or success of the theory about the impact of the intervention or infer failure or success about the way the intervention was executed (Margoluis *et al.*, 2013). For example, the regrowth of an invasive alien plant species following application of herbicide may indicate that a) herbicide mix requires adaptation, or b) the species is immune to the herbicide applied, or c) herbicide was not applied properly, or d) the invasive alien plant seed bank was activated. Thus, the execution of the intervention requires adaptation, or the mechanical management intervention needs to be supplemented with the use of fire as a management tool. Thus, the theory about the impact of the intervention requires adaptation. Alternatively, mismatched stakeholder interests and objectives about the control of invasive alien plant species may lead to ineffective strategies (e.g. poverty alleviation objectives versus ecological objectives, see Chapter 2). Similar to other studies, the application of the Conservation Standards opened dialogue to establish root cause of threats helping bridge diverse objectives and views (Carr *et al*., 2017; Núñez-Regueiro *et al*., 2020) and link action to objectives (Redford *et al*., 2018).

3.4.4 Concluding remarks

In conclusion, this study relied on practitioners reflecting their experience in producing management plans prior to the adoption of a decision support framework. The results do not diminish the planning products and monitoring programmes produced in the absence of the decision support framework. However, they highlight that PA management planning and associated conservation outcomes evaluation have necessitated evolution for conservation efforts to respond to global conservation concerns and to the rapidly changing and unpredictable socio-economic contexts within which PAs exist (Roux *et al*., 2015; Núñez-Regueiro *et al*., 2020; Geldmann *et al*., 2021, Smit, Maze & van Wilgen, 2024). Results of the current study do not overshadow that evidence was not sought or adaptive management principles not applied prior to the Conservation Standards. Results do however confirm a more collaborative and focussed approach to the source and type of evidence accessed at the foundational stages of management planning to enable adaptive management upon application of the framework, with due consideration for the conservation situation. The systematic approach promoted by the Conservation Standards unpacks PA context in terms of their situation in the social-ecological system, articulates PA values and establishes thresholds of acceptable variation, assesses threats and articulates goals based on evidence and collaboration with stakeholders. Actions are then formulated in view of threats and their contributing factors and PA values that need management intervention. It is expected that impact evaluation is attainable over

time since measures of success have been established at the onset of planning and are linked to PA goals, provided plans are implemented and the dynamic social-ecological context is considered and understood.

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Supplementary Material:

Supplementary S3.1 Questionnaire: QUESTIONS FOR QUALITATIVE INTERVIEWS WITH CONSERVATION PRACTITIONERS

Participant rights and ethical integrity

To address potential bias that may be introduced through participation only by practitioners with an interest in the research, those naturally inclined to seek evidence or improve systems, or having time to participate, CapeNature Top Management will be approached to garner support for maximum participation in the survey. A formal letter requesting participation in the research will then be circulated to a random pool of participants via e-mail and discussed telephonically prior to commencing the research. The letter will outline why the candidate has been selected for participation and provide a brief overview of the research project, aims and approach. Details of ethics approval granted, parameters of participation and contact details for inquiries will be outlined.

The letter will inform participants that participation in the research is voluntary and that interviews will be recorded with a voice recorder. The prescripts of the Protection of Personal Information Act (Act No.4 of 2013) (PoPIA) will be adhered to and participant personal identity shall be kept confidential, including the names of protected areas in question. Participants will be notified that research results may be presented at scientific conferences or in special publications and may be made available for comparative research studies in the future.

Participants will be requested to sign a letter of consent and semi-structured interviews will be carried out in person.

Background to questions

Practitioners make decisions about the attributes of a protected area that represent the suite of biodiversity and cultural value of the site. Decisions are made about which threats to respond to, what to monitor and where to allocate resources, and essentially, to decide on actions that will lead to goals. Based on the need for decision science and management practice to be founded upon evidence, the questionnaire is aimed at eliciting practitioners' knowledge on the sites for which they are responsible, and the evidence source and type used in the protected area management planning process. The survey is also designed to understand opportunities and constraints related to accessing and/or using evidence in protected area planning and management and to gain practitioner perceptions of the planning process. The questionnaire is a two-part questionnaire. The first part is designed to capture descriptive site-specific contextual data and understand how well practitioners understand their site and associated outputs of planning. The second part is semi-structured with open and closed questions designed to understand how practitioners' access and use evidence, how they experience the planning process, and the kinds of evidence practitioners feel they are

responsible for collating and using in their specific areas of responsibility. Explanation of terminology used in the questionnaire will be guided during the interview. Please refer to the proposal, Section 3.3.

QUESTIONAIRE FOR INTERVIEWS WITH PRACTITIONERS

PART 1: BACKGROUND DATA (AIMED AT UNDERSTANDING HOW WELL PRACTITIONERS KNOW THEIR PROTECTED AREA)

1. JOB FUNCTION: Please indicate your position in the organisation.
2. YEARS OF RELEVANT EXPERIENCE: Please indicate the number of years in your field of expertise.
3. PROTECTED AREA: How many protected areas do you manage/support.
4. ROLE IN PROTECTED AREA MANAGEMENT: What is your role in the management of the protected area/s?
5. LEGAL STATUS: Please indicate the Legal Status of your protected area/s.
6. MANAGEMENT PLAN: Is there a current management plan for your protected area/s?
7. MANAGEMENT PLAN: How many management plans have you authored (written contribution)?
8. PROTECTED AREA VALUES: Please indicate the values for your protected area/s.
9. KEY MANAGEMENT ISSUES: Please indicate the key management issues in your protected area/s.
10. KEY THREATS: Please indicate the key threats to the biodiversity of the protected area/s you work in.
11. CRITICAL MANAGEMENT ACTIVITIES: Please list the critical management activities for your protected area/s.
12. SOCIO-ECOLOGICAL SYSTEM: Can you briefly describe the socio-ecological context of your protected area/s?

PART 2: SEMI-STRUCTURED INTERVIEW

1. Do you use evidence for the development of protected area management plans?
   [ ] Yes
   [ ] No

Briefly describe what evidence you use:

……..

2. Do you use evidence in the review of protected area management plans?
   [ ] Yes
   [ ] No

Briefly describe what evidence you use:

……

3. How do you know if the protected area is well designed (e.g. adequacy of size, shape, location?)

Answer: ……

4. Do you consult evidence when planning, if so, why?

Answer:…….

5. How do you know the condition of protected area values?

Answer:…… …….

6. Pease select the option which best describes the evidence source used to inform protected area management planning:
    a. Selection of values: rate your selection on a scale of 1 to 5 (1- Never, 2-Rarely, 3-Sometimes, 4-Often, 5-Always)

Management plans	Grey literature	Peer reviewed literature	Raw data	Analysed data	Expert opinion	Anecdotal / experience / indigenous / traditional knowledge

    b. Viability analysis of protected area values: rate your selection on a scale of 1 to 5 (1-Never, 2-Rarely, 3-Sometimes, 4-Often, 5-Always)

Management plans	Grey literature	Peer reviewed literature	Raw data	Analysed data	Expert opinion	Anecdotal / experience / indigenous / traditional knowledge

    c. Threats assessment: rate your selection on a scale of 1 to 5 (1- Never, 2-Rarely, 3-Sometimes, 4-Often, 5-Always)

Management plans	Grey literature	Peer reviewed literature	Raw data	Analysed data	Expert opinion	Anecdotal / experience / indigenous / traditional knowledge

    d. Analysing the conservation situation (socio-economic context): rate your selection on a scale of 1 to 5 (1- Never, 2-Rarely, 3-Sometimes, 4-Often, 5-Always)

Management plans	Grey literature	Peer reviewed literature	Raw data	Analysed data	Expert opinion	Anecdotal / experience / indigenous / traditional knowledge

7. How would you describe the type of evidence used in management planning? Rate your selection on a scale of 1 to 5 (1- Never, 2-Rarely, 3-Sometimes, 4-Often, 5-Always)

Specific	Proximate	Generic

Please explain your answer:……..

8. Please select the option which best describes how evidence for protected area management planning is accessed:
    a. Selection of values: rate your selection on a scale of 1 to 5 (1- Never, 2-Rarely, 3-Sometimes, 4-Often, 5-Always)

Create data and analyse data	Analyse existing data	Web-based search	Web-based search of publications database	Systematic review	Hand search of resources	Phone a friend	Other

    b. Please describe how you keep up to date with new developments, information, research, literature, etc. related to the site or field of protected area management.

Answer: ……..

9. Do monitoring programmes collect information to measure impact of interventions outlined in the management plan?

Strongly disagree	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Strongly agree

Optional explanation of answer: .....

10. Do monitoring programmes collect information to measure condition and trend of ecological values outlined in the management plan?

Strongly disagree	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Strongly agree

Optional explanation of answer: .....

11. Do monitoring programmes collect information to measure condition and trend of cultural values outlined in the management plan?

Strongly disagree	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Strongly agree

Optional explanation of answer: .....

12. Do monitoring programmes collect information to measure the contribution of protected areas to human well-being outlined in the management plan?

Strongly disagree	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Strongly agree

Optional explanation of answer: .....

13. Is the evidence sufficient to evaluate effectiveness of actions outlined in the management plan?

Definitely not	Probably not	Possibly	Probably	Very Probably	Definitely

Optional explanation of answer: .....

a. On a scale of 1-6, please rate your perception of evidence-based information used for evaluation, 1 being ‘all qualitative, expert opinion’ and 6 being ‘all quantitative measurement and experimental analysis’:
Answer: ……

14. Is the evidence sufficient to evaluate achievement of goals outlined in the management plan?

Definitely not	Probably not	Possibly	Probably	Very Probably	Definitely

a. On a scale of 1-6, please rate your perception of evidence-based information used for evaluation, 1 being ‘all qualitative, expert opinion’ and 6 being ‘all quantitative measurement and experimental analysis’:
Answer: ……

15. Please describe whether primary literature (peer reviewed published papers) is accessed and used for management planning?

