Using structured decision making to set restoration objectives when multiple values and preferences exist

Running head: Setting restoration objectives

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Abstract

Achieving global targets for restoring native vegetation cover requires restoration projects to identify and work towards common management objectives. This is made challenging by the different values held by concerned stakeholders, which are not often accounted for. Additionally, restoration is time-dependent and yet there is often little explicit acknowledgement of the time frames required to achieve outcomes. Here, we argue that explicitly incorporating value and time considerations into stated objectives would help to achieve restoration goals. We reviewed the peer-reviewed literature on restoration of terrestrial vegetation and found that while there is guidance on how to identify and account for stakeholder values and time considerations, there is little evidence these are being incorporated into decision-making processes. In this paper, we explore how a combination of stakeholder surveys and workshops can be used within a structured decision making framework to facilitate the integration of diverse stakeholder values and time frame considerations to set restoration objectives. We demonstrate this approach with a case of restoration decision making at a regional scale (south east of Queensland, Australia) with a view to this experience supporting similar restoration projects elsewhere.

Implications for practice:

- Restoration projects can benefit from the formal objective setting step in a structured decision making (SDM) framework to achieve project goals when there are multiple stakeholder groups with varying values.
- The adoption of a SDM framework can also incorporate stakeholders' expectations and preferences for when outcomes are delivered to help make decisions about time frames for achieving a trajectory of restoration objectives
- A combination of targeted surveys and small-group workshops facilitates the process of identifying consensus for restoration objectives among multiple stakeholders.
- The 'why is that important? test' (i.e. the WITI test) can be used to help separate fundamental objectives from a much larger list of means, process and strategic objectives.

The importance of setting objectives that incorporate multiple values and time frame considerations in ecological restoration

Ecological restoration is a key activity to address global concerns of widespread environmental degradation associated with vegetation clearing or deforestation. This trend is reflected in its growing importance in global environmental policy, with ambitious commitments to restore vegetation cover to degraded land in coming decades (Menz et al. 2013; Suding et al. 2015). Already there are several existing and proposed large scale restoration projects around the world, for example the Atlantic Forest Restoration Pact, the United Nations Billion Trees Campaign, the National Greening Program in the Philippines, the 5 million hectare reforestation program in Vietnam (Melo et al. 2013; Le et al. 2014), and the 20 million trees by 2020 program in Australia (Commonwealth of Australia). Achieving these ambitious targets requires careful planning to select restoration projects that achieve desired conservation outcomes with limited funding.

Clear objectives are a necessary prerequisite for efficient restoration, but objective setting can be multi-faceted by the variety of stakeholder values that often characterize restoration projects (Fig. 1). Values encompass people's judgments of what is important and reflect what people care about (Keeney & Raiffa 1993). Values can be translated into clearly defined measurable statements (objectives) that can be used to evaluate the outcomes of management interventions. In the context of restoration, different values might be reflected, ranging from the re-creation of habitat for flora and fauna, meeting basic human needs (e.g., by providing timber resources or clean air), or reconnecting humans with nature (Shackelford et al. 2013; Wiens & Hobbs 2015). This diversity of values is increasingly recognized (Wiens & Hobbs 2015; Hagger et al. 2017), but delivery of multiple benefits depends on how well restoration objectives are conceived from the outset.

An additional important but often overlooked factor is the influence of ecological time frames on the achievement of management objectives (Hastings 2016). In the restoration context, achieving objectives is time-dependent and this dependency is often not explicitly incorporated into restoration objectives. While restoration interventions can offer immediate outcomes, such as planting native

