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Ecological Engineering 26 (2006) 113–122
ECOLOGICAL ENGINEERING
www.elsevier.com/locate/ecoleng

Proximity of valuable habitats affects succession patterns in abandoned quarries☆

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Received 28 October 2004; received in revised form 6 May 2005; accepted 7 June 2005

Abstract

The study tested the hypothesis that the composition of vegetation formed during primary succession in basalt quarries is affected by the distance to, and area of, conservation-valuable biotopes of surrounding xerophilous grasslands. The successional vegetation was recorded in 270 relevés collected in 34 quarries in the area of Ceske Stredohori Hills, Czech Republic. We used detrended correspondence analysis to visualise the relationship between successional vegetation, ages of individual sites, and distances to the closest xerophilous grasslands. Subsequent regression analyses of fidelities of individual relèves to the grassland alliances *Festucion valesiacae* and *Allyso-Festucion pallentis* corroborated the view that the probability of development of valuable habitats within the quarries decreased with distance to the closest grassland sites, and increased with their area. It also increased with successional age, but this effect was suppressed if quarry identity was considered as covariable in the regressions. Our results show that the valuable biotopes would eventually develop in quarries situated less than 100 m from adjoining xerophilous grasslands. We advocate that quarry operators pay attention to conservation management of biotopes that surround excavation sites, because maintaining valuable vegetation in the vicinity will eventually reduce costs of post-excavation restoration.

Keywords: Basalt quarry; Primary succession; Restoration; Species pool; Xerophilous grasslands

1. Introduction

Most of the xerophilous grasslands in Western and Central Europe are products of traditional non-intensive land use, including light grazing, small-scale hay cutting, occasional burning, and scrub removal for fuel purposes (Thomas, 1993; Bignal and McCracken,

☆ *Nomenclature:* Kubat (2002) for taxa and Oberdorfer (1992) for syntaxa.

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doi:10.1016/j.ecoleng.2005.06.008

1996; Wilmanns, 1997; Poschlod and WallisDeVries, 2002). As intensive agriculture coupled with abandonment of less productive lands has replaced the traditional land use during the last decades, a considerable diversity of specialised plants and animals whose survival depends on now-outdated management practices face extinction threats (Hillier et al., 1990; Van Swaay, 2002).

One approach to battle this development is creation of protected areas (reserves) that are actively managed by mimicking traditional land use (e.g., Bobbink and Willems, 1993; Pärtel et al., 1998; Dolek and Geyer, 2002). However, since only small fragments of once extensive xerophilous grasslands remain in many regions, the approach will ultimately reach the limits of available space. Therefore, it is increasingly argued that areas of protected lands should be augmented by restoration of unproductive and even degraded lands for conservation of biodiversity (e.g., Young, 2000; Benes et al., 2003). Particularly promising in this respect are various types of post-industrial barrens, such as quarries, sand and gravel pits, mining dump heaps or old factory yards (e.g., Davis, 1982; Cullen et al., 1998; Novák and Prach, 2003). They typically contain thin topsoil, which slows down forest growth and maintains the sites in arrested successional stages. Spontaneous colonisation of post-industrial barrens by species of conservation interest has been reported for many organisms, including plants (Wheater and Cullen, 1997; Prach and Pysek, 2001), butterflies (Benes et al., 2003), beetles (Brandle et al., 2000), spiders (Bell et al., 2001), and birds (Bejcek and Tyrner, 1980), whereas the supply of traditionally managed habitats transferable into reserves is steadily shrinking, the extent of restorable barrens increases, as abandoning of once-exploited sites is an inherent feature of an industrial economy (Schulz and Wiegleb, 2000). Hence, conservation use of localities exploited by industry offers a cheap and socially acceptable opportunity to augment the already small and fragmented areas of high quality biotopes in many regions (cf. Rosenzweig, 2003).

Quarries rank highly among such localities because they represent large and prominent landscape features and occupy larger areas than reserves in many regions. They may host valuable assemblages of both plants and animals (e.g., Usher, 1979; Jefferson, 1984). Recently, restoration of abandoned quarries via spontaneous succession has been proposed as a cheap alternative to expensive technical reclamation (Benes et al., 2003; Novák and Prach, 2003; Prach, 2003). However, the conditions channelling successional development in disused quarries towards specific vegetation are little known. In particular, there is minimum information to what extent the vegetation surrounding quarry sites influences the course of succession.

We studied the role of surrounding vegetation on the course of successional development in abandoned quarries within an ancient volcanic region of the Czech Republic. In this region, the biotopes most valuable from the conservation point of view are semi-natural xerophilous grasslands, protected by the EU Habitat Directive (Appendix A classification: Rupicolous pannonic grasslands and semi-natural dry grassland and shrubland facies on calcareous substrates). We tested the hypothesis that the distance to adjoining xerophilous grasslands and the proportion of the grasslands in quarry surroundings affects the vegetation of successional sites within the quarries. We used an ordination technique to describe the changes in plant species composition during succession in relation to the age following site abandonment, and the distance and extent of xeric grasslands in the quarry vicinity. Then, we use regression techniques to assess the effect of surrounding grasslands upon the composition of vegetation of successional sites.

2. Methods

2.1. Study area

The study was conducted within a 500 km^2 area situated in the Ceske Stredohori Hills, located in the northwestern part of the Czech Republic, Central Europe, latitude 50°34′–50°48′N, longitude 13°41′–14°32′E (Fig. 1). The altitude ranges from 180 to 420 m, the climate is mild with a low snow cover in winter, the mean annual temperatures range between 7.5 and 9 °C, and the annual precipitation ranges between 500 and 600 mm (Kubat, 1970).

The landscape is a mosaic of deciduous forests, fields, hay meadows, human settlements, and xerophilous grasslands. The forests, dominated by mesophilous oak-hornbeam and thermophilous oak woodlands, cover 30% of the landscape, whereas xerophilous grasslands (less than 5% of the landscape)