……

16. How would you describe access to evidence?

Very difficult and time consuming	Difficult and time consuming	Somewhat difficult and time consuming	Neutral	Somewhat quick and easy	Quick and easy	Very quick and easy

Please explain your answer:

……

17. On a scale of 1 to 6, please rate your perception of evidence-based information used in the management planning process, 1 being 'all qualitative, expert opinion' and 6 being 'all quantitative measurement and experimental analysis': ……

Please explain your answer:

……

18. The METT-SA assessment provides sufficient evidence to inform conservation outcomes evaluation.

Strongly disagree	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Strongly agree

Please explain your answer:

……

19. What information do you feel is important to support your management decisions?
Answer:

……..

20. What evidence do you think will determine whether actions led to conservation outcomes?
Answer:

……..

21. What evidence do you think will determine whether actions were unsuccessful?
Answer:

……..

22. How do you experience the Conservation Standards in terms of bringing evidence into the planning process?

Answer:

……..

23. What do you think has been the benefit of applying the Conservation Standards to management planning?

Answer:

……..

24. Did anything change in management planning with the application of the Conservation Standards to the planning process? If yes, what was the change? If no, what was the status quo?

Answer:

……..

25. Do you think the strategic management intention for plans drafted prior to the application of the Conservation Standards are clear to direct actions towards conservation outcomes? Please explain your answer. If not, what would you change?

Answer:

……..

26. Do you think the strategic management intention for plans drafted using the Conservation Standards is clear to direct action towards conservation outcomes? Please explain your answer. If not, what would you change?

Answer:

……..

27. What is your experience with the Conservation Standards (years of experience and role (practitioner / facilitator / coach / participant)?

Answer:

……..

28. How do you experience the Conservation Standards framework and would you change anything?

Answer:

……..

Table S3.1. Likert-scale survey question score aggregation for ease of analysis.

<table>
<tr><th>Question</th><th>Likert-scale</th><th>Aggregation</th></tr>
<tr><td>6.</td><td>6. Pease select the option which best describes the evidence source used to inform protected area management planning:
a. Selection of values: rate your selection on a scale of 1 to 5 (1- Never, 2-Rarely, 3-Sometimes, 4-Often, 5-Always)
<table>
<tr><th>Management plans</th><th>Grey literature</th><th>Peer reviewed literature</th><th>Raw data</th><th>Analysed data</th><th>Expert opinion</th><th>Anecdotal / experience / indigenous / traditional knowledge</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
b. Viability analysis of protected area values: rate your selection on a scale of 1 to 5 (1- Never, 2-Rarely, 3-Sometimes, 4-Often, 5-Always)
<table>
<tr><th>Management plans</th><th>Grey literature</th><th>Peer reviewed literature</th><th>Raw data</th><th>Analysed data</th><th>Expert opinion</th><th>Anecdotal / experience / indigenous / traditional knowledge</th></tr>
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</table>
c. Threats assessment: rate your selection on a scale of 1 to 5 (1- Never, 2-Rarely, 3-Sometimes, 4-Often, 5-Always)
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<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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d. Analysing the conservation situation (socio-economic context): rate your selection on a scale of 1 to 5 (1- Never, 2-Rarely, 3-Sometimes, 4-Often, 5-Always)
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</table></td><td>‘Yes’; ‘No’</td></tr>
<tr><td>7.</td><td>7. How would you describe the type of evidence used in management planning? Rate your selection on a scale of 1 to 5 (1- Never, 2-Rarely, 3-Sometimes, 4-Often, 5-Always)
<table>
<tr><th>Specific</th><th>Proximate</th><th>Generic</th></tr>
<tr><td></td><td></td><td></td></tr>
</table></td><td>‘Yes’; ‘No’</td></tr>
<tr><td>8.</td><td>8. Please select the option which best describes how evidence for protected area management planning is accessed:
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<table>
<tr><th>Create data and</th><th>Analyse existing data</th><th>Web-based search</th><th>Web-based search of</th><th>Systematic review</th><th>Hand search of resources</th><th>Phone a friend</th><th>Other</th></tr>
</table></td><td>‘Yes’; ‘No’</td></tr>
</table>

<table>
<tr><th>Question</th><th>Likert-scale</th><th>Aggregation</th></tr>
<tr><td></td><td>
<table>
<tr><th>analyse data</th><th></th><th></th><th>publications database</th><th></th><th></th><th></th><th></th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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</td><td></td></tr>
<tr><td>9.</td><td>9. Do monitoring programmes collect information to measure impact of interventions outlined in the management plan?
<table>
<tr><th>Strongly disagree</th><th>Disagree</th><th>Somewhat disagree</th><th>Neither agree or disagree</th><th>Somewhat agree</th><th>Agree</th><th>Strongly agree</th></tr>
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</td><td>‘Yes’; ‘No’; ‘Maybe’</td></tr>
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<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td><td>‘Yes’; ‘No’; ‘Maybe’</td></tr>
<tr><td>12.</td><td>12. Do monitoring programmes collect information to measure the contribution of protected areas to human well-being outlined in the management plan?
<table>
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</table>
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<tr><td>13.</td><td>13. Is the evidence sufficient to evaluate effectiveness of actions outlined in the management plan?
<table>
<tr><th>Definitely not</th><th>Probably not</th><th>Possibly</th><th>Probably</th><th>Very Probably</th><th>Definitely</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td><td>‘Yes’, ‘No’, ‘Maybe’</td></tr>
<tr><td>14.</td><td>14. Is the evidence sufficient to evaluate achievement of goals outlined in the management plan?
<table>
<tr><th>Definitely not</th><th>Probably not</th><th>Possibly</th><th>Probably</th><th>Very Probably</th><th>Definitely</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td><td>‘Yes’, ‘No’, ‘Maybe’</td></tr>
<tr><td>18.</td><td>18. The METT-SA assessment provides sufficient evidence to inform conservation outcomes evaluation.
<table>
<tr><th>Strongly disagree</th><th>Disagree</th><th>Somewhat disagree</th><th>Neither agree or disagree</th><th>Somewhat agree</th><th>Agree</th><th>Strongly agree</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td><td>‘Yes’, ‘No’, ‘Maybe’</td></tr>
</table>

Table S3.2. Evidence categories to describe data source (adapted from Pullin & Knight, 2005; Cook, Hockings & Carter, 2010).

Evidence Category	Description
Management plans	Existing management plans.
Grey Literature	Reports, working papers, government documents, evaluations, reviews, handbooks, guidelines, information published outside of academic publishing house.
Peer reviewed literature	Published scientific papers.
Raw data	Data collected from the site: monitoring, surveillance, assessments, mapping.
Analysed data	Analysed raw data synthesised into unpublished reports, knowledge derived from research, monitoring and/or formal assessment.
Expert opinion	Specialist knowledge and expert opinion from external individuals.
Anecdotal/experience/indigenous or traditional knowledge	Observational/anecdotal information derived from practitioners, locals, indigenous groups; documentation / personal accounts of traditional management practices.

Table S3.3. Evidence categories to describe data type (adapted from Salafsky *et al*., 2022).

Evidence Category	Description	Examples
Specific	Evidence from the specific protected area or system of interest.	Camera trap data providing detail about populations.
Proximate	Evidence that may not be from the specific protected area or system but is from a spatially or conceptually close situation.	Data from collared leopards that show dispersal ranges and territory size.
Generic	Evidence from the rest of the world about relevant systems or programs.	Systematic reviews about success of interventions to eradicate pests (e.g. Feral pig eradication in Australia)

Table S3.4. Categories to describe how evidence is accessed (adapted from Pullin & Knight, 2005).

Evidence Category	Description
Create and analyse data	Data is collected and analysed, and results used for evidence.

Evidence Category	Description
Analyse existing data	Data from monitoring, surveillance, assessments are analysed, and results used as evidence.
Web-based search	The web is searched for literature and information.
Web-based search of publications database	Publications databases are searched for literature.
Systematic review	Systematic analyses of site level and previous world experience.
Hand search of resources	Literature and information are sought by searching archives, files, libraries.
Collaborate with experts	Reliance on advisors / expert groups to source and provide information.

Table S3.5.1. The frequency of key management issues (Ervin, 2003a; Hockings, Leverington & Cook, 2015; Hocking *et al*., 2009b) associated with protected areas (PA) as perceived by Practitioners. Thematic areas of alignment between the perceived management issue, the threat and the critical management activity (i.e. management response) are coded by *, ~ and > (only top thematic areas have been coded).

KEY MANAGEMENT ISSUES: Thematic areas	KEY MANAGEMENT ISSUES HIGHLIGHTED BY PRACTITIONERS	% Respondents (n=15)
Access *	managing unauthorised access	27%
	too many users, overuse of trails	
	whether it be legal or illegal and whether for tourism or for sustainable harvesting, access is a big management issue	
Budget **	inadequate and becoming smaller	87%
	funding is a key constraint to help manage protected areas properly	
	syphoned off, with a lot of focus on one threat (e.g. invasive species) and not enough for other areas of work	
	limited to do monitoring and other work	
Climate change	climate change impacts	47%
Disease	disease outbreaks (Avian Influenza)	
Eco-tourism	appropriateness of products	
	Management	
Fire management ***	managing for appropriate regime, reactive tendency towards fire management (i.e. suppressions response as opposed to use as a management tool)	53%
	appropriate frequency, interval and size	
Human resources >	mismatched to operational requirements	80%
	capacity limited generally	

KEY MANAGEMENT ISSUES: Thematic areas	KEY MANAGEMENT ISSUES HIGHLIGHTED BY PRACTITIONERS	% Respondents (n=15)
	capacity limited to do monitoring and other work	
	attitude ito low enthusiasm and passion	
	attitude related to rigidity about work hours (in respect of field work) (links to budget since no compensation, links to passion)	
	capacity limited in terms of capability, skills and expertise to do the work	
	staff management	
Invasive alien species management >>	inability to clear upper reaches and inaccessible areas of invasive alien plants with conventional funding	67%
	flora and fauna (freshwater fish)	
	lack of clearing invasive alien plants	
Knowledge ~	gaps in knowledge and research (more so for new PAs and marine PAs)	27%
	research to inform management limited	
	integrity of science to justify a commercial need (e.g. bee industry and promoting bee hives in PAs)	
Land use	edge effects	27%
	irresponsible farming practices (edge effects, river degradation)	
	expansion of development nodes (pockets of private land within a protected area (relates to protected area design and shape)	
Law enforcement *	ability to respond to poaching	53%
	Illegal harvesting	
	compliance and law enforcement	

