# SOURCES OF AUTUMN OLIVE INVASION FOLLOWING SILVICULTURAL TREATMENTS

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Exotic, invasive plants are a significant concern for forest managers and conservation-minded private landowners. Autumn olive (*Elaeagnus umbellate* Thunb.), originally introduced for wildlife forage and for the stabilization of mine soils in the 1920s (Fowler and Fowler 1987), has become ubiquitous along many roads. Autumn olive is shade tolerant (Yates and others 2004), salt tolerant, drought tolerant and thrives across a wide range of soil pH (Dirr 1998). Of particular concern is the potential for this shade-tolerant exotic, invasive plant to spread from roadside areas into the understories of adjacent forests and displace native flora.

Results of previous research have linked soil disturbance (Bergelson and others 1993), light levels (Winter and others 1982), and the frequency of human traffic (Lundgren and others 2004) with successful exotic plant invasions. All three of these factors are often more abundant along roadways, which tend to have greater exotic, invasive plant presence than other areas (Trombulak and Frissell 2000). In the present study, relationships between several factors and the success of autumn olive were examined along forest-road edges. Specific objectives were: (1) to investigate the effect of forest-road edge aspect on autumn olive patch depth, abundance, and height; (2) to determine the relationships between the height and abundance of autumn olive and those of woody native plants and other woody, exotic, invasive plants; and (3) to record slope, elevation, canopy cover, and basal area at points of invasion to investigate factors potentially related to patch depth, abundance, and height of autumn olive.

To achieve these objectives, autumn olive patch depth and the abundance of autumn olive in five height class categories (0-0.50 m, 0.51-1.00 m, 1.01-2.00 m, 2.01-3.00 m, and > 3.00 m) were measured in 5- by 10-m rectangular sample plots. Indices of average autumn olive height were calculated using the midpoints for each height class. Plots were established on forest-road edges having aspects within ± 10° of cardinal north, east, south, and west, and the short axis of each plot was centered on the boles of the trees along the forest edge. Fifteen plots were established for each aspect. Slope toward the road, slope toward the forest interior, elevation, canopy cover, and basal area were measured at plot center, and the numbers of native, woody species and exotic, invasive, woody species in each of the size classes developed for autumn olive were tallied. Differences between forest-road edge aspects were analyzed with an analysis of variance (ANOVA). Relationships between autumn olive and other plant species were evaluated using linear regression. The range of values for each site factor measured was subdivided into logical categories and analyzed with ANOVA to determine effects of these variables on autumn olive success.

Forest-road edges with northern, southern, and western aspects had the greatest autumn olive patch depths ($p = 0.0273$). Density of 2.00- to 3.01-m-tall autumn olive was greatest on south-facing forest-road edges and least on north-facing forest-road edges ($p = 0.0324$). All other measures of autumn olive success did not vary with aspect. Linear regression indicated that there was a positive relationship ($y = 0.54061 + 0.28205 * x$) between the average height of autumn olive and the average height of native tree species along south-facing forest-road edges (table 1). In addition, east-facing forest-road edges exhibited an increased density ($y = -46.79446 + 66.06644 * x$) of all species of woody, exotic, invasive plants with greater average autumn olive heights. On north-facing

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**Table 1--Linear regression relationships between the density and height of autumn olive and the density and height of woody, native plants and other woody, exotic, invasive plants across all aspects and by individual aspect**

| Variables | All aspects | North | East | South | West |
|---|---|---|---|---|---|
| Average height of native trees[a] | ρ = 0.0498<br>$R^2$ = 0.0647 | ρ = 0.6602<br>$R^2$=0.0153 | ρ = 0.7240<br>$R^2$=0.0099 | ρ = 0.0200<br>$R^2$=0.3509 | ρ = 0.9596<br>$R^2$=0.0002 |
| Density of all exotic, invasive plant species[a] | ρ = 0.8537<br>$R^2$ = 0.0006 | ρ = 0.8946<br>$R^2$=0.0014 | ρ = 0.0556<br>$R^2$=0.2537 | ρ = 0.3796<br>$R^2$=0.0598 | ρ = 0.4120<br>$R^2$=0.0524 |
| Avg. height of exotic plants (all species)[b] | ρ = 0.1472<br>$R^2$=0.0359 | ρ = 0.0271<br>$R^2$=0.3229 | ρ = 0.3643<br>$R^2$=0.0637 | ρ = 0.9231<br>$R^2$=0.0007 | ρ = 0.6883<br>$R^2$=0.0128 |
| Density of all exotic, invasive plant species[b] | ρ = 0.7596<br>$R^2$=0.0016 | ρ = 0.2756<br>$R^2$=0.0906 | ρ = 0.5416<br>$R^2$=0.0293 | ρ = 0.0128<br>$R^2$=0.3902 | ρ = 0.4688<br>$R^2$=0.0411 |

[a]Independent variables related to the average height of autumn olive.
[b]Independent variables related to the density of all height classes of autumn olive combined.

forest-road edge aspects, the average height of all other woody, exotic, invasive plants was positively related (y = 0.51011 + 0.00516 * x) to the density of all size classes of autumn olive combined. The density of autumn olive in all height classes combined was positively related (y = 25.42396 + 1.03242 * x) to the density of all other woody, exotic, invasive species in all height classes combined. When data for site factors were subdivided into categories, average height of autumn olive differed (fig. 1) with changes in slope toward the road (p = 0.0100) and slope toward the interior forest (p = 0.0188). Density of 0.51- to 1.00-m autumn olive differed with changes in slope toward the road (p = 0.0494), and 2.01- to 3.00-m autumn olive differed with changes in elevation (p = 0.0324).

These results suggest that edge aspect, slope characteristics, and elevation may be important in influencing autumn olive success. The positive relationships between the heights and densities of autumn olive and those of native woody plants and other invasive woody plants suggest that conditions that favor autumn olive may also favor other native and exotic species. Knowing which forest edges are particularly susceptible to shade-tolerant, exotic, invasive plants will increase the efficiency of managing existing populations and detecting new invasions. The factors identified in this study that appear to be linked to autumn olive success may prove useful in the development of GIS-based predictions of when and where autumn olive is likely to become a problem. If successful, this approach could be used to produce more comprehensive, multi-species prediction tools for managers.

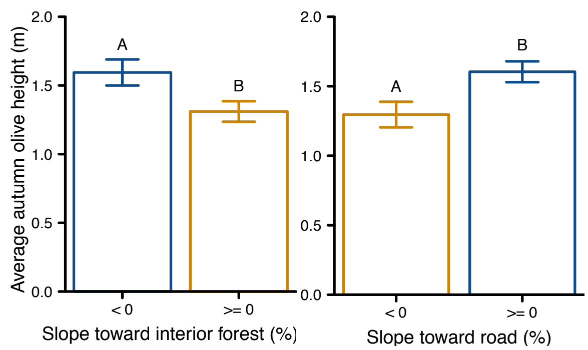


Figure 1--Average autumn olive height by upward or downward slope from plot center. Blue bars for slope toward the interior forest represent a downward slope from plot center and blue bars for slope toward road represent a downward slope from the road toward plot center. Groupings based on Tukