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Towards a common set of criteria and indicators to identify forest restoration priorities: An expert panel-based approach

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ABSTRACT

Ecological restoration of forest ecosystems is increasingly being implemented in many parts of the world, as a response to widespread forest loss and degradation. In common with other conservation management interventions, restoration efforts should be directed towards areas where the maximum benefits are likely to be achieved. Such prioritisation requires the development of appropriate criteria and indicators (C&I), an issue poorly addressed by previous research. In particular, there is need for C&I that are operational, suitable for spatial analysis and mapping and applicable to a broad range of contexts. This investigation aimed to verify whether this might be achieved through the elicitation of experts' opinion, when considering biodiversity conservation as the main objective of restoration. A Delphi process was performed, aimed at defining the key ecological criteria and a broad set of indicators. 389 criteria and 669 related indicators were provided in total and grouped into clusters relating to individual criteria. A total of 20 criteria referred to the need for restoration and 18 to its feasibility. In the second round of the Delphi process, 8 definitive criteria were identified along with some 90 related indicators. Finally, a face-to-face meeting was conducted to show how ready-to-use C&I can be obtained for application to a specific context starting from the Delphi's results. The study highlights the potential value of combining the Delphi process and face-to-face meetings for identifying practically applicable C&I for planning ecological restoration. However, the diversity of views identified within a single group of stakeholders suggests that the development of a generally applicable set of C&I for forest restoration will be difficult to achieve in practice.

1. Introduction

An urgent question in nature conservation is: where to act first? This is primarily related to concerns of an economic kind: financial resources are limited, hence conservation efforts should focus on areas where interventions will produce the greatest benefits. Conservationists have addressed the prioritisation issue in a variety of ways (Mittermeier et al., 1998; Roberts et al., 2002). According to Myers et al. (2000), areas with exceptional concentration of endemic species and with high rates of habitat loss may be defined as biodiversity hotspots, which constitute a priority for conserving the most species at the least cost. Alternatively, species richness, endemism, unusual ecological or evolutionary phenomena and habitat rarity have been used at a global scale to identify ecoregions that should be accorded priority for conservation (Olson and Dinerstein, 2002). Previous research into conservation priority-setting has primarily focused on the design of protected area networks, which may be informed by analysis of the relative vulnerability of different areas to environmental pressures or threats (Wilson et al., 2005). However, relatively little attention has been given to priority-setting in the context of ecological restoration activities.

Ecological restoration refers to the concept of re-establishing the main characteristics of an ecosystem that has been degraded, damaged or destroyed (Jordan et al., 1987), and is usually carried out to enhance the conservation value or productivity of a given area (Hobbs and Norton, 1996). Restoration actions are increasingly being implemented throughout the world (van Andel and Aronson, 2005; Rey Benayas et al., 2009), supported by global policy commitments such as the Convention on Biological Diversity (Article 8f), in response to growing concerns about widespread ecological degradation and habitat loss. Forest ecosystems have received particular attention in this respect (Lamb et al., 2005), reflecting both the widespread extent of the deforestation and the high importance of forests with respect to the maintenance of biodiversity and the provision of ecosystem services to human populations (FAO, 2006). The problem of prioritising forest areas to be restored is a critical one. The identification of priorities depends upon the objectives

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of the restoration process, which are often multiple and different in nature: enhancing biodiversity, providing local communities with financial and livelihoods benefits. (Lamb and Gilmour, 2003; Mansourian et al., 2005). Different objectives may result in identification of different priority sites, establishment of different tree species and selection of different restoration methods. Approaches are therefore required that are able to account for multiple objectives and enable their potential implications to be explored (Lamb et al., 2005).

Operationally, the objectives driving restoration prioritisation can be linked to a number of criteria that express the degree of achievement of restoration objectives (Kangas and Kangas, 2002). With respect to forests, criteria relating to management objectives might usefully be viewed in the context of Sustainable Forest Management (SFM), which has been the focus of an intensive international policy dialogue during the past two decades (Nussbaum and Simula, 2005). Specifically, this has led to the development of a wide variety of different criteria and indicators (C&I) designed to assess progress towards SFM. Criteria may be defined as the essential elements or major components that define SFM (e.g. 'structure and diversity of forest ecosystem resemble original forest'), whereas indicators are qualitative or quantitative parameters of a criterion, which provide a basis for assessing the status of, and trends in, forests and forest management (e.g. 'canopy opening is minimised') (Prabhu et al., 1996). The C&I have been developed under a series of international processes, including ITTO, the Pan-European (or 'Helsinki') Process, the Montreal Process, and the Tarapoto, Lepaterique, Near East, Dry Zone Asia and Dry Zone Africa processes, each of which have generated sets of C&I (Newton, 2007). Criteria and Indicators have found widespread application in the forest sector and they are considered as a useful tool for assessing progress towards SFM (Wijewardana, 2008), as indicated by a substantial literature (Stork et al., 1997; Mendoza and Prabhu, 2003; ITTO, 2005). Although the C&I processes share similar objectives and overall approach, and provide a valuable source of information on the indicators that are considered important for forests in different regions, most have focused on developing C&I for application at the regional or national level. Only four of the nine processes (ATO, ITTO, Lepaterique and Tarapoto) have produced sets of C&I for application at the local level, which is the level most likely to be of value in supporting practical forest management.