KEY MANAGEMENT ISSUES: Thematic areas	KEY MANAGEMENT ISSUES HIGHLIGHTED BY PRACTITIONERS	% Respondents (n=15)
	succulent plant poaching	
Management	infrastructure	33%
	of endangered species (islands) and response to incidents that can impact these species e.g. predation by seals and kelp gulls, Avian Influenza	
	cultural and heritage resources	
	erosion control and restoration	
Monitoring ~	ability (technical expertise and human resources) to collect to inform PA value status; first thing to fall when budgets are reduced	40%
	biodiversity baseline and monitoring data collection and management; surface and groundwater abstraction monitoring and management	
	of rare and endangered species	
	limited in marine sector	
	priority species	
Pressures *	freshwater abstraction	80%
	land invasion	
	environmental conditions lend themselves to resource utilisation and abstraction	
	human settlement encroachment	
	freshwater rights, river ecological reserves, over abstraction impacts	
	estuary health as a result of inflows, utilisation and abstraction	
	harvesting of wildflowers	
	natural resource extraction (mining, prospecting, bioprospecting)	

KEY MANAGEMENT ISSUES: Thematic areas	KEY MANAGEMENT ISSUES HIGHLIGHTED BY PRACTITIONERS	% Respondents (n=15)
	natural resource harvesting	
Process	communication system ineffective	40%
	supply chain constraints, ability to spend funds if we were given more and getting contractors on site	
	cooperative governance in the sense that we do not operate in silos and need our authority partners to be present and productive	
	supply chain procurement processes limiting hindering getting things done	
	bureaucracy in our own unnecessary systems	
	contractor management	
Protected area network	marine PA protection with applicable zonation and legislation	13%
	expansion and legal status	
Stakeholder engagement *>	community involvement	33%
	neighbours	
	willingness of people, buy in for conservation	
	stakeholder engagement	
	volunteers	

Table S3.5.2 The frequency of key threats (Salafsky *et al.*, 2008) associated with protected areas (PA) as perceived by Practitioners. Thematic areas of alignment between the perceived management issue, the threat and the critical management activity (i.e. management response) are coded by colour (only top thematic areas have been coded).

KEY THREATS: Thematic areas	KEY THREATS HIGHLIGHTED BY PRACTITIONERS	% Respondents (n=15)
Agriculture and aquaculture	edge effects in relation to the wildland urban interface, farming, nutrification	20%
	encroachment of farming	
Biological resource use *	illegal harvesting	73%
	human pressure (consumptive activity) on natural resources (terrestrial and marine)	
	illegal hunting with dogs	
	biodiversity crime	
	succulent plant poaching	
Climate change and severe weather	climate change and severe weather	47%
	droughts more prevalent	
	floods more frequent	
Energy production and mining	energy production (oil and gas drilling, oil exploration and mining)	13%
	mining	
Human intrusions and disturbance *	land invasion (unlawful occupation of PAs)	40%
	irresponsible behaviour by visitors	
	unauthorised recreational activities	
Invasive and other problematic species and genes >>	invasive species	100%
	invasive freshwater species	
	inability to keep a handle on invasive species	

KEY THREATS: Thematic areas	KEY THREATS HIGHLIGHTED BY PRACTITIONERS	% Respondents (n=15)
	domestic animals (livestock, horses)	
	predation of threatened seabird species	
	disease outbreaks (threatened seabird species)	
	habitat loss (of threatened seabirds by seals)	
	lack of genetic diversity, inbreeding in priority species	
Natural system modifications ***	inappropriate fire regime	100%
	bush encroachment	
	over abstraction of water from rivers	
	fire (anthropogenic ignitions)	
	instream and riparian structures (dams, bridges, weirs, jetties)	
Pollution	sewerage systems not working	40%
	Litter	
	water quality (urban and industrial development)	
	edge effects in relation to the wildland urban interface, farming, nutrification	
	domestic, industrial and urban wastewater, oil spill	
Residential and commercial development	habitat destruction (connectivity lost)	27%
	human settlement encroachment	
	development not in line with biodiversity	
Transportation and service corridors	fragmentation within PAs	7%

KEY THREATS: Thematic areas	KEY THREATS HIGHLIGHTED BY PRACTITIONERS	% Respondents (n=15)
Contributing factors	insufficient human resource allocation to keep up with operational requirements and new and expanding tourism products >	7%
	human resources inadequate to enable visible surveillance across the protected area >	7%
	communication systems are sub-standard for emergency response and incident management	7%
	unauthorised access due to open access PAs *	27%
	land use change (and reduced availability of land for biodiversity conservation)	27%
	societal buy-in to conservation questionable	7%
	lack of and/or limited funding **	20%
	budget taken away from conservation to fund other mandates **	7%
	people forgetting why a conservation agency exists	7%
	biodiversity mandate not considered important by people	7%
	limited budget **	7%
	limited funding for invasive alien plant control and eradication **	7%
	suboptimal human resources >	7%
	lack of compliance and law enforcement *	7%
	knowledge and understanding of ecological processes is limited to adaptively manage ~	7%
	knowledge and understanding is limited for coastline and marine systems ~	7%
	knowledge and understanding is limited for archaeological sites ~	7%
	knowledge and understanding is limited ~	7%

KEY THREATS: Thematic areas	KEY THREATS HIGHLIGHTED BY PRACTITIONERS	% Respondents (n=15)
	threats have shifted since drafting of protected area management plans. Over the past three years there has been a marked increase in biodiversity crime and mining pressure in and around the PA ~	7%
	focus since drafting the protected area management plan is now completely shifted away from the direction outlined in the protected area management plan	7%
	anthropogenic greed and need	7%

Table S3.5.3 The frequency of critical management activities (Ervin, 2003b; Stolton *et al.*, 2003) associated with protected areas (PA) as perceived by Practitioners. Thematic areas of alignment between the perceived management issue, the threat and the critical management activity (i.e. management response) are coded by colour (only top thematic areas have been coded).

CRITICAL MANAGEMENT ACTIVITIES: Thematic areas	CRITICAL MANAGEMENT ACTIVITIES HIGHLIGHTED BY PRACTITIONERS	% Respondents (n=15)
Budget **	seeking alternative funding sources	13%
Eco-tourism	responsible and lawful eco-tourism development (conservation agency should set example)	20%
	eco-tourism	
	tourism development and maintenance, visitor management	
Environmental education and awareness *>	creating and disseminating the right message to the right audience	20%
	helping visitors understand how to behave, where to go when in a protected area or in nature	

CRITICAL MANAGEMENT ACTIVITIES: Thematic areas	CRITICAL MANAGEMENT ACTIVITIES HIGHLIGHTED BY PRACTITIONERS	% Respondents (n=15)
	taking the conservation message beyond our borders (if we can get the general public understanding that no matter where they are they can create their own bit of nature and manage their own bit of nature and become more sustainable as humans)	
Fire management ***	firefighting	40%
	identification of ecologically sensitive and hotspot areas; firebreak construction; fire preparedness and training; firefighting; communication; neighbours, Fire Protection Association and local authority engagements; incident command; fire reports; fire mapping; fire interval and post-fire monitoring)	
	firebreaks prioritisation alongside forestry areas	
Human resources >	having the right kind of capacity on the ground	27%
	management of staff	
Infrastructure maintenance	firebreaks, trails, roads	33%
	tourism infrastructure such as buildings, trails	
Invasive alien species >>	invasive alien plant clearing	67%
	invasive alien vegetation management (prioritisation of areas for clearing and implementation of integrated work plans; project management and quality control; biocontrol agent releases)	
	revisiting the invasive alien plant clearing models (contractor model not working)	
	invasive freshwater fish species control	
Knowledge ~	collecting and using information	13%
	biodiversity, crime, what is going on, what research is necessary	

CRITICAL MANAGEMENT ACTIVITIES: Thematic areas	CRITICAL MANAGEMENT ACTIVITIES HIGHLIGHTED BY PRACTITIONERS	% Respondents (n=15)
Law enforcement *	law enforcement and compliance monitoring	53%
	Prosecutions	
	law enforcement and compliance in estuaries	
	access control to address poaching	
Management	project management and implementation (invasive species control and eradication, making and maintaining firebreaks)	67%
	activities in view of PA goals	
	management of threats	
	Planning	
	logistics management (coordination of staff and getting into field)	
	PA management	
	freshwater system management (clean water, free of pollution, invasive alien plants removed, groundwater systems)	
	disaster management (e.g. oil spills, floods, fires, droughts, loadshedding, etc.)	
	cultural heritage resources	
	wildlife management	
Monitoring ~	priority species	40%
	estuaries and freshwater systems	
	marine PAs	
	biodiversity and monitoring data collection	
	productivity (outputs, planned versus actual)	33%

CRITICAL MANAGEMENT ACTIVITIES: Thematic areas	CRITICAL MANAGEMENT ACTIVITIES HIGHLIGHTED BY PRACTITIONERS	% Respondents (n=15)
Monitoring and evaluation ~	reporting and ensuring that managers' report on the right things and whether it makes sense	
	critical management activities	
	ensuring appropriateness of ecological monitoring (to inform whether management activity is effective, using effective techniques, is management implementing an activity correctly, making impact or wasting money)	
	information dissemination	
Process	compliance management to ensure that PA management complies with the various legislative requirements (fire management to health and safety to safety at sea to law enforcement)	20%
	organisational systems management	
	management interventions aligned to organisational strategic direction	
Protected area network	zonation of marine PAs	13%
	PA expansion and consolidation	
Research	assisting with research	6%
Stakeholder engagement *>	collaboration with neighbours and partners (to work together and for them to address threats such as invasive alien plants on their land)	33%
	engaging with all the relevant parties	
	managing internal and external clients (neighbours, volunteers, students, protected area advisory committee members, government institutions, municipalities, etc.)	
	achieving ecological connectivity and between partners and stakeholders and landowners	

Table S3.6. Practitioners' (managers (M) and ecologists (E)) attitudes on specific, proximate and generic evidence types used for protected area (PA) management planning and review.

