Glossy Buckthorn, *Rhamnus frangula* L.: A Threat to Riparian Plant Communities of the Northern Allegheny Plateau (USA)

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Glossy buckthorn, *Rhamnus frangula* L., is a tall shrub or small tree native to Eurasia and North Africa (Haber 1997). It was introduced into North America for ornamental purposes in the mid-1800s and has since become widely naturalized in portions of the midwestern and northeastern United States and adjacent Canada (McClain 1996, Haber 1997, Reinartz 1997). Glossy buckthorn is a problematic pest in natural areas as it can aggressively invade open and semi-open wetland habitats as well as dry sites such as sand plains, prairies, forest edges, fencerows, and old fields (Reinartz and Kline 1988, Haber 1997, Reinartz 1997). Both Environment Canada (1999) and the U.S. Forest Service (1999) list glossy buckthorn as a highly invasive alien plant, particularly in wetlands. It is thought that the chief threat posed to natural plant communities by glossy buckthorn invasion is alteration of plant species composition and structure by shading from the dense canopy that this species often produces (McClain 1996, Reinartz 1997).

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Glossy buckthorn occurs sporadically in wetlands, roadsides, and old fields of the northern nonglaciated Allegheny Plateau of northwestern Pennsylvania (Rhoads and Klein 1993). Little is known about the ecology and invasive potential of this species in the region. Recent vegetation surveys conducted in the Allegheny National Forest (41° 45' N, 79° 00' W) (ANF) have documented the occurrence of glossy buckthorn in several habitats, particularly those associated with open graminoid-shrub fringe wetland, wet riparian savanna, wet to mesic roadsides, riverine big bluestem (*Andropogon gerardii* Vitman) grasslands, and to a lesser extent, mesic Allegheny hardwood forest (typified by black cherry, *Prunus serotina* Ehrh., red maple, *Acer rubrum* L., sugar maple, *A. saccharum* Marsh., and American beech, *Fagus grandifolia* Ehrh.; nomenclature follows Gleason and Cronquist 1991) (Western Pennsylvania Conservancy 1990; Williams 1994; Williams and Rubino 1997; C.E. Williams, unpubl. data). At present, the main invasion focus of glossy buckthorn is the Portland Mills topographic quadrant (Elk County) in the southeastern corner of the ANF along the tributaries and mainstem of the Clarion River. A smaller focus occurs in the south-central portion of the ANF along Salmon Creek in the Marienville West quadrant (Forest County).

A key concern is the preponderance of glossy buckthorn occurrences in riparian plant communities of the ANF. Our recent studies suggest that riparian zones are "hotspots" for regional vascular plant richness. We have documented over 200 vascular plant species occurring in the herbaceous layer (all vascular plants ≤ 1 m tall) of riparian plant communities of the ANF, some of which occur almost exclusively in riparian zones or reach their greatest abundance in these areas (Rubino 1997; Hanlon et al. 1998; Williams and Moriarity 1998, 2000; Mosbacher 1999; Walters and Williams 1999; Williams et al. 1999a,b). Light availability is a major factor influencing the species composition, richness, and productivity of regional riparian vegetation, particularly in savannas and other open habitats (Rubino 1997, Williams et al. 1999a,b). Development of a dense canopy of glossy buckthorn would greatly decrease light availability in riparian savannas and other open wetlands, potentially causing undesirable changes in the composition, richness, and productivity of herbaceous layer vegetation.

We examined the influence of glossy buckthorn invasion on the species composition and richness of herbaceous layer vegetation in a riparian savanna at Salmon Creek in the ANF. Riparian savannas are usually typified by a sparse canopy of black cherry and/or red maple and a dense herbaceous layer dominated by graminoids, forbs, bracken fern (*Pteridium aquilinum* [L.] Kuhn), and patches of *Rubus* spp. (e.g., *R. allegheniensis* Porter, Allegheny blackberry, *R. idaeus* var. *strigosus* [Michx.] Maxim., red raspberry) (Williams et al. 1999a). Within a 2-ha study site, we established four 70-m belt transects, each consisting of seven contiguous 10-m x 5-m plots, two in riparian savanna and two in an area heavily invaded by glossy buckthorn (hereafter savanna plots and invaded plots, respectively). Mean density of glossy buckthorn stems was significantly greater in invaded plots (83 ± 14.2 SE stems 50 m^{-2}) than in savanna plots (8 ± 4.3 SE stems 50 m^{-2}) (two-sample *t*-test, $P \leq 0.01$). In each 50-m^2 plot, we visually estimated the total cover and cover by species of herbaceous layer plants in three randomly located 1-m^2 plots. Canopy density was estimated at the center of each 50-m^2 plot with a spherical densiometer (Lemmon 1956).