Although forest restoration can be viewed as one of the management options that might contribute to the broader goals of SFM, indicator sets specifically designed for the identification of forest restoration priorities are few. There have been some attempts at defining prioritisation criteria at global and regional levels (WCMC, 2000; Newton and Kapos, 2003). At a more local level, some studies coupling decision analysis and GIS have used small sets of case-specific criteria to identify priorities (Cipollini et al., 2005; Marjokorpi and Otsamo, 2006). Nevertheless, a ready-to-use list of criteria that restoration practitioners can directly apply in practice is lacking. On the one hand, regional-level criteria are too generic (e.g. 'potential of a given area to support forest cover') or vague (e.g. 'areas in close proximity to forests'), and few specifications are made regarding how they might be assessed in practice (WCMC, 2000; Newton and Kapos, 2003). On the other hand, local-level criteria are context-specific; their applicability to other contexts has rarely been examined (Cipollini et al., 2005).

Consequently, there is a need for C&I appropriate for prioritising forest restoration actions at local levels, that are readily applicable to different contexts. In order to be useful for the identification of priority sites, C&I should be able to capture spatial variability, given that forest management plans are spatially explicit and are typically developed and implemented using a Geographical Information System (GIS) (Kangas et al., 2000). The development of C&I sets is commonly based on past experience: existing sets are considered and a pool of experts is involved to review and/or develop them (Prabhu et al., 1999). The use of expert knowledge for natural resource management, though not the best choice in absolute terms, is the only way of taking decisions when knowledge based on objective observations is not available (Hannah et al., 1998; Burgman et al., 2001; Kangas and Leskinen, 2005; Geneletti, 2007).

Based on these considerations, this study aims to provide a contribution towards defining a generally applicable set of ecological criteria and indicators to identify forest restoration priorities that may contribute to the specific objective of biodiversity conservation. The method is based on surveys and interviews conducted with a panel of experts. In this paper, we use the term criterion to indicate the general concept (e.g. 'fragmentation of native forest'), while the term indicator is used to refer to an operational way to express or measure a criterion (e.g. 'edge density', 'patch density'). Both definitions are consistent with SFM C&I processes, such as the Montreal Process (1995). The study was designed to develop criteria and indicators that are applicable to a wide range of ecological contexts and appropriate for use at the landscape scale (i.e. tens to hundreds of square kilometres), being the scale at which forest restoration decisions are typically made in practice.

2. Methods

Previous studies on the selection of restoration priorities (WCMC, 2000; Newton and Kapos, 2003) simultaneously considered areas where restoration is needed (e.g. owing to the presence of endemic species or threats), and areas where restoration is likely to succeed (e.g. owing to soil conditions). This suggested that C&I should belong to two main groups: those that refer to the need for biodiversity restoration (B), and those that refer to the feasibility of the restoration interventions (F) (Orsi and Geneletti, 2010). The first group of C&I is then expected to define where restoration is more urgent for the conservation of biodiversity. The second group is intended to provide an information about the 'restorability' of land (Hobbs and Harris, 2001; Suding et al., 2004; Miller and Hobbs, 2007), which is the ecological cost of successfully achieving the restoration goals. Starting from this rationale, we used a distance survey with a panel of experts to develop a list of generally applicable C&I linked to B and F. Subsequently, we managed a face-to-face meeting to show how a compact set of C&I readily applicable to a specific context can be obtained starting from the overall list.

The Delphi survey technique was used for the distance elicitation. This technique, developed in the early 1950s by the RAND Corporation, is a method for structuring a group communication process in a way that allows individuals to deal with a complex problem (Linstone and Turoff, 1975). Delphi surveys aim to solicit the advice of a panel of experts, and whenever possible to forge a consensus (Richey et al., 1985; Oliver, 2002). The approach is based on structured and written questionnaires to which panellists are asked to answer anonymously. All responses are summarised and reported back to panellists who have the opportunity to revise their judgments. Turoff and Hiltz (1996) highlighted the opportunities offered by computer-based Delphi processes and today most Delphi surveys are carried out via the Internet. The Delphi technique has been extensively applied to conservation and natural resource management (Crance, 1987; Hess and King, 2002; Oliver, 2002; MacMillan and Marshall, 2006; Geneletti, 2008), but rarely to ecological restoration.

The Delphi survey, which was entirely managed via email, was based on questionnaires with both open and closed questions. In the first round participants were asked to specify their expertise and draw preliminary lists of C&I. Responses were rearranged by clustering similar criteria, and the reviewed lists were