Participant	Quotation content
P1	*M: The specific would have been a strong yes always based on data that's available and where data wasn't available, I would more use the generic. Proximate for me less so because if it's around the area, we've probably got something inside. So definitely whatever was available knowledge for the reserve [PA] specifically was used and generic was that was more the socio-economic stuff.*
P2	*M: More proximate than specific because planning was at [PA] complex level. We manage a unique part of the world, so going to struggle to get global inputs to our specific situations.*
P4	*M: There is not enough data for us to be specific enough to be able to say this is what we need to do, whereas with proximate stuff we would say, based on what's happening there we could potentially do it. Small Floral Kingdom… certain risk in looking at things generically.*
P5	*M: It is based on specific information for the management unit and usually of a quantitative nature.*
P6	*M: Obviously you're going to use all your local data that you can, for example water quality monitoring results. Fisheries data is often proximate (Agulhas subregion) and generic aspect relate to for example climate change.*
P7	*M: We often look first at specific information when we do management planning, and we would also consider that proximate information… we talk about the [PA] zone of influence a lot and what happens in other areas especially with systems that are alike and generic information… We do have very specific information for our specific reserves [PAs] ... there is a major difference in threats for PAs.*
P8	*E: Proximate, site level data for species and ecosystems; data may be relevant for a species but not for an entire site; generic evidence relates to protocols in developing plans and monitoring impacts and species and ecosystems after.*
P9	*E: We have a lot of specific evidence that we use in management planning. For the approximate stuff, there is work happening outside PAs that we rely on (e.g. population), generic less so...*
P10	*E: The general comment is that when we have the information we will always try and incorporate as much site-specific information as we have. And if you don't have, then you're going to start using proximate or generic information. But always if you have the information of the site, that's what you're going to be going for.*
P12	*E: Sometimes we have reserve specific stuff and then use it but quite often we don't have it and then we resort to more generic answers and in the face of not having that, we go completely generic, there's nothing, intrinsically wrong with doing that.*
P13	*E: Because we often work very local and proximate is a little bit more strategic. It depends if we work at site level or PA complex level which might be bigger at catchment system. Generic also applies since we always refer to the wider stuff. …it has to be wider than local or proximate since we don't only work on nature reserve [PA] properties.*

Participant	Quotation content
P14	*E: Specific data is not always available but if it is, we use it. Otherwise, we look for a similar area example other management plans, like coastal management plans consider how they handled their information and what they use to derive information, types of indicators and key ecological attributes. For values, stuff that can be used is generic, example freshwater ecosystems. Information is well thought through, so we have a set of generic information that applicable across all systems.*
P15	*E: I use all available PA specific evidence that I can get hold of, know of or gather myself in the plans. When not available I use proximate information, for example from SANParks, biodiversity spatial plan where relevant.*

Table S3.7. Practitioners' (managers (M) and ecologists (E)) description of the evidence they use in PA management planning and review, providing insights on accessibility of evidence by the two groups.

Participant	Quotation content
P1	*M: Knowledge of threats and risks, knowledge derived from experience, data, science derived from internal/external monitoring data; intelligence gathered e.g. during routine patrols (in relation to poaching); monitoring and surveillance data.*
P2	*M: Fire history, invasive alien clearing history, infrastructure mapping, zonation scheme, ecological data.*
P4	*M: veld age and fire frequency, fire hotspots and ecologically sensitive areas, invasive alien clearing planned and actual operations.*
P5	*M: vegetation maps, infrastructure registers, species lists, protection status, heritage registers, income generated, expenditure, municipal socio-economic data.*
P6	*M: Monitoring results, social surveys, ground-truthed spatial data.*
P7	*M: invasive alien clearing plans, veld age maps.*
P8	*E: In house and external specialist input and research documents, monitoring data, species counts, point locality biodiversity data, climate data, research, threats.*
P9	*E: Scientific literature, ecological data, weather data, flora species data, camera trap data to guide mammal inputs, point locality and biodiversity survey data, marine line fish data and catch per unit effort, rocky shore surveys for coastal ecosystems; data results in implementation tables and feedback into goals and strategies for the management plan.*
P10	*E: Best available science and the latest information, workshop style settings to engage with people.*
P11	*E: research papers, public literature, expert knowledge.*
P12	*E: monitoring data, formal and informal literature.*
P13	*E: Monitoring results, research, literature.*
P14	*E: Ecological data, socio-economic information, heritage information, information to inform viability, situation analysis.*

P15	*E: Available research studies discussions with relevant experts/scientists or experienced managers, published papers and reports, monitoring data analysis and recommendations.*

Table S3.8. Emerging themes based on practitioners' (managers (M) and ecologists (E)) descriptions of the evidence that they perceive to provide evidence on conservation outcomes. These themes highlight the multifaceted approach required to determine conservation outcomes, emphasising the need for robust monitoring, comprehensive data analysis, and review aligned with specific conservation goals.

Theme	**Evidence**
Monitoring and Data Collection	Analysed Data: Importance of turning raw data into analysed trends to assess conservation outcomes (P2M, P4M, P13E). Specific Monitoring Programs: Designing monitoring programmes tailored to specific actions (P6M, P9E, P12E). Species Persistence and Ecosystem Health: Monitoring data on species persistence and ecosystem health (P8E, P14E).
Checklists and Management Plans	Checklists for Verification: Using checklists to establish if specific objectives have been achieved (P1M). Management Plan Reviews: Reviewing management plans to determine goal achievement (P10E).
Qualitative and Quantitative Evidence	Comparable Results: Ensuring evidence includes both qualitative and quantitative elements (P5M). Baseline and Comparative Data: Using historic and current data to measure progress (P14E).
Outcome-Specific Evidence	Ecological and Biodiversity Improvement: Evidence should reflect improvements in ecosystem resilience, general ecology, and biodiversity (P7M, P15E). Documented Changes: Evidence of documented changes indicating progress or setbacks (P11E).
Action-Specific Metrics	Responsive Factors: Monitoring should target factors responsive to management actions (P12E). Reduction Metrics: Specific metrics like alien vegetation reduction (P1M, P9E).
Challenges in Measurement	Understanding Sustainability: Difficulty in proving comprehension and impact on sustainability (P3M). Social Science Indicators: Challenges in using social science data, such as user psychology (P8E).

Table S3.9. Practitioners' (managers (M) and ecologists (E)) perceptions on ease of access to evidence, managers appearing to rely on experts and/or stakeholders to gain access to evidence.

Participant	Quotation content
P1	*M: …subject matter dependent. …some things that's very easy to access or you find someone who's a specialist in that field… for instance on species of concern evidence was very easy to access. Something on the archaeological sites - not so easy because there's less peer reviewed information. I'm not overly scientific, I'm all practical and common sense, …some of the research documents are written in such a way that it makes it difficult sometimes to understand. And some of them are written in such a way that the only outcome you can find is more research needed. It doesn't really come up with concrete management recommendations and that makes it difficult.*
P2	*M: There is the internet these days but it's actually scientific data that you require and that's specific…you can probably get pretty close to what you want pretty quickly.*
P3	*M: It is very difficult and it is time consuming, but at the same time it can also be very easy because it depends on if you know your environment and you know the role players within the environment.... You speak to the people in the field that does the physical work, and you work through them to access it. But it is time consuming, and it can be very difficult because you have to do your homework to figure out who to contact and who's verifiable sources so that you don't waste too much time.*
P4	*M: It wouldn't be very difficult, but again for [John], who's 28 years old and he's just come out of Technikon [tertiary institution], it's going to be very difficult and time consuming. Whereas for me and [Steven] and … the guys that have been in a bit long in the tooth that we kind of know what we're looking for... actually have that information at my fingertips and I think that's where institutional knowledge is important.*
P5	*M: It is not always readily available. There should be repository created where information per PA management plan can be readily accessed.*
P6	*M: More time consuming, information has not been analysed, time constraint, access to published papers is difficult.*
P7	*M: …I've read some papers … in the last couple of years I only read legal journals.*
P8	*E: For lesser-known sites there was trolling for information, fortunately there was existing references applicable to the protected area (PA).*
P9	*E: It can be challenging. Researchers help to find papers, battle to get access on more formal platforms such as Science Direct, can request from the author, difficult to get old papers.*
P10	*E: Our systems are just not... We have lots of data but it's not for example analysed or it's not easily available at the click of a button. Our models haven't been set up yet, so you know if we ask fire database for example, its only analysed once a year. It should be available at the click of a button…*
P11	*E: quick and easy, but time consuming.*
P12	*E: Easy to search papers, not so quick and easy to find them, download and read them; reading properly takes time; papers produced faster and faster so there is more and more to read.*

Participant	Quotation content
P13	*E: Quick and easy depending on internet connectivity.*
P14	*E: For me somewhat quick and easy because I've got links to the university, but if I didn't have that, it would be somewhat difficult to time consuming. I've been doing it for so many years, I know how to access the best papers and where to go and look and which journals are best for which publications.*
P15	*E: Certain information is easy to access (e.g. monitoring data collected by PA staff; weather data; fire data); other information is more difficult to get hold of (e.g. collected by other institutions such as …, researchers; etc.).*

Table S3.10. Practitioners' sentiments on monitoring programmes collecting information on the condition and trend of ecological, cultural and human well-being protected area (PA) values outlined in management plans. Sentiments were associated with themes such as 'institutional capability', 'accessibility of information' and biases in monitoring programmes. 'Uncertainty' related to practitioners' mentioning the consistency of implementation of monitoring projects and knowledge of what should be monitored. Managers' responses are depicted by 'M' and ecologists by 'E'.