vegetation to increase cover, other outcomes, such as tree hollows and vegetation structure, invariably need time to develop. There are multiple reasons why being explicit about time frames is important in setting restoration objectives. First, being clear about the time required to achieve particular outcomes could help to garner support longer-term projects (Wilson et al. 2016). Second, ideally, there would be a match between time expectations (i.e., time taken to achieve a trajectory of restoration outcomes) and time preferences (i.e., time in which stakeholders would like trajectory of outcomes to appear). However, in some cases the time taken for restoration outcomes to appear may be unacceptable. For example, sites degraded by past land-use can resist restoration efforts (Hobbs et al. 2014). In this case, acknowledging the unacceptable time frames for these efforts to be rewarded could prompt the setting of alternative goals and tools that ultimately help to achieve a measure of restoration success for the site. Third, time can condition decisions about preferred outcomes (i.e. outcomes that can be experienced sooner are valued higher relative to delayed experienced outcomes; Keren & Roelofsma 1995). Lastly, some stakeholders may value time frames such that time itself becomes a restoration objective, or become a constraint to the decision making process. For example, stakeholders may prefer to know that progress towards restoration outcomes could be visibly assessed at 12 months.

Clearly stated restoration objectives should thus explicitly capture both the diverse range of values stakeholders place on restoration projects, as well as their expectations and preferences for when outcomes are delivered (Shackelford et al. 2013; Suding et al. 2015). We appraised the peer-reviewed literature to identify the extent to which values and time frame considerations have been accounted for in vegetation restoration decision-making (Appendix S1; Fig. S1). We found only 19 examples in the peer-reviewed literature where formal decision-making processes have been employed in the vegetation restoration context (Table S1), with only five describing how objectives were identified (e.g. Kangas, 1993; Qureshi & Harrison, 2001). In those papers, the restoration decision processes usually involve a variety of stakeholders, but we found no examples describing how multiple stakeholder perspectives could be incorporated into project objectives (Table S1). In addition, we found little evidence of explicit project time frame considerations (Table S1; 4 of 19 documented

examples). Most examples did not report project time frames and in the very few that did, it was not clear if the time preferences (for achieving objectives) of stakeholders were accounted for.

Here we focus on how the diversity of values and time considerations can be captured in the process of setting restoration objectives. Decision science offers theories, techniques and decision-support tools that can be used to facilitate problem formulation and objective setting, including those found in the operations research literature (Keeney & Raiffa 1993; Mingers & Rosenhead 2004). Structured Decision Making (SDM, Fig. 2) is a framework that utilizes a range of decision analytic tools for guiding decision makers through a decision process to facilitate transparent, logical and defensible decisions (Keeney & Raiffa 1993; Gregory et al. 2012a). The SDM framework involves a core set of steps that help to structure and guide thinking about the decision problem (Runge 2011).

The advantage of SDM over other decision support tools is its integral focus on objectives and mechanisms for capturing different stakeholder values (Gregory et al. 2012a). An SDM approach has been used to involve a diverse set of stakeholders in the decision-making process and serve as a vehicle for minimizing potential conflicts in applications such as tidal marsh preservation under climate change (Thorne et al. 2015), river rehabilitation (Failing et al. 2013; Kozak & Piazza 2015) and endangered species management (Lyons et al. 2008; Gregory et al. 2012b). For example, Kozak & Piazza (2015) emphasize how an SDM approach can help involve different types of stakeholders in the decision-making process. While application of SDM in vegetation restoration has been limited (see Cipollini et al. 2005), these examples highlight the potential of SDM as a useful framework that facilitates the integration of a variety of stakeholder values and time frame considerations in restoration decisions.

In this paper we demonstrate how an inclusive set of objectives for restoration projects can be obtained through conducting a survey to elicit values from a large range of stakeholders that are then integrated into a facilitated SDM workshop. We demonstrate this through application to a case study of restoration decision making by a local council in south east Queensland, Australia that has

responsibilities to maximize outcomes of public expenditure in a region with a diverse array of stakeholders and budget considerations. The local government authority sought a formalized process for specifying restoration objectives to ensure public expenditure on vegetation restoration across 800 conservation parks (covering 12,000 hectares) was effective, efficient and transparent. The approach was applied at the outset of a large collaborative research project between natural area managers, restoration ecologists and decision scientists.

Setting objectives for restoration using a structured decision making approach supported by a stakeholder survey

The approach

SDM is commonly applied in a facilitated environment with a group of key decision makers and stakeholders (Gregory et al. 2012a), but restoration projects often concern numerous and diverse stakeholders, particularly if projects are publically funded. Thus, while participatory approaches to decision making are advocated (Addison et al. 2013), it can be difficult to ensure a wider range of stakeholders are included in a workshop setting. Recognizing this challenge, we used a survey (*Stakeholder survey*) prior to a facilitated SDM workshop to efficiently involve the views of a diverse suite of stakeholders in the process of setting restoration objectives for the study area. Our approach involves four practical steps (Table 1), and was designed to identify the broad range of values held on restoration, and stakeholder's views in relation to time frames, so that this information can then be used to inform the elicitation of objectives. Our approach includes steps to maximize the participation of all stakeholder groups. We distributed the Stakeholder survey via an online environment (SurveyMonkey; Table S2) to 97 individuals representing a wide range of restoration stakeholder groups (Fig. S2) ranging from individuals who work in on-ground restoration, research, restoration planning and other related activities, in government and non-government organizations (Fig. S3). By involving all stakeholder groups, we felt the restoration project would have a greater possibility of being designed and implemented in a way that addressed the things that matter the most to concerned stakeholders (Menz et al. 2013). Data was collected during June 2015. A total of 80 responses were obtained from the survey (82% response rate).

We then ran a two-day facilitated SDM workshop. While a key focus of the workshop was the identification of objectives, we also conducted a rapid prototyping of all the steps in the SDM process (Fig. 2). Prior to the workshop we drafted the problem statement (Step 1 in the SDM process; Fig. 2) using existing documents and prior conversations among proposed workshop participants, and circulated the draft document ahead of the workshop. Research on group decision making performance suggest that group performance plateaus at round 10 to 12 participants (Troyer, 2003), while very small groups can constrain idea generation and diversity of input, and thus can lead to less informed decisions (Napier & Gershenfeld, 1973). The workshop participants included key decision-makers, restoration planners and leaders of restoration teams (a total of 13 participants).

During the objective-setting step of SDM, emphasis is placed on identifying and separating fundamental objectives (i.e. the basic things that matter) from means objectives (i.e. the methods of meeting the fundamental objectives) and process objectives (reflect how the decision should be made), and strategic objectives (relate to the organization's strategic priorities; Fig. 3) (Gregory et al. 2012a). To this end, we used a 'why is that important? test' (i.e. the WITI test; Clemen, 1996) in both the survey (Table S2), and in the workshop (Fig. 4) to identify a shortlist list of fundamental objectives, separating them from a much larger list of means, process and strategic objectives. This test asks "why is that important?" repeatedly until a fundamental objective is reached (Fig. 4). These objectives were then organized into an objectives hierarchy (Table 2) to help illustrate how the fundamental objectives are related to the other specified objectives, help identify missing objectives and encourage thinking about alternative ways to achieve fundamental objectives (Keeney & Raiffa 1993).

Integrating stakeholder values

After workshop participants had developed their own list of objectives, objectives identified in the Stakeholder survey were presented. This activity allowed for explicit consideration of the values held

by stakeholders, to ensure that the suite of objectives identified at the workshop was complete. The Stakeholder survey highlighted some objectives in addition to those proposed by workshop participants (Table 3). Most values from the survey captured ideas for how to achieve fundamental objectives, and so they were classified as means objectives (Table 3). This result highlighted the importance that people affected by decisions tend to place on *means* and *process* objectives (Table 3). Considering the preferences of the general public for different types of benefits from restoration programs in the study area (Matzek et al. in preparation), we found that about two thirds of the public's 'preferred benefits' are captured by the initial objectives identified at the workshop. This result points to potential gaps in the set of objectives identified at the workshop that could be considered when revisiting objectives or management alternatives at later phases in the SDM process, or taken into account when communicating with the public about the project aims and its expected outcomes. Nonetheless, the fundamental objectives identified at the workshop (Table 2) are consistent with the findings of a study on what motivates restoration in Australia (Hagger et al. 2017).

