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Canopy shade and the successional replacement of tamarisk by native box elder

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Summary

1. Tamarisk species (*Tamarix ramosissima* Ledeb., *T. chinensis* Lour., *T. gallica* L. and hybrids) have invaded riparian areas throughout western North America, resulting in expansive control efforts. Tamarisk is a relatively recent addition to North American plant communities, and competitive and successional processes are still developing. Box elder (*Acer negundo* L. var. *interius* (Britt.) Sarg.) is a native competitor found in canyons throughout western North America. We investigated the establishment chronology, competition and comparative shade tolerances of tamarisk and box elder to determine the superior competitor and to predict successional trajectories in mixed stands.

2. Competition was studied through neighbourhood analysis, and successional trends were analysed through dendrochronology in the canyons of Dinosaur National Monument, CO, USA. The shade tolerance of mature tamarisk was studied by enclosing individual plants in shade cloth for two growing seasons. The comparative shade tolerances of juvenile tamarisk and box elder were studied using five levels of shading in a glasshouse experiment.

3. Box elder and tamarisk established concurrently, or tamarisk establishment preceded box elder establishment. Box elder was the superior competitor; the presence of canopy box elders within 1 and 2 m was significantly related to tamarisk mortality but not box elder mortality. The presence of canopy tamarisk trees was not related to box elder or tamarisk mortality.

4. In the field-based experiment, mature tamarisks were killed when subjected to one to two growing seasons of 98% shade. In the greenhouse-based experiment, box elder had superior shade tolerance to tamarisk, maintained positive growth and survived under higher shade than tamarisk.

5. *Synthesis and applications*. Box elder is a superior competitor to tamarisk, and is capable of establishing under dense tamarisk canopies, overtopping and eventually killing tamarisk. Superior shade tolerance appears to be the mechanism for the successional replacement of tamarisk by box elder. The manipulation of competitive and successional processes through the promotion of box elder and other native tree establishment is suggested as a means of tamarisk control to complement traditional control techniques.

Key-words: competition, directed succession, ecological restoration, non-native plants, shade tolerance, succession, tamarisk

Introduction

Non-native plant invasions constitute a substantial threat to native plant and animal communities, and are considered to be one of the major anthropogenic alterations of global ecosystems (Mack *et al.* 2000). The high productivity, frequency of natural and human-induced disturbance, linear nature and heterogeneity of habitats intrinsic to riparian zones make these areas prone to invasion by non-native species (Planty-Tabacchi *et al.* 1996; Stohlgren *et al.* 1998; Hood & Naiman 2000). Semi-arid and arid riparian zones in western North America, southern Africa, Argentina, Hawaii and Australia have been invaded extensively by species in the genus *Tamarix*. *Tamarix ramosissima* Ledeb., *T. chinensis* Lour., *T. gallica* L. and hybrids now occupy over a million hectares of riparian areas and other wetlands in western

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