Participant	Quotation Content	Sentiment	Institutional Capability	Accessibility of Information	Ecological Monitoring Bias	Output Bias	Uncertainty
P1	*M: we still need to analyse that information, see if we're on the right road. But definitely there's a strong natural (PA) values focus [ecological values].*	Positive			√		
P11	*E: Difficult one for me to generalise because ... in some instances we are doing it very well and we are doing trends and condition and that but in other instances we're not. Some of our monitoring has fallen by the wayside, some of the species (monitoring) are good…[ecological values].*	Positive			√		
P13	*E: For sure, made sure that it does for freshwater systems. Also having been part of the Open (Conservation) Standards process I think at least for the ecological values put in. We'll definitely measure the condition and the trends, any trends of changes quite effectively. …not sure how much of it is being implemented across the board, but at least it's written in that way [ecological values].*	Positive			√		√
P14	*E: Eco monitoring projects are linked with PA management plan strategies and*	Positive			√		

Participant	Quotation Content	Sentiment	Institutional Capability	Accessibility of Information	Ecological Monitoring Bias	Output Bias	Uncertainty
	objectives, and if a project does not link, it's not added to the eco matrix and vice versa. Considered viability assessments, and strategic implementation framework tables, ecological or data collection projects, some projects added but flagged for a later date [ecological values].						
P11	*E: We're not doing trends [cultural values]. We can maybe do condition of some things, but you know like rock art and maybe the fish traps are somewhat good like [Manager x] is good with some stuff, but other stuff.*	Positive	√				
P12	*E: Information is not uniformly collected across the Province, potentially site specific [cultural values].*	Positive					√
P13	*E: For some sites strongly agree but I cannot say this is across the board [cultural values].*	Positive					√
P5	*M: There is a heavily reliance on anecdotal evidence. This aspect requires stronger quantitative and qualitative elements [human well-being].*	Positive	√	√			
P2	*M: The monitoring we're doing is mainly ecological, so on the ecological side I agree that it is [ecological values].*	Positive			√		
P8	*E: Its more reporting e.g. number of visitors cannot tell one what is taken from the reserve [human well-being].*	Positive				√	

Participant	Quotation Content	Sentiment	Institutional Capability	Accessibility of Information	Ecological Monitoring Bias	Output Bias	Uncertainty
P10	*E: if it's come out as one of the (PA) values then definitely our monitoring is, is monitoring that as well [cultural values].*	Positive					
P12	*E: Yes, but massive room for improvement [ecological values].*	Positive	√				
P9	*E: Yes, depends how it's all designed [ecological values].*	Positive	√				
P14	*E: We know the ecological values linked to the human well-being. The strategic water source area - the most important thing is water collection and water provision, and we do measure that and we do measure ecological values linked to that. So yes for some things and for others, like Geometric tortoise, its intrinsic, it's not something specific that you can link to human well-being [human well-being].*	Positive	√		√		
P4	*M: It depends on the thing that's being measured. ... there are reserve managers out there that don't know what they don't know. Meaning that they don't know that they need to measure the condition. E.g. quality of veld: Renosterveld out there looks good but it's 40 years old and we can't get it to burn. So it's becoming moribund and eventually we're losing Renosterveld because we've excluded fire [ecological values].*	Neutral					√

Participant	Quotation Content	Sentiment	Institutional Capability	Accessibility of Information	Ecological Monitoring Bias	Output Bias	Uncertainty
P1	*M: there is reference to archaeological sites and the rock art sites and there's a specific Eco matrix item that speaks to that. I think there's a lot of work of work to be done there. It's sort of more yes, we put it on a list and we make a note of it (inventory) [cultural values].*	Neutral				√	
P14	*E: There are some issues, some things that are not being done, but we do have an inventory for most of our reserves [cultural values].*	Neutral	√				
P4	*M: We measure the number of people that come and go … we only look at numbers when it comes to humans in the reserve. We support people coming out of the reserve to practise cultural and traditional practices as well as, cultural, traditional practices, but it's not measured. I intimately understand the connection between man and the environment ...but it's not monitored [human well-being].*	Neutral	√	√		√	
P12	*E: We would have to design stuff a bit more specific before we could answer that properly [human well-being].*	Neutral	√				
P7	*M: I think we can spend more energy on human well-being and not only report on job creation and our alien clearing contractors. Sometimes it's a broader concept. So I think it again needs some unpacking, but I agree we do that. But there's still some*	Neutral	√			√	

Participant	Quotation Content	Sentiment	Institutional Capability	Accessibility of Information	Ecological Monitoring Bias	Output Bias	Uncertainty
	work that needs to be done there [human well-being].						
P3	*M: There's information being collected, but you kind of have to go look for it and be very specific around what you want. If you look at the specific information that's collected, if you have to appoint 14 people and you've appointed 14 people in an area where job searches are 52% of their area... it's not even a drop in the area itself but I don't think we actually touch on that [human well-being].*	Neutral	√			√	
P3	*M: I can prove that I've had interventions. I don't have to prove that I've got an answer… is the eco matrix aligned to the protected area management plan and the values and the protected area management plan, yes it is …the means of verification can be produced but you're not getting an answer [ecological values].*	Negative	√	√		√	
P5	*M: The monitoring and evaluation can be more specific and detailed. At any given stage the tracking should be designed to give you a snapshot of what is happening and your progress against targets [ecological values].*	Negative	√				
P3	*M: Some PAs have good cultural management and have good information*	Negative					

Participant	Quotation Content	Sentiment	Institutional Capability	Accessibility of Information	Ecological Monitoring Bias	Output Bias	Uncertainty
	on where sites are. We don't have that [cultural values].						
P5	*M: More can be done. Currently we don't have thresholds to identify excessive degradation (heritage assets). No measures are put in place to critically analyse the field reports [cultural values].*	Negative	√				
P6	*M: So we're not really geared in the conservation agency overall, to look at that. It is something we need to address … we talk about human well-being in the new management plans and we talk about human well-being quite often lately [human well-being].*	Negative	√				
P7	*M: I do not think that we focus enough on cultural values, I do know that we address them in our management plans, but I think we could monitor them better. So we do include it in our management plans, but I think we can we can spend more time in monitoring that and that's I think your cultural values is a complicated ... it's not as easy, it's not always from A to B [cultural values].*	Negative	√		√		
P9	*E: No, I think we could do more. Going to check out Bushman paintings and cataloguing them is great. But I don't think we go in depth and specially we should engage more communities around the cultural aspects [cultural values].*	Negative					

Participant	Quotation Content	Sentiment	Institutional Capability	Accessibility of Information	Ecological Monitoring Bias	Output Bias	Uncertainty
P1	*M: we just have a long way to go to really measure the impacts of people. I'm worried that sometimes conservation and tourism is a bit at loggerheads. We don't gather enough information on that and our eco matrix, although eco matrix in itself is environmental, but perhaps we should look at re-labelling that [human well-being].*	Negative	√				
P2	*M: We need to look more at our social side than ecological. We've got a lot of information and I think we've got a good understanding of the ecological side, but we don't have a good understanding of the social side [human well-being].*	Negative	√	√	√		
P6	*M: We collecting the information (ecological PA values)... It's not feeding back [ecological values].*	Negative					
P9	*E: Pockets of excellence; and that's not enough in my opinion. Maybe it's a lack of capacity to properly analyse a lot of the data that's being collected [ecological values].*	Negative	√	√			
P13	*E: No, I've not been very directly involved in a lot of that… pockets of excellence [human well-being].*	Negative	√				
P11	*E: … we're getting there. We can get there [human well-being].*	Negative					
P10	*E: sometimes we do. Like how many tourists that we have, How many permits that we write, how many research permits*	Negative	√				

Participant	Quotation Content	Sentiment	Institutional Capability	Accessibility of Information	Ecological Monitoring Bias	Output Bias	Uncertainty
	did we provide for? Sure those sorts of things we know exactly, but the sort of larger ...natural ecological services? No, we don't [human well-being].						
P9	*E: No, partners or researcher do that. We are not very clever at that [human well-being].*	Negative	√				
P6	*M: No [human well-being].*	Negative					
P8	*E: It's something I think that's lacking everywhere [human well-being].*	Negative					
P3	*M: No, because there's no monitoring programme for that [cultural values].*	Negative	√				
P2	*M: I don't think we are collecting enough information on our on our cultural trends [cultural values].*	Negative					

Table S3.11. Practitioners' sentiments on protected area (PA) management effectiveness assessment using the Management Effectiveness Tracking Tool – South Africa (METT-SA) generating evidence to evaluate conservation outcomes. Managers' responses are depicted by 'M' and ecologists by 'E'.

Participant	Quotation content	Sentiment
P6	*M: I agree that questions in the METT can actually give a good idea of what's happening.*	Positive
P14	*E If you look at the at the whole assessment, if you can make the link between what we're assessing in METT versus what we're doing in management planning and the viability assessment and the threats identification, etc. I do think that there are some shortfalls, but I think the information that we get from the METT-SA assessment, can inform whether we are implementing the PA management plan or we reaching our goals, etc. Not in all cases, but I think in most cases.*	Positive
P5	*M: Some qualitative assessments require adequate interpretation, which is not always readily available.*	Neutral
P7	*M: I don't think it provides that. It depends on how you're filling it in. You can score very high or very low depending on what your perception is. You can have a very pretty picture.*	Neutral
P10	*E: The METT process, there Section 6 in the METT. It's kind of what measures those things, but it's one of the shortest sections in the METT. I think to be quite honest, there's only three questions that really evaluate outcomes in the whole METT properly. I think that METT is not evaluating it in depth, it's very broad scale. I think if we do a PA management plan analysis or PA management plan review, we will have a much better understanding of the conservation outcomes than doing a METT evaluation.*	Neutral
P12	*E: sort of bound up and hidden in the in the METT assessment, the kind of details are around some of the conservation objectives and goals, the METT addresses it partially, but it's obscured in the current form of the METT.*	Neutral
P1	*M: …we've had lengthy discussions about this. I am concerned that it's still being used to chase scores and messing around with definitions and that sort of thing.*	Negative
P2	*M: I don't think that would be able to get that from the from the METT. The limit I see is it [METT] more looking at the organisation (indicators) as opposed to a PA.*	Negative
P3	*M: I think there's a lot that falls off of the table because of the questions itself. I can produce the evidence but are we actually achieving it as a different story.*	Negative
P4	*M: It tells you what is wrong and tells you where you are. But it does not tell you what to do. The METT is too strategic. METT means of verification it could be the negative or the positive. Yes we are achieving it or no, there's not enough evidence to sufficiently prove.*	Negative

Participant	Quotation content	Sentiment
P8	*E: Indicators are not adequate to show whether there really has been improvement; might show improvement on management action, but it does not mean there been improvement on the ground.*	Negative
P9	*E: I don't think so. There's a disconnect in terms of what we put in a PA management plan in how we should manage something and look after something and the best way to go about it - the METT is not the right tool to monitor that, because the METT looks at all sorts of other aspects that are not necessarily considered. I think it's not the correct tool for managing that exact process.*	Negative
P11	*E: METT is institutional.*	Negative
P13	*E: It is a national based thing and not necessarily 100% relevant to on the ground in the Western Cape, in the different areas in the Western Cape. I'm not sure. Maybe too strategic. So that's not level information is maybe not there.*	Negative
P15	*E: The METT-SA provides no evidence about the ecological state of the PA.*	Negative

Table S3.12.1. Practitioners' sentiments on clarity of protected area (PA) management strategic intent for plans drafted prior to the application of the Conservation Standards to direct action towards conservation outcomes. Managers' responses are depicted by 'M' and ecologists by 'E'.