The incorporation of the WITI test in both the workshop and the Stakeholder survey (Fig. 4 and Table S2), helped ensure that specified restoration objectives captured the fundamental things that matter, and at the same time it helped identify multiple pathways for how these objectives might be achieved for consideration at a latter phase in the SDM process (e.g. Management alternatives; Fig. 4 and Table 2). These included insights into the practices and processes that people would like to see more or less of and thus was helpful in understanding stakeholder expectations of resource management and likely receptiveness to changes in operational practices. These ideas have been retained as important elements in the land manager's wider decision making processes. The WITI test also allowed stakeholders present at the workshop to gain new awareness of how easy it is to focus on *means* and *process* objectives and risk of failing to identify the fundamental motivation behind these.

Integrating time preferences

The Stakeholder survey provided a formal mechanism for decision makers to learn from a broad range of stakeholders about expected time frames for achieving restoration objectives, and the preferences over which stakeholders desired outcomes to be demonstrated (Table S2). We discovered that there were varied time frames among stakeholders, with many *expecting* outcomes to be achieved in the first 15 years and acknowledgement that ideal outcomes could take decades to achieve (Fig. 5). Indeed, some stakeholders acknowledged that ideal outcomes could take more than 100 years to materialize (Fig. 5). However, stakeholders *preferred* to see some benefits soon after initiation of restoration activity and especially in the first 5 years after project implementation (Fig. 5). Though not resolved at the workshop, participants agreed that further exploration of explicitly incorporating time expectations and time preferences into the decision-making process was necessary. This highlights the need to carefully choose performance measures that can assess progress toward objectives over multiple time frames.

Reflecting on our approach

We found that the approach to include a pre-workshop survey to involve a broad range of stakeholders results in a robust process of setting restoration objectives and ensures that a broad range of values are taken into consideration. This consideration is particularly relevant for vegetation restoration given it is a social as much as an ecological endeavor. At the workshop, presentation of the survey results led the key decision makers to conclude that the fundamental objectives specified during the SDM process largely captured the values and time preferences expressed by the broader stakeholder groups not represented at the workshop. We consider this outcome to be positive as it ensured all values held were being considered, thus reinforcing the workshop design and process. That said, a pre-workshop stakeholder survey could prove even more instructive in cases where there is a strong misalignment in values held by the different groups.

We also found that most of the objectives expressed by survey participants were means objectives (Table 3). While this provided ideas for how fundamental objectives identified at the workshop could

be achieved, this result reflects the difficulty of articulating fundamental objectives, and the value of an experienced facilitator in eliciting this information in a workshop setting.

While our SDM workshop was focused on eliciting restoration objectives, we also applied the rapid prototyping approach to complete all the steps in the SDM process (Garrard et al. 2017). This proved useful to reveal missing objectives and to refine the objectives that had been identified in the first stages. In particular, an understanding of the consequences and trade-offs allowed for objectives to be refined. This prompted participants to check that their values were adequately captured by the objectives identified, and also permitted the problem statement to be refined to more closely reflect the subset of objectives that fell under the responsibilities of the council. It was also revealed that portions of the operating budget were already pre-committed to activities and programs that largely addressed some of the fundamental social objectives and process objectives identified in the workshop, such as community outreach. The results presented here are part of an ongoing iterative process and there are follow up steps that need attention, one of which is the development of performance measures for the identified objectives to ensure that identified objectives are specific, measurable, achievable, realistic and time-bound (SMART; Park et al. 2013). Large multi-faceted problems such as ours will likely require several iterations of the SDM framework to fully incorporate the necessary detail (Gregory et al. 2012).

