Falcataria moluccna Impacts Information

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1.0 Introduction

The exotic nitrogen-fixing tree *Falcataria moluccana* dramatically alters forest structure and litter inputs in forests it invades. In rare wet lowland forest on young lava flows in Hawaii, *F. moluccana* is a particular problem as it grows rapidly, reducing light-levels and outcompeting native slow-growing *Metrosideros polymorpha*. Enhanced leaf litter quality and quantity of *F. molucccana* compared to native species causes increases in soil nutrient levels, decomposition rates, microorganism community composition and soil invertebrates. Ecosystem processes are altered in both terrestrial and aquatic environments where *F. moluccana* invaded riparian areas (Hughes & Denslow, 2005; Allison *et al*., 2006; Atwood *et al*., 2010).

2.0 Competition

In Hawaii *Falcataria moluccana* is currently invading the few remaining stands of native-dominated wet lowland forest on early-successional lava flows. These flows tend to have minimal soil development and are dominated by native *Metrosideros polymorpha* during initial stages of primary succession (30-200 year old flows). Less common, older flows (> 300 years of age) support a greater variety of native tree species including *M. polymorpha* (Allison *et al*. 2006; Hughes & Denslow, 2005). *F. moluccana* grows very rapidly, outcompeting *M. polymorpha* and creating a canopy over top of this slow-growing native. Where this occurs, *M. polymorpha* often dies from lack of light under the canopy of Falcataria trees (Mueller-Dombois, 2008; Mascaro *et al*., 2009). Other factors such as increased competition for water may also contribute to the decline of this native species. The loss of *Metrosideros* represents a profound compositional and structural change to native Hawaiian forests (Hughes & Denslow, 2005).

3.0 Modification of nutrient regime

Invasion by *F. moluccana* significantly increases litterfall rates (1.3 to 8.6 fold) (Hughes & Denslow, 2005) and litter quality and increases decomposition rates (Allison *et al*., 2006; Hughes & Uowolo, 2006). Due to its nitrogen-fixing biology, invasion by this tree in Hawaii dramatically alters the nutrient regime. The litter quality of *F. moluccana* is greater than its native counterparts, having lower C: N and C: P ratios and higher N: P ratios. Litter N may be 4–55 times greater (Hughes & Denslow, 2005). However on the P-limited soils of the Seychelles *F. moluccana* only negligibly increased soil N. N-fixation by *F. moluccana* may be restricted by P deficiency (Kueffer *et al*., 2008; Kueffer, 2010).

Changes in litter inputs provide C and N substrates that can support increased microbial growth and enzyme production. Microbes synthesise enzymes required for degradation of *Falcataria* litter, which further accelerates litter decomposition and nutrient mineralization. Thus *F. moluccana* creates a positive feedback to nutrient cycling through its litter production (Allison *et al*., 2006). Allison *et al*. (2006) found *Falcataria* invasion to increase the activity of soil acid phosphatase dramatically. They also found large shifts in microbial community composition under *Falcataria*. Although mycorrhizal abundance and total microbial biomass did not change, fungal: bacterial ratios declined dramatically in younger sites under *Falcataria*, which may correspond to dominance to bacteria adapted to nutrient-rich soil conditions. The effect of *Falcataria* invasion on soil microbes and enzymes diminished with substrate age (Allison *et al*., 2006).

Where *F. moluccana* invades riparian zones, leaf litter inputs into streams are altered with up to 13 times more bioavailable dissolved organic carbon (BDOC) than from native *M. polymorpha*. While the amount of dissolved organic carbon was found to be similar between invaded and non-invaded streams, sustained increases in the amount of BDOC entering riverine systems in Hawaii has the potential to affect nutrient and organic matter dynamics and food webs that depend on riparian vegetation (Wiegner & Tubal, 2010).

4.0 Ecosystem change

Changes in litter resources caused by nitrogen-fixing *F. moluccana* exert bottom-up control on litter-based food chains in Hawaii. Leaf litter of *F. moluccana* was found to create an invertebrate community that greatly differed from that found in native *Metrosideros polymorpha* litter. In particular, *F. moluccana* litter had 400% more non-native fragmenters (Amphipoda and Isopoda) and 200% more non-native predaceous ants (Tuttle *et al*., 2009). This is attributed to greater N and P concentrations, lower CN ratio and greater leaf surface area of *F.moluccana* litter compared to *M. polymorpha* (Hughes & Uowolo, 2006).

Nitrogen-rich leaves of *F. moluccana* also have the potential to alter ecosystem processes in aquatic environments. Decomposition of leaves may lead to increases in nitrogen concentration of streams with riparian margins invaded by *F. moluccana*. This may stimulate algal production and further alter the stream food web and community composition through increased densities of herbivorous organisms, and cause the food web to change from autochthonous-based to allochthonous-based. This may make streams with *F. moluccana*-invaded riparian zone more susceptible to future invasions by aquatic species (Atwood *et al*., 2010).

5.0 Interaction with other invasive species

In addition to altering ecosystem processes, *F. moluccana* changes the composition and structure of wet lowland forests in Hawaii from native-dominated to strongly alien-dominated. In particular *F. moluccana* may facilitate invasion of other exotic species such as *Psidium cattleianum*, possibly due in part to increased N and P supply (Hughes & Denslow, 2005).

While litter resources were found not to improve the diet, growth or survivorship of the invasive frog *Eleutherodactylus coqui*, other characteristics of *F. moluccana* may have positive impacts. Additional habitat structure (e.g. larger boles, more vines on boles, and greater tree height) for foraging and calling, and more shade, might support more *E. coqui* on a landscape-scale. Further research is necessary to determine whether this occurs (Tuttle *et al*., 2009).