Participant	Quotation content	Sentiment
P1	*M: there were clear strategic management intentions, but I think they again they're focused more on reserve [PA] stuff and very much, unless I read them wrong, but it was very much your conservation focused, and I think that's historically how it was ...conservation, fences and doing pure conservation... the importance of expanding, (and we don't do it enough with our current plans) tourism projects, expanding population and the needs of people... we look at what are the numbers currently... we should be looking 20 years from now... the old strategic stuff I think was much more sort of pure conservation focused with flowers and plants and monitoring and rivers and things and that's wonderful because that's the core of what we need to do. With the Open Standards [Conservation Standards], I think it's sort of expanded our range of thinking and I think the next phase can do even more.*	Positive
P2	*M: I think they were clear… Looking at the same actions and it was kind of like an expert opinions idea that this is where we need to be focusing and that's what the actions were aimed at, with the Open Standards [Conservation Standards] actually guided you to come up with those.*	Positive
P3	*M: I think the intentions or the outcomes for a set site (within fences) yes, but not for the larger, within the larger community landscape wouldn't have been considered, freshwater fish management as an*	Positive

Participant	Quotation content	Sentiment
	example... So I think for within the fences, yes, for specific outcomes, but not in a grand scheme of things.	
P5	*M: Yes. There were clear targets set within the original Strategic Management Framework. Formalised M&E has been lacking though.*	Positive
P6	*E: Yes.*	Positive
P8	*E: Yes, PA management plans were highly variable, some were, some were not.*	Neutral
P9	*E: It does seem like it was a fairly good product beforehand ... I'm not saying that Conservation Standards made it better or worse. I'm just saying it's probably a different product now than it was before.*	Positive
P10	*E: It depends on who developed them and how much did they know because I think previously plans were done very much in isolation … one man plan. Depending on whether that person had good knowledge of the site … didn't do property situation analysis, their understanding of threats facing the system might not have been that good, so whether they actually addressed the threats is a question, I don't think plans were that strategic.*	Neutral
P11	*E: yes*	Positive
P12	*E: Hard to tell, past PA management plans were more direct, not entirely off the mark, just limited and adaptive feedback not formally part of it. So harder to tell if they were achieving outcomes even though quite specific and direct.*	Neutral
P13	*E: To some degree before but it has improved a lot with the Conservation Standards. It is definitely more directed and it accounts for in many cases the capacity and budget issues. So we could prioritise, and that thing about the pet projects - that got almost cleared out. I feel it's an improvement. Not everyone will agree with me.*	Positive
P14	*E: No, we did not know what we were planning for.*	Negative
P15	*E: Yes the previous protected area management plans were practical and clearer ito the strategic implementation framework tables where actions were specifically stipulated under each action plan.*	Positive

Table S3.12.2. Practitioners' sentiments on clarity of protected area (PA) management strategic intent for plans drafted following the application of the Conservation Standards to direct action towards conservation outcomes. Managers' responses are depicted by 'M' and ecologists by 'E'.

Participant	Quotation content	Sentiment
P1	*M: … the old strategic stuff I think was much more sort of pure conservation focused with flowers and plants and monitoring and rivers and things and that's wonderful because that's the core of what we need to do. With the Open Standards [Conservation Standards], I think it's sort of expanded our range of thinking and I think the next phase can do even more.*	Positive
P2	*M: Yes. It highlighted things that I don't think a question with expert opinion on a certain subject would have necessarily said, that it was the thought process to get there sort of just created that these are the values that we need to be looking at and the attributes. You know, the thought process.*	Positive
P3	*M: If you think about the old management plans, you were focused on achieving outcomes within specific areas within specific time frames. When now, with the Conservation Standards it's much broader and it's not attainable necessarily to a point where you can say this is the outcome because it's broad as not necessarily just a CapeNature thing. You're depending on your partners, you're depending on everybody bringing their parts together for that outcome to be achieved.*	Positive
P5	*M: I have not compared the two processes to adequately to make an informed decision.*	Neutral
P6	*M: Yes, it's looking at the level they sit.*	Positive
P8	*E: Yes, strategies clear, linked to clear objectives that are more measurable; however, other PA management plans have too many goals, too many strategies that may result in overlap and confusion and lack of people taking responsibility for strategies.*	Positive
P9	*E: I think the Conservation Standards has grabbed a wider audience to help us inform our management plans and that makes ... it feel like it's more ... it helps us as the wording, helps us inform strategic adaptive management better ... because we get a broader idea of what's happening and when we write up the plan, I think the other ones appear to be more reserve-centric [PA centric].*	Positive
P10	*E: It is up to standard… we haven't fully implemented the Conservation Standards process … we're still very much in a planning / implementation phase. We need to move along now and do the actual assessment and review and adaptation. We just need to, as an organisation, embrace and move forward with those last steps of the Conservation Standards process.*	Positive
P11	*E: yes.*	Positive
P12	*E Hugely improved; but not doing enough monitoring, or the right kind of monitoring and putting enough effort into it. Constantly*	Positive

	looking at our impact - still need to do that to give effect to the plans; on the right track but implementation not done yet.	
P13	*E Yes. I am not aware of anything that directs it more. There's probably some more direction that can happen, but it's definitely allowed us to prioritise, which is definitely we doing specific to inform specific questions. And it's not just for monitoring's sake.*	Positive
P14	*E: Yes. The first few that we did, the [PA1], [PA1] [PA3], were a little bit less so. But as we learned and we used the Conservation Standards more and more, we learned quite a lot. I think it has improved quite a lot. If you follow the Conservation Standards correctly, there is no reason why it shouldn't be the case.*	Positive
P15	*E: We have adapted the strategic implementation framework tables to include the actions from the old PA management plans in order for the document to be practical, understandable and implementable. The language/terminology used in the Conservation Standards process is foreign to managers and staff. They do not understand it and if they do not understand the language then they will not read the document.*	Neutral

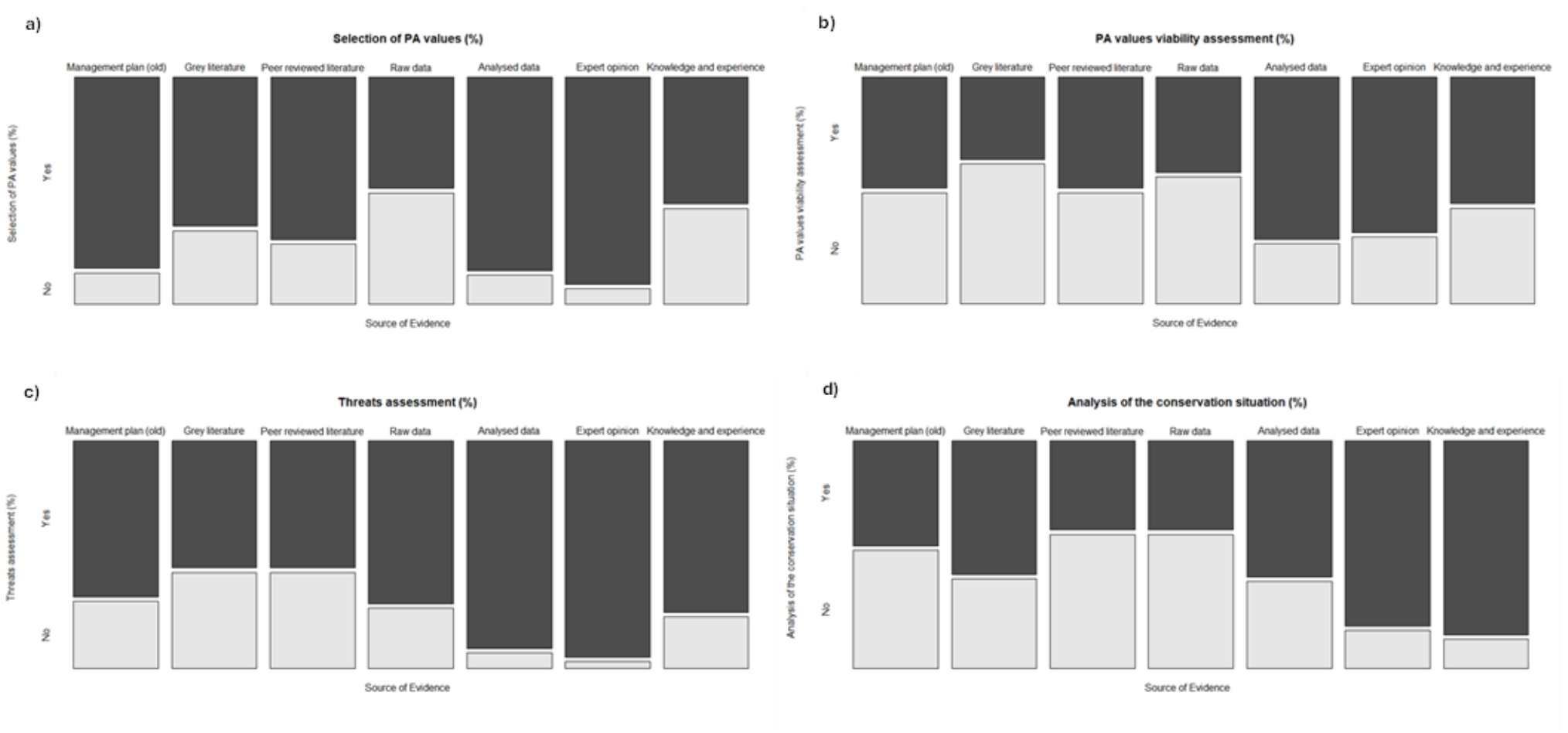

Figure S3.1 Mosaic plot of observed frequencies of the source of evidence by a) selection of protected area (PA) values (%), b) PA values viability assessment (%), c) threats assessment (%) and d) analysis of the conservation situation (%).