We recognize that our approach can be improved in a number of ways. While the incorporation of the WITI test in the survey permitted capturing of the fundamental things that matter, for some stakeholders this was difficult to do, as some of the answers provided were too vague or not clear enough. In addition the answers were subject to the interpretation of those at the workshop. The use of choice experiments (Adamowicz et al. 1998) in a survey can provide a mechanism to analyze stakeholder preferences in relation to a pre-defined list of restoration objectives (choices reflecting different restoration values) that can be developed in consultation with a representative group of stakeholders. This approach would ensure that all responses are comparable and permit a statistical comparison of preferences, as well as trade-offs among a broad set of objectives (Rolfe et al. 2000).

Alternatively, a post-workshop survey or report (sent to the wider stakeholder group) could help assess the acceptability of objectives. As the workshop and survey were only part of an initial prototype of the decision (Garrard et al. 2017), it is expected that objectives, the associated performance measures, and the preferred time frames for measurement, may be iteratively updated over time. Thus, we acknowledge the communication of how and why some objectives do not appear 'fundamental' to the decision context to be a crucial step in ensuring stakeholders are satisfied with the process.

Conclusions

The peer-reviewed literature on restoration decision-making lacks approaches to address the challenge of setting restoration objectives that include multiple values and time preferences from multiple stakeholders in a holistic and structured way. Overall, we found that while there has been some development of decision-support approaches for ecological restoration, little attention has been given to the process of identifying objectives, particularly where there are multiple stakeholders and values involved. Explicit consideration of time is also rare. The evidence that emerged from our survey suggested that stakeholders are realistic about time and expect a trajectory of restoration outcomes in the short and longer term.

Through application to a real case study we identify lessons on how Structured Decision Making could be used as a decision-support tool to assist restoration decisions. The SDM process allows decision makers to analyze each component of a restoration problem in detail, facilitates a shared understanding of the complexities and particulars of the problem, helps to identify key knowledge gaps, and recognize different types of restoration objectives and underlying values. Our modified SDM process (Table 1) allowed us to ascertain more broadly held underlying values and time frame considerations, alerted us of process issues and time frames that mattered to stakeholders, and helped us facilitate transparent and inclusive establishment of restoration objectives.

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387 **Table 1.** Approach including the development of a pre-workshop survey to involve a broad range of
388 stakeholders in setting restoration objectives

Steps		Description
1	Careful and deliberate identification of all decision-makers and stakeholder groups	• This was accomplished through interaction with an initial core set of key stakeholders.
2	Identification of values held by stakeholder groups and their views around time preferences	• Online survey instrument designed based on a "Why Game" method i.e. asking "why is that important?" several times to reach a fundamental objective (Clemen, 1996). The survey instrument can also be designed to understand time preferences for achieving the identified fundamental objective. • Stakeholder views summarized to inform step 3.
3	Facilitated (workshop) objectives setting exercise	• Following an SDM approach (Fig. 3) and involving key decision makers. Values, translated into statements of objectives, are elicited using the WITI test (Clemen, 1996). • Present workshop participants with a list of stakeholder views (from survey) and examine for overlap or additional objectives. • Objectives hierarchy developed to distinguish fundamental, means, process and strategic objectives (Table 2; Keeney & Raiffa 1993).
4	Ongoing refinement of objectives and	• The next phase of the project will develop a decision support tool to allocate funds for vegetation recovery

preferences	that maximizes return on investment. We aim to quantify expected outcomes and potential tradeoffs between objectives. We anticipate that new knowledge of expected outcomes will in turn prompt further refinement of fundamental objectives and attributes of the restoration problem that matter to decision-makers.

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391 **Table 2.** The list of fundamental and means objectives. The WITI test (Fig. 4) helped structure the
392 ideas elicited during the workshop into fundamental and means objectives. These objectives have
393 been refined since.

