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Regrowth forests on abandoned agricultural land: A review of their habitat values for recovering forest fauna

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ABSTRACT

Human land use has modified the structure and function of terrestrial landscapes throughout much of the world, with cropping and livestock grazing the major drivers of landscape change. In many tropical, sub-tropical, temperate and Mediterranean regions, regrowth forests regenerate naturally on abandoned agricultural land if human disturbance declines. With the exception of some tropical forest literature, the broader ecological and conservation literature has largely ignored the potential of regrowth forests to facilitate passive landscape restoration and the recovery of fauna communities in fragmented agricultural landscapes. This paper addresses this deficiency by reviewing the available global evidence of fauna recovery in regrowth forest from 68 papers, identifying the main gaps in current knowledge, and providing directions for further research. The majority of reviewed studies focus on regrowth in tropical regions, which often contain large areas of mature forest. Species' utilisation of regrowth forest is highly variable and is particularly influenced by land-use history, an important determinant of the structural and compositional characteristics of regrowth forests. While site-scale (<1 ha) forest structure and floristic diversity were frequently studied, only 11 studies considered the spatial configuration and context of habitat patches and just two studies explicitly considered landscape structure. Based on this review, six key research questions are posed to direct future research on this important issue. We conclude that a broader perspective of the role of regrowth forest in the landscape is required if we are to realise the potential benefits of regrowth forest for passive landscape restoration and fauna conservation and recovery.

1. Introduction

Human land use influences a large proportion of the Earth's land surface and few ecosystems remain undisturbed by some form of anthropogenic activities (Brown and Lugo, 1990; Kammesheidt, 2002; Sanderson et al., 2002; Foley et al., 2005). Pastures and crops are the two most extensive forms of land use, occupying 25% and 12% of the global land surface, respectively (Ramankutty and Foley, 1999a; Asner et al., 2004). These land uses, particularly cropping, often result in the transformation of landscape structure and function, and contribute significantly to global deforestation. As habitat loss and fragmentation are recognised as major threats to global biodiversity (Pimm and Raven, 2000; Fahrig,

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2001, 2002, 2003), management and recovery of biodiversity in regrowth forests is an important emerging issue in conservation biology. While conservation within an expanded reserve system remains an important priority, many native fauna species occupy modified landscapes outside the formal reserve system. Furthermore, the reality for agricultural landscapes suffering high levels of habitat loss and fragmentation is that the protection of remnant (not previously cleared) habitat alone will not be enough to achieve biodiversity conservation goals and some form of landscape restoration is necessary (Young, 2000; Crossman and Bryan, 2006).

Recent satellite monitoring reveals a declining trend in the area of agricultural land throughout many developed regions, with social, political and economic forces interacting as drivers of the abandonment of agricultural land (Ramankutty and Foley, 1999a; Young, 2000; Lugo and Helmer, 2004). Although alternative forms of human land use, such as urban development, often replace abandoned agricultural lands, many areas remain largely unmanaged and successional native vegetation begins to regenerate (Kammesheidt, 2002; Brown et al., 2005). In the north-east United States, large areas of agricultural lands were abandoned from the mid 1800s onwards (Ramankutty and Foley, 1999b), and today regenerating forests (hereafter referred to as regrowth) are widespread throughout this region (Matlack, 1997; Foster et al., 1998; Bellemare et al., 2002).

Regrowth forests are also associated with the Indigenous practice of shifting-agriculture in tropical forest landscapes, with the clearing of small areas of mature forest for short-term cultivation (e.g., <5 years) followed by abandonment and natural regeneration of forests (Brown and Lugo, 1990; Kammesheidt, 2002; Lugo and Helmer, 2004). Larger areas of regrowth forest also occur in tropical South America as a result of broad-scale agricultural practices in the early 20th century and subsequent land abandonment episodes during the 1930s, 1950s and more recently (Ramankutty and Foley, 1999a). Since the 1960s, abandoned croplands have become widespread throughout Europe, China, and Asia, and to a lesser extent in Africa, Australia and New Zealand (Ramankutty and Foley, 1999a). However, globally, the amount of regrowth forest is small in comparison to agricultural land under active management. For example, Ramankutty and Foley (1999a) estimate the global extent of croplands to cover 17.92 million km^2, compared to 1.47 million km^2 of abandoned croplands. Nonetheless, regrowth forests can constitute a large proportion of the total forested area in many regions (e.g., Foster et al., 1998; Lugo and Helmer, 2004; Etter et al., 2005), and potentially provide a viable option for landscape restoration (Young, 2000; Brown et al., 2005). Protection of regrowth forests from further clearing represents a form of passive landscape restoration (sensu McIver and Starr, 2001).