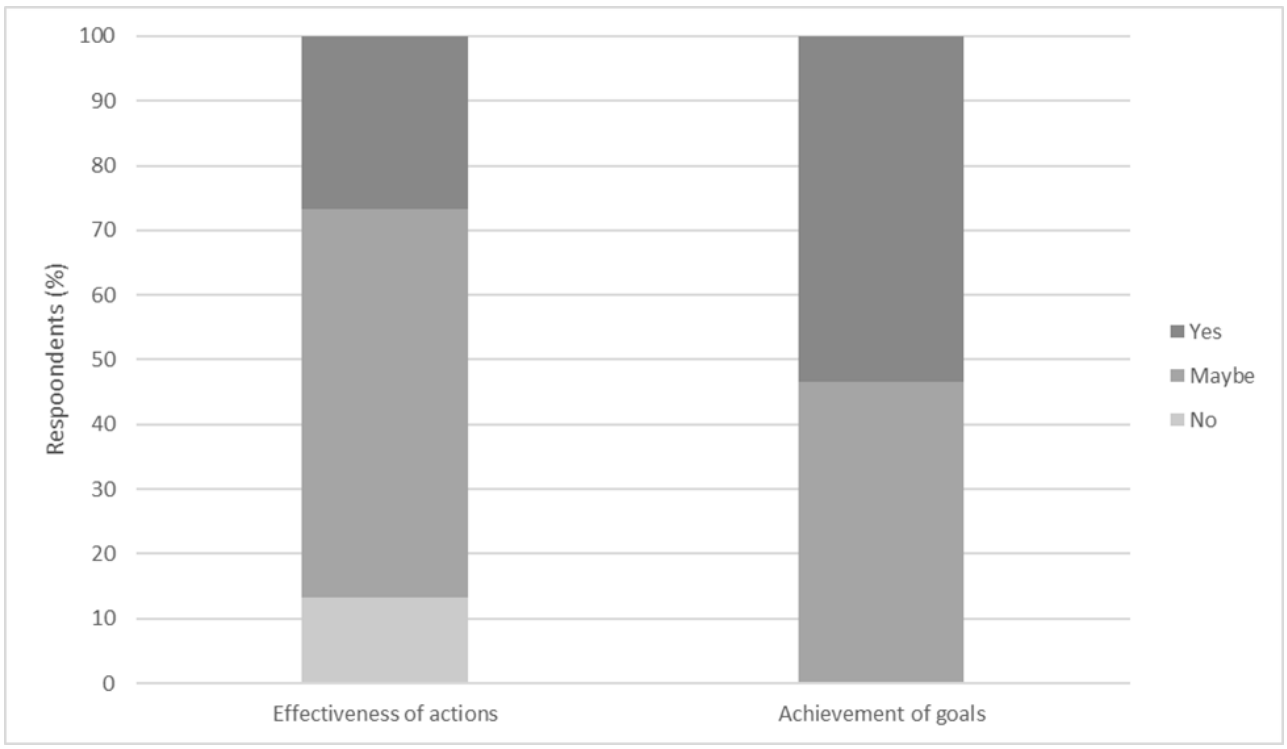

Figure S3.2 Perceptions of practitioners on whether evidence generated from monitoring programmes is sufficient to evaluate the effectiveness of actions and the achievement of goals.

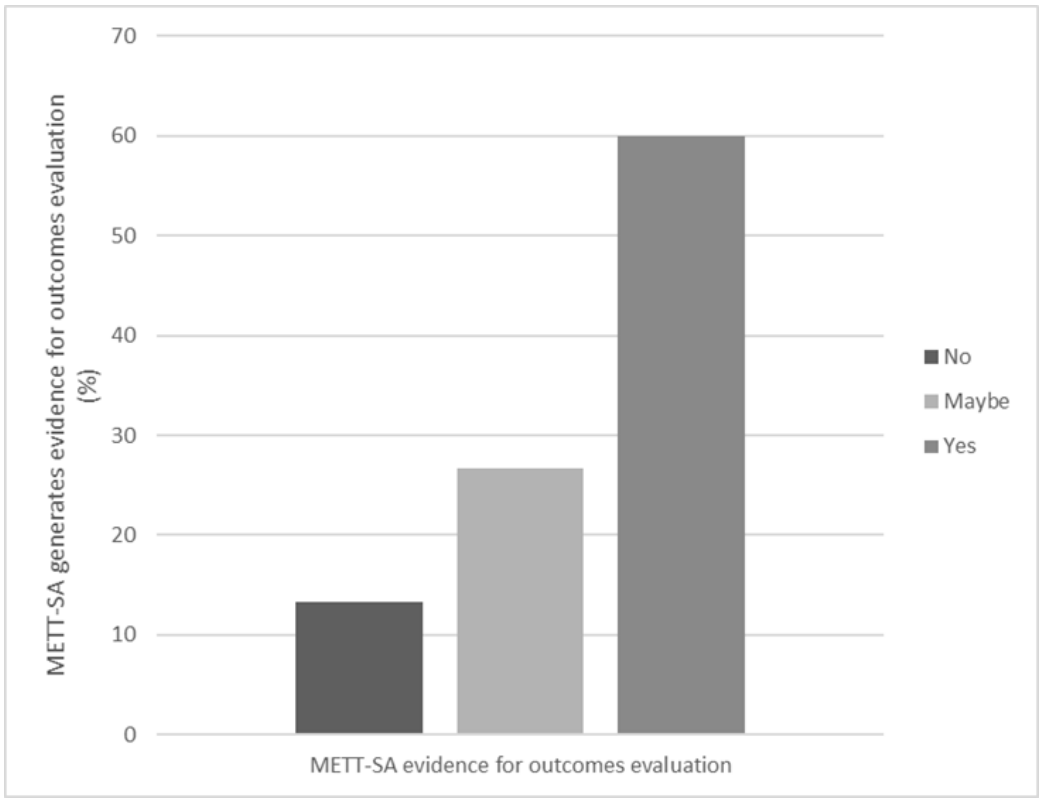

Figure S3.3 Practitioners' perceptions on protected area management effectiveness assessment using the METT-SA, providing sufficient evidence to inform conservation outcomes evaluation.

CHAPTER 4: CONCLUSIONS AND RECOMMENDATIONS

The aim of the thesis was to firstly investigate the change in protected area (PA) management effectiveness pre and post the introduction of a decision support framework (i.e. the Conservation Standards for the Practice of Conservation) and secondly the drivers of change in management effectiveness. The thesis then investigated practitioner perceptions on the use of evidence for PA management planning and review, and the contribution of the decision support framework to promote evidence-based planning.

These thesis aims are grounded in three critical aspects of conservation strategy, namely, the effectiveness of PA management for positive outcomes, the value of decision support frameworks, and adaptive management. This chapter highlights key conclusions, discusses some limitations and makes recommendations at the management and policy levels.

4.1 Main Conclusions

Protected area management effectiveness (PAME) is well researched globally (Hockings, 2003; Leverington *et al*., 2010; Cook, Carter & Hockings, 2014; Coad *et al*., 2019; Geldmann *et al*., 2015; 2018; 2019; Stolton *et al*., 2019; Zafra-Calvo & Geldmann, 2020; Geldmann *et al*., 2021; Ghoddousi, Loos & Keummerle, 2022). However, the South African context and the utility of the management effectiveness tracking tool South Africa (METT-SA) as a methodology, is not well understood (Carbutt & Goodman, 2013). The results of this study showed that the improvement in PAME based on assessments using METT-SA requires time for implementation and planning. Although overall PAME scores improved, there were declines in outcomes indicators. Indicator score analysis showed that although PAs are resourced, these human and financial resources may not be sufficient to drive a positive conservation outcome (Chapter 2).

At the onset of the study, it was expected that management planning would drive improved scores (i.e. enhance management effectiveness) but that at the strategic and operational levels, planning may be overly ambitious either due to a lack of experience, evidence or frameworks to guide planning. Although the PA management element Planning was significantly correlated with METT-SA scores, the tool does not consider the quality of planning (Chapter 2). Thus, PAs are at risk of resourcing and implementing management plans unfit for the achievement of positive conservation outcomes. However, it is imperative to also acknowledge that the relationship between management indicators and effectiveness is not causal (Leverington *et al*., 2010; Geldmann *et al*., 2015), thus external non-management factors and their potential influence on aspects of management should be considered (Gill *et al*., 2017; Chapter 2). The significant improvement in management elements Inputs and Outputs over time for this study suggests that PA management systems and processes exist and are adequate for critical activities, but insufficient to achieve conservation outcomes.

Despite significant improvement in the PA management elements Inputs and Outputs, conservation outcomes indicators continued to decline. The quality of planning is key to the pursuit of positive

conservation outcomes but PAs face financial and human resource constraints and rely on external funding for operations, so human resource capacity is sufficient only for critical management objectives (Chapter 2). The improvement in PAME scores over an average period of seven years from 69% to 73%, is largely attributed to meeting indicator requirements such as the existence of registers, plans or policy, which suggests that actual nature conservation progress is slow, and that practitioners are caught up in a cycle of administration rather than implementation. The overall METT-SA average score of 73%, coupled with inadequate resourcing, begs the question as to whether PA resourcing (and subsequent management) is adapting to, and matching, the changes in environmental conditions and social-ecological systems highlighted by van Wilgen and Biggs (2011).

The study was inconclusive about the Conservation Standards contributing to improved METT-SA scores. However, the decision support framework's requirement for the introduction of evidence and stakeholder engagement at the onset of PA management planning, considers the condition of PA values and PA context, setting management intention. Practitioners indicated that the planning process was more focussed and enabled a more focussed application of evidence to plan within and beyond the fences of PAs. This implies that the management planning approach evolved from insular and protected area-centric, to one of enhanced collaboration and co-production of knowledge as advocated by Roux *et al*. (2006; 2021). As a result, the PA management planning team's enhanced consideration for external factors that influence the PA should enable strategic planning for the pursuit of conservation outcomes through adaptive management (Chapter 3), acknowledging however, that environmental conditions and social-ecological systems constantly change (van Wilgen & Biggs, 2011; Smit, Maze & van Wilgen, 2024). The reliance by practitioners on evidence sources such as collaboration with experts, creating and analysing data and the use of multiple types of evidence, suggests a strong evidence-based approach to planning based on the results of this study. Practitioner focus on creating and analysing data also suggests a reliance on monitoring programmes (Chapter 3). This highlights the dependencies that exist between planning, implementation, review and associated feedback loops in the adaptive management cycle.