Fundamental Objectives	**Means objectives**
Environmental theme	
Maximize conservation of native biodiversity	Reinstate native vegetation cover on cleared land
Maximize persistence of threatened species and ecosystems	Improve quality of existing vegetation
	Improve water quality
	Improve soil quality
	Maintain population sizes of plants and animals
	Protect threatened fauna species
	Protect threatened plant communities
Social theme	
Maximize community health and wellbeing	Maximize recreation opportunities
Maximize recognition and public support for local government programs/services	Maximize quality of recreation experience
	Maximize park utilization
	Maximize visual/scenic amenity
	Maximize flood protection

	Maximize safe and reliable drinking water

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Table 3: Comparison of the types of objectives identified in the survey and workshop. The objectives identified in the stakeholder workshop (first row) were compared against the types of objectives identified through the stakeholder survey (second row). The three additional fundamental objectives identified by the stakeholder survey were deemed to be outside the scope of the decision problem during the workshop (i.e. generate jobs – grow economy, increase political support, support restoration industry).

	Fundamental	Means	Process	Strategic
Number of objectives identified in the stakeholder workshop	4	9	5	2
Additional objectives identified in the *Stakeholder survey*	3	28	3	3

Figure Captions

Figure 1. Diverse values driving environmental, social and economic restoration objectives. A restoration project can support the intrinsic value of nature (top left, photo by CSIRO), reinstate ecological services (e.g. provision of clean drinking water) degraded through land use (top right left, photo by CSIRO), reconnect humans with nature (bottom left, photo by A. Guerrero), or build communities and employment (bottom right left).

Figure 2: Structured Decision Making framework (adapted from Gregory et al. 2012). Steps are iterative allowing for feedback between each step. This study focuses on the highlighted sections.

Figure 3: Types of objectives. Fundamental objectives reflect the outcome those making the decision really care about (e.g. achieve healthy ecosystems) and are used to evaluate the performance of management alternative. Means objectives inform the specific methods for meeting the fundamental objectives (e.g. maximize vegetation condition), process objectives inform the design of the decision process but do not directly influence the outcome (e.g. achieve accreditation of all restoration works staff) and strategic objectives reflect the strategic priorities of the individual or organisation that governs all decisions (e.g. improve agency accountability).

Figure 4: The WITI was used to separate means objectives from fundamental objectives. Increasing native biodiversity and recovery of threatened ecosystems were identified as the most important (fundamental) objectives. Some examples of the different pathways identified during the workshop (means objectives and actions) are provided. Figure adapted from Gregory et al. 2012.

Figure 5: Time preferences of survey respondents.