Recovering native flora and fauna assemblages in regrowth forests to a similar composition to the pre-clearing mature forests appears problematic. Studies of forest succession indicate that even after 100–150 years of regeneration, the floristic composition and structure of regrowth forests often differ considerably from mature forests (Turner et al., 1997; Foster et al., 1998), with regrowth forests regularly including exotic plant species not typically present in mature forests (Lugo and Helmer, 2004). The regeneration pathways of regrowth are difficult to predict and are strongly dependent on the land use history, including the type, duration and intensity of land management (Uhl et al., 1988; Guariguata and Ostertag, 2001; Mesquita et al., 2001; Chazdon, 2003; Pereira et al., 2003). Moreover, the landscape context can add a further dimension of variability to regeneration pathways, with proximity to mature forest being a particularly important determinant of the diversity of seeds capable of dispersing into regenerating areas (Matlack, 1994; Wijdeven and Kuzee, 2000). Thus, the ecological values of regrowth forest for fauna recovery are likely to depend on the land use history and landscape context.

Given the increasing area of regrowth forest in many tropical and non-tropical regions, albeit with varied regeneration pathways and outcomes for fauna, it seems appropriate to provide a critical synthesis of research findings of the recovery of fauna in regrowth forests. While several reviews have been conducted, they only consider tropical ecosystems, and either infer ecological values for fauna based on structural and floristic similarity to mature forest habitat conditions (Brown and Lugo, 1990; Corlett, 1995), or consider a limited set of faunal taxonomic groups (Dunn, 2004; Gardner et al., 2007). In the earliest of these reviews, Brown and Lugo (1990) commented that tropical regrowth forests "are often disregarded by managers and the public as useless brush". Five years later, Corlett (1995) lamented the lack of research on tropical regrowth forests and, amongst other research priorities, called for a comparison of fauna recovery at sites with differing fertility and land-use histories. Nearly 10 years on, Dunn (2004) noted that current studies of forest faunal recovery in tropical regrowth forests had limited generality due to the "small spatial and temporal scales, often with no replication". To our knowledge, the meta-analysis by Dunn (2004) is the only quantitative synthesis of fauna recovery in regrowth forests, primarily focusing on the recovery of species richness and composition of bird and ant communities in tropical landscapes. While this meta-analysis suggests that the species richness of some fauna assemblages can recover to levels similar to mature forest within 20–40 years, such rapid recovery may not occur where the landscape context and land use history are less conducive to rapid forest regeneration (Dunn, 2004).

Recently, the potential for regrowth forests to prevent mass extinction of tropical forest fauna has been the subject of strong debate (see Brook et al., 2006; Wright and Muller-Landau, 2006a,b; Gardner et al., 2007). This debate centres on Wright and Muller-Landau's (2006a,b) prediction that future tropical deforestation rates will decrease and that the increasing area of regrowth forest will prevent mass extinctions of forest fauna. However, this prediction relies to a large extent on the assumption that regrowth forests can provide an adequate replacement for the loss of mature forest. Gardner et al. (2007), in a review of studies of bird, amphibian, reptile and primate community recovery in tropical regrowth forests, suggested that regrowth forests may not provide adequate habitat resources for many species and that we currently lack the level of knowledge necessary to support Wright and Muller-Landau's suggestions (2006a,b). Many questions therefore remain about the recovery of fauna populations in regrowth forests.