Limnologica 43 (2013) 381–387

Contents lists available at SciVerse ScienceDirect

Limnologica

journal homepage: www.elsevier.com/locate/limno

Effects of the invasive plant *Lupinus polyphyllus* on vertical accretion of fine sediment and nutrient availability in bars of the gravel-bed Paloma river☆

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ARTICLE INFO

Article history:
Received 6 November 2012
Accepted 15 May 2013
Available online 1 July 2013

Keywords:
Chilean Patagonia
Nitrogen fixation
Vacant niche
Fluvial
Biogeomorphology
Geomorphology
Riparian vegetation

ABSTRACT

Floodplain vegetation is fundamental in fluvial systems, controlling river corridor geomorphology and ecology through a series of hydraulic, sedimentological, and biological processes. Changes caused by introduced plant species can thus result in shifts in river regime, succession trajectories and nutrient availability, affecting native biodiversity. The exotic bigleaf or marsh lupine *Lupinus polyphyllus*, introduced in Patagonia in the last decades, is aggressively invading fluvial corridors. It fills unoccupied ecological niches in southern Chilean rivers, due to its capacity for nitrogen fixation, its perennial habit, and high shoot density and leaf surface area.

We investigated the effects of *L. polyphyllus* on vertical accretion of fine sediment, and soil carbon and nitrogen content, on gravel bars of the Paloma river, Chilean Patagonia, where lupine is believed to have been introduced in 1994. We sampled plot pairs with and without lupine, with each pair located at the same elevation above river stage, and plots distributed over the reach scale. We measured the thickness of the fine soil horizon, grain size distribution, and soil carbon and nitrogen content. We also compared aerial photographs to evaluate changes in spatial coverage of lupine along the study reach.

Presence of lupine was strongly correlated with a thicker layer of finer sediment, in turn characterized by higher organic carbon, carbon to nitrogen ratio, and inorganic carbon content. Contrary to our expectations, we did not find any significant differences in total nitrogen. Aerial photographs did not reveal important differences in coverage between 2007 and 2010, but plant density appears to have increased between the two dates, and invaded gravel bars also appear to be more stable. Lupine dominance of otherwise sparsely vegetated gravel bars in Patagonian rivers appears to have greatest consequences on bar physical structure (increased rates of accretion of fines) and secondary repercussions on soil quality (increase in recalcitrant organic matter), with potential transient effects on nutrient availability (possible increased soil metabolism, followed by carbon mineralization and loss of lupine nitrogen subsidy).

Introduction

Vegetation is one of the most important controls on geomorphological processes and landforms (Kirkby 1995). Riparian plants affect fluvial landforms through changes in water budgets, soil moisture, resistance to flow, nutrient availability, sediment deposition, bank strength and erosion, channel and floodplain evolution, etc. (Simon et al. 2004). As a rule, river landscapes have been considered to be controlled mostly by hydrogeomorphic processes, the interaction between the flow and sediment regimes. This idea was first challenged by Hickin (1984), who emphasized the effects of vegetation on flow resistance and bar sedimentation, among others. More recently, Gurnell and Petts (2002) and Gurnell et al. (2012) show that vegetation actually plays an active role, particularly in the case of wandering gravel-bed rivers. For example, Tal et al. (2004) confirm the role of riparian vegetation as a primary control on channel form, in the case of multi-thread gravel-bed rivers. Indeed, Paola (2011) argues that the emergence of terrestrial vegetation corresponds in geological time with dramatic global changes in river morphology. Not only does riparian vegetation directly affect many hydrogeomorphic processes, its development depends in turn on those same processes, through positive feedback loops (Gregory et al. 1991; Richards et al. 2002; Francis 2006; Corenblit et al. 2007, 2009; Schnauder and Moggridge 2009).

☆ This article is part of a Special Issue entitled 9th International Symposium on Ecohydraulics 2012.

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http://dx.doi.org/10.1016/j.limno.2013.05.004