METT methodology offers more value when comparing the same site over time rather than comparing different sites at a specific time (Dudley *et al.*, 2007; Stolton *et al*., 2019). PAME research highlights the need for, and limitations in the availability of, counterfactual studies to better understand the conditions that drive management effectiveness (Coad *et al*., 2015; Powlen, Gavin & Jones, 2021). The current study assumed that in the absence of a decision support framework, PA management plans were drafted inconsistently as it relates to the author of the plan, the process used to prepare the management plan, and sources of evidence used. The expectation was that management plans developed prior to the Conservation Standards were drafted in isolation by manager/s, and that evidence was largely anecdotal, and experience based. Practitioner perceptions validate these assumptions about the management planning process, highlighting that the Conservation Standards introduced structure, prioritisation and the early integration of evidence and

stakeholder engagement in the development of PA management plans (Chapter 3). Practitioners relied on multiple sources of evidence, showing a preference for collaborating with experts and creating and analysing data. The change brought about by the Conservation Standards included a targeted use of evidence at the onset of planning, coupled with early stakeholder engagement (Chapter 3).

The METT-SA is embedded in adaptive management theory (Hockings, Leverington & Cook, 2015) although practitioners risk their decisions and actions being directed by indicators in the tool as opposed to planning and managing adaptively (Chapter 2). Tools such as the METT provides the necessary governance, administrative and operational insights that practitioners require to ensure that PAs are equipped to pursue biodiversity conservation, with the aim of protecting and conserving the ecological, cultural and human well-being values of PAs (Stolton *et al*., 2019; Stolton, Dudley & Hockings, 2021). The existence of a plan does not imply that management is effective, neither achieving a positive conservation outcome (Chapter 2). Therefore, the benefit of a decision support framework for PA management planning lies in its utility to guide practitioners to think about their decisions (Hemming *et al*., 2021) and facilitate an improved understanding of these systems to define goals, management objectives and strategies (Roux *et al*., 2022). The enhanced collaboration and focussed approach to the source and type of evidence accessed at the foundational stages of management planning introduced by the Conservation Standards, can enable adaptive management (Chapter 3). The framework's systematic focus on foundational aspects of the PA such as PA context, condition of PA values, assessing threats and articulating goals, enables adaptive management capability. This capability is enabled because goals are based on the desired state of PA values and management intervention is linked to threat mitigation and/or PA value condition. Goals are thus expected to be measurable should the necessary PA value monitoring programmes exist. PA impact evaluation can therefore be attainable in time, provided plans are resourced and implemented, and monitoring programmes are appropriate and feedback loops are established.

The use of PAME tools such as the METT-SA have limitations as standalone measures of PAME. These tools must be supplemented by site level monitoring and evaluation on the condition and trend of PA values and tracking of management interventions. Employing a decision support framework or adaptive management approach is likely to improve the quality of planning by introducing stakeholder engagement and scientific evidence. Moreover, adaptive management promotes a more systemic thinking in management, moving away from an insular outlook to PA management.

4.2 Study design strengths and limitations

This study was undertaken in a somewhat controlled environment since the PAs that were the subject of the study are managed by a single publicly administered provincial conservation agency. Institutional arrangements such as standard operating guidelines promote consistency in PAME assessment processes, interpretation of METT-SA indicators and scoring (Hayward, 2019). Additionally, practitioners who participated in the study represent on average, 18 years' experience

in the field of nature conservation, suggesting consistency in PAME assessments using the METT-SA and having participated in PA management planning before and after application of the decision support framework. The study therefore reflects the situation of PAs managed by a publicly administered provincial nature conservation agency in the Western Cape only (Chapter 2; Chapter 3).

Global PAME studies cited in the current study draw upon large datasets from across the global PA network. For example, research by Geldmann *et al.* (2015) (the inspiration for Chapter 2) extracted METT assessments for 722 PAs from 74 countries. For the current study, the sample size was limited to 38 PA complexes for one country. Since the study was restricted to a single conservation agency in the Western Cape, the sample size for practitioners was also limited (n=15) (Chapter 3). In particular since the sample size was restricted to those who had participated in PA management planning before and after the application of the Conservation Standards.

An intended investigation into the utility of evidence used in PAME assessment using the METT-SA was not within the scope of this study. The validation of practitioner perceptions on PAME assessments generating evidence to provide information on conservation outcomes could thus not be tested (Chapter 3), although it is expected to be largely administrative and unfit for conservation outcomes evaluation.

4.3 Recommendations

4.3.1 Management and policy

The Policy framework for protected area management is strong in South Africa, although vulnerable to time consuming, counterproductive administration and 'tick boxing' (Chapter 2). The application of a decision support framework as a standard, can improve management effectiveness, a standard that should be advocated in South African PA management Policy.

The IUCN Green List for Protected and Conserved Areas establishes a global standard for PA management, based on the pillars of good governance, sound design and planning, effective management and successful conservation outcomes (IUCN & WCPA, 2017). The standard requires management to demonstrate implementation for the maintenance of PA values and ecological processes as foundation for healthy biodiversity and associated human well-being (Hockings *et al*., 2019). In South Africa, adaptive management practice may be constrained by the statutory Policy environment governing PA management. The National Environmental Management: Protected Areas Act (Act No. 57 of 2003) requires that PA management plan amendments (often the result of PA management plan review in response to adaptive management) is agreed to by the relevant political head (South Africa, 2003). Furthermore, the National Environmental Management Act: Protected Areas Act (Act No. 57 of 2003): Norms and Standards for the Management of Protected Areas in South Africa establishes specific management standards applicable to South African PAs (South Africa, 2016). These Norms and Standards require PA managers to include adaptive

management frameworks to ‘ensure monitoring of ecological processes’, feedback loops as it relates to research, and management of ecosystem services (South Africa, 2016). Furthermore, the Norms and Standards direct PAs to be designed and planned to meet their objectives - by implication, top-down objectives then drive management interventions rather than management intervention being driven bottom-up by the condition of PA values and the dynamic social-ecological context within which these PAs exist. The shortcoming is that these standards do not make provision for the application of a decision support framework to take practitioners’ systematically through the design of PAs and management plans and ultimately, to facilitate adaptive management.

The adoption and application of a decision support framework is thus recommended as a standard to enable systematic PA objective setting based on the condition and desired state of PA values with consideration for the dynamic social-ecological context of PAs. To promote and strengthen adaptive management via the PA management Policy framework, it is proposed that PA management planning and adaptive management feedback loops such as management plan review and amendments be enabled via the Norms and Standards rather than the Protected Areas Act.

Based on the results of this study (Chapter 2; Chapter 3), at country level, PA management authorities should consider adopting the four components of successful nature conservation (good governance, sound design and planning, effective management and successful conservation outcomes) in PAs as a standard (IUCN & WCPA, 2017; Geldmann *et al*., 2021). These four components should serve as a conceptual foundation in the pursuit of effective PA management. Due to the requirement for Parties to the Convention on Biological Diversity (CBD) to report on management effectiveness and the current functionality of the Global Database for PAME (Leverington *et al*., 2010), the METT-SA is likely to remain as the preferred statutory tool to measure PAME in South Africa. It is recommended however that the tool is based on the pillars of the Green List Standard and distilled from 70 indicators to fewer key indicators designed to evaluate PA management planning, resourcing, equitable governance, and conservation outcomes. The assessment should be informed by a state of PA assessment that articulates progress towards PA goals, the condition of PA values, the status of threats, progress with implementation and recommendations for adaptive management / management intervention review (for example, Health Checks in Australia (Melzer, Ezzy & Hines, 2019)).

The geographic scope of this study incorporated the Fynbos biome in its entirety and the Cape Floristic Region global biodiversity hotspot (Chapter 2; Chapter 3). The contribution and obligation of the provincial conservation agency in directing PA management for effective conservation is critical for the long-term survival of endemic taxa and for the conservation of this globally recognised biodiversity hotspot. Based on the findings of this study, financial and human resources to effectively manage PAs need to be augmented urgently (Chapter 2; Chapter 3). Threat mitigation such as the eradication and control of invasive alien plant species requires a revived strategy to balance ecological and poverty alleviation objectives. Monitoring and evaluation capacity and capability is

required in addition to field ranger capacity for implementation of plans and adaptive management. Social science capability should be considered as a prerequisite for officials who undertake stakeholder engagement to lead and guide practitioners as they navigate PA management within complex social-ecological systems. Strategic partnerships should be prerequisite to the provision of scientific capability and human resources over and above funding. Donors may also consider project funding application scope to augment science and human resources due to the limited human resources available within publicly administered conservation agencies. Generally, at country level, practitioner capacity building and training should incorporate cultural sensitivity and the social sciences, modules on conservation strategy and theory of change, PAME theory, adaptive management, and the application and utility of decision support frameworks.

4.3.2 Potential future research avenues

To establish a reflection of PAME and the use of evidence at country scale in South Africa, a similar study with wider scope to include for example South African National Parks, would be beneficial to understand the state of PAME and evidence-based management across the South African PA network, and associated social-ecological systems.

The value of the evidence generated from the PAME assessment process using the METT-SA requires further investigation to validate practitioner perceptions that were highlighted in the current study (Chapter 3) and establish what the evidence generated from assessment reveals about management and conservation outcomes. This can help streamline administration of the PAME assessment process and validate qualitative assessment results. However, a well-designed state of the PA report should be sufficient as evidence to inform qualitative METT-SA assessments.

To demonstrate the utility of the Conservation Standards for the measurement of conservation outcomes and adaptive management in support of PAME assessment, one or two newly established PAs on the West Coast, South Africa, could serve as a case study. The research would require these PA's to be established in areas not previously managed for biodiversity conservation, subject to PAME assessment prior to the PA management planning process, and subject to PA management planning using the Conservation Standards or similar decision support framework. Change in PAME over time coupled with assessing PA resourcing and governance and the condition and trend in PA values following management intervention, would be key aspects to investigate. The results are expected to provide insight into progress towards PA goals and trends in the condition of PA values, the utility of the framework for adaptive management and the effectiveness of management in a complex social-ecological system.

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