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An assessment of restoration success to forests planted for ecosystem restoration in loess plateau, Northwestern China

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Abstract Using ecosystem attributes identified by the Society of Ecological Restoration International, we assessed three restoration projects in the loess plateau, northwestern China, including planting *Larix principis-rupprechtii* (LS) and *Pinus tabulaeformis* (PS) on shrubland, and planting *L. principis-rupprechtii* on open forest land (LO). The reestablishment of native species in LS and PS was poorer than LO because of the excessive stand density. Species diversity, seedling number, and seedling diversity were significantly higher in LO than in LS and PS. Soil nutrient was also significantly higher in the LO treatment. The vegetation composition, species diversity, and soil nutrient in LO, however, were more similar to these in the reference. Our results indicate that planting *L. principis-rupprechtii* on open forest land had accelerated the succession of the ecosystem for approximately 30 years. But the poor natural regeneration of *L. principis-rupprechtii* suggests that post-planting activities in LO are required after timber harvesting or the natural mortality of the *L. principis-rupprechtii*. Management operation such as selective thinning will be

required in LS and PS to promote the true restoration of native species diversity in the future.

Keywords Restoration success · Vegetation composition · Species diversity · Regeneration · Soil nutrient

Introduction

Ecological restoration is the process of assisting in the recovery of an ecosystem that has been degraded, damaged, or destroyed (SER 2004) and is becoming an increasingly important tool in humanity's attempt to manage, conserve, and repair ecosystems in recent years (Hobbs 2007). In order to assess the success of a restoration project, previous studies have utilized an integrated approach that includes many variables such as vegetation structure (Jones et al. 2004; Salinas and Guirado 2002), plant diversity (Peterson et al. 1998), ecosystem function (Davidson et al. 2004; McKee and Faulkner 2000), and even invertebrate fauna (Dodd et al. 2006). The Society of Ecological Restoration International produced a primer that provides a list of nine ecosystem attributes as a guideline for measuring restoration success. In 2005, however, Ruiz-Jaen concluded that there are three major ecosystem attributes which determine the success of a restoration project: vege-

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