We found that total herbaceous layer cover was significantly lower (two-sample *t*-test, $P \leq 0.002$) in invaded plots ($64.9\% \pm 6.0$ SE) than in savanna plots ($87.9\% \pm 1.9$ SE). Also, total species richness (9.1 ± 0.3 SE species m^{-2}, two-sample *t*-test, $P \leq 0.002$) and woody plant seedling richness (2.2 ± 0.3 SE species m^{-2}, two sample *t*-test, $P < 0.0001$) were significantly greater in the herbaceous layer of invaded plots than in savanna plots (total species richness = 6.5 ± 0.6 SE species m^{-2}, woody plant seedling richness = 0.6 ± 0.2 SE species m^{-2}). However, species richness of nonwoody plants (ferns and allies, forbs, graminoids) did not differ significantly (two-sample *t*-test, $P = 0.2$) between invaded plots (7.0 ± 0.4 SE species m^{-2}) and savanna plots (6.0 ± 0.4 SE species m^{-2}).

Composition of herbaceous layer vegetation was similar between savanna plots and those invaded by glossy buckthorn, but species dominance differed between the two plot types. In savanna plots, rough goldenrod (*Solidago rugosa* Ait.) was dominant, followed by swamp dewberry (*Rubus hispidis* L.), New York fern (*Thelypteris noveboracensis* [L.] Nieuwl.), poverty grass (*Danthonia compressa* Austin), and bracken fern. In heavily invaded plots, short-husk grass (*Brachyelytrum erectum* [Schreb.] P. Beauv.) was dominant followed by swamp dewberry, hayscented fern (*Dennstaedtia punctilobula* [Michx.]), bracken fern, and Allegheny blackberry. Mean canopy density was significantly greater for invaded plots ($64.9\% \pm 6.0$ SE) than for savanna plots ($27.5\% \pm 7.6$ SE) (two-sample *t*-test, $P \leq 0.001$).

Our results from Salmon Creek indicate that glossy buckthorn decreases total cover and alters the species dominance of herbaceous layer plants in riparian savanna, presumably by shading. This shading effect is particularly evident in the shift from dominance by rough goldenrod, a species of open habitats, in savanna plots to short-husk grass, predominantly a forest species, in invaded plots. The enhanced total species richness observed in invaded plots relative to savanna plots was due primarily to the significantly greater species richness of woody plant seedlings in invaded plots. Dense riparian savanna is not easily colonized by many native tree species of the northern Allegheny Plateau because of light limitation, lack of appropriate regeneration microsites, and allelopathy, among other factors (Horsley 1985, Williams et al. 1999a). Therefore, it is not surprising that woody plant seedling richness was elevated in invaded plots with a less dense herbaceous layer. We think it unlikely that the presence of glossy buckthorn patches will facilitate the development of islands of woody plant regeneration in riparian savanna as has been suggested for the alien European mosqueta rose (*Rosa rubiginosa* L. = *R. eglanteria* L.) in degraded forests of southern Argentina (De Pietri 1992). Glossy buckthorn can maintain a dense persistent canopy by

continually filling gaps with root sprouts and/or seedlings, providing little opportunity in time or space for woody plant seedlings to grow above the canopy (e.g., Reinartz and Klein 1988).

We are concluding other ecological studies of glossy buckthorn in northern Allegheny Plateau riparian savanna, including an assessment of allelopathic potential, age structure and stem dynamics, fruit production, and postdispersal seed predation by small mammals. With the results of these studies and further field inventory, we hope to develop an ecological model of glossy buckthorn invasion that can be used to manage this alien species in the rich riparian plant communities of the northern Allegheny Plateau.

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