Figure 1

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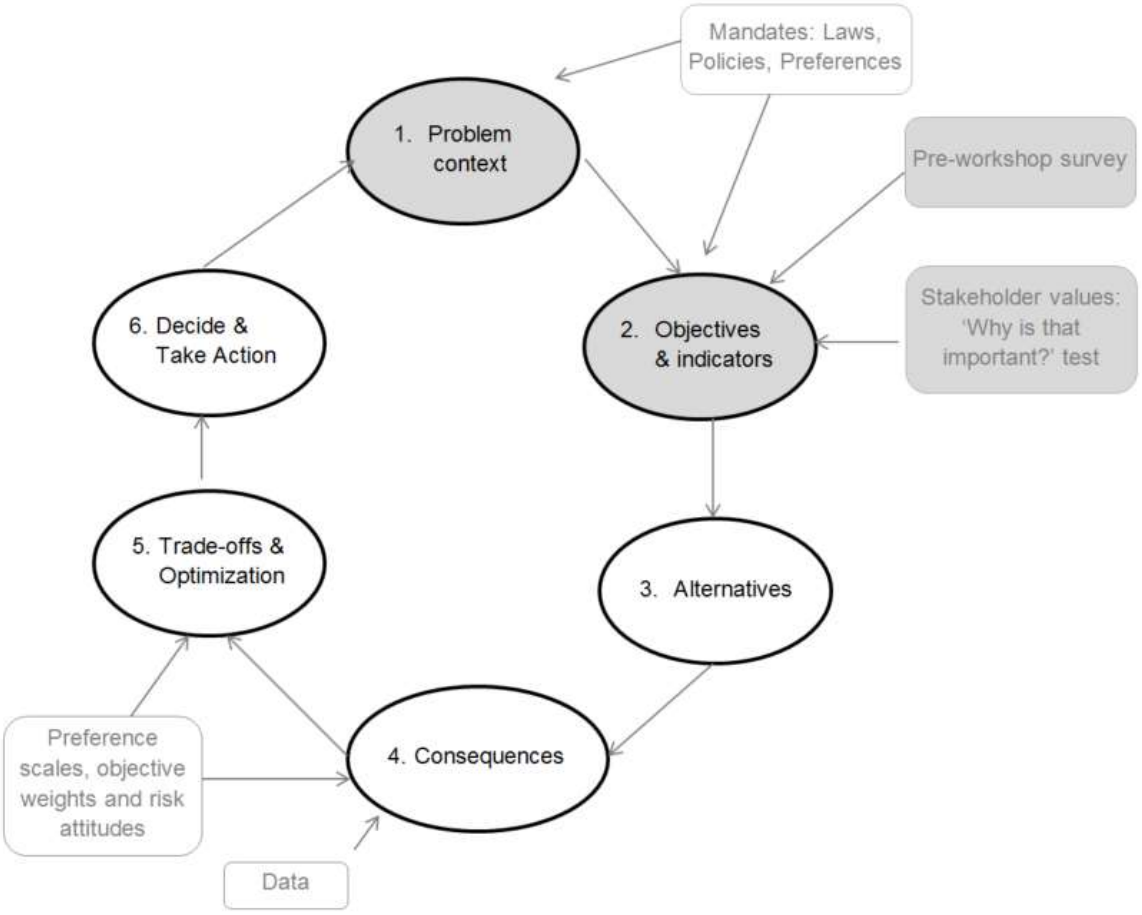

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435 **Figure 2**

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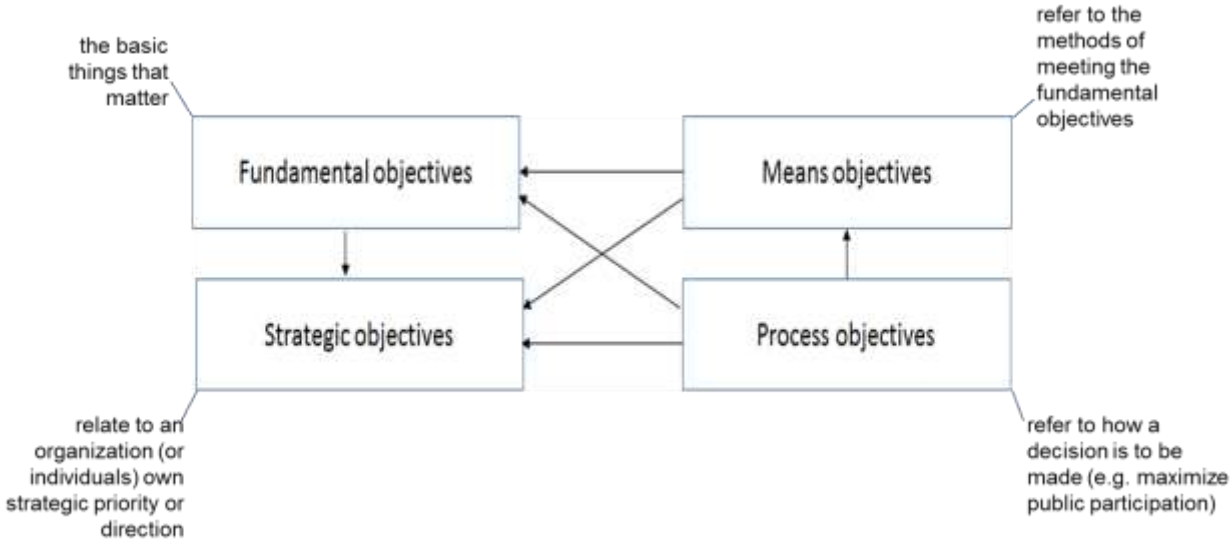

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438 **Figure 3**

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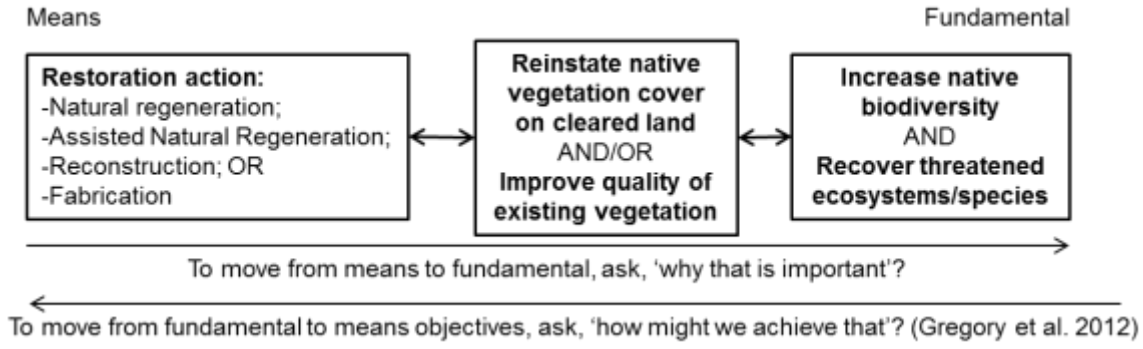

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441 **Figure 4**

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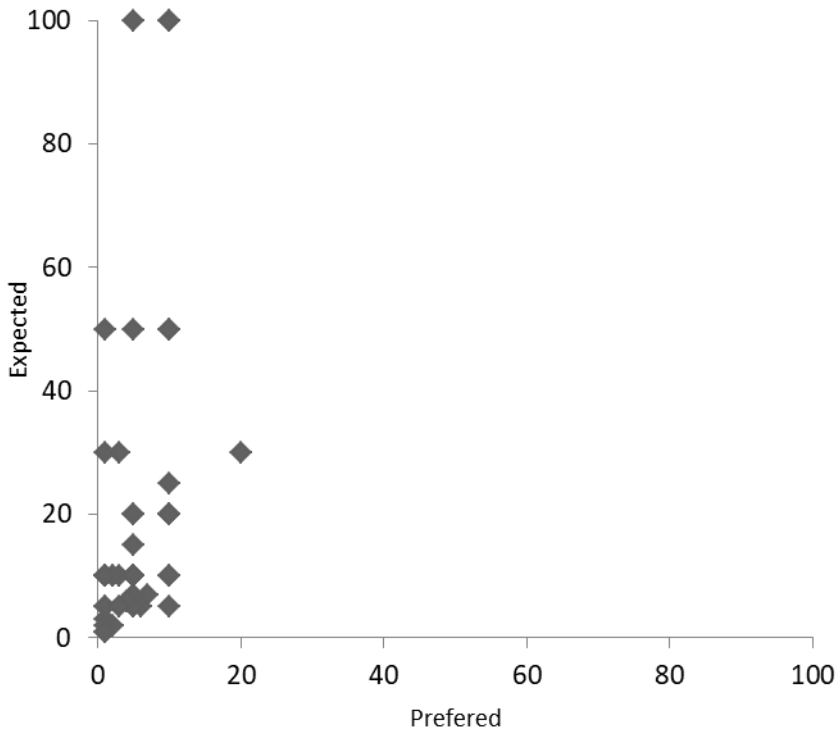

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446 **Figure 5:** Preferred vs expected timeframe (years) of outcomes to be achieved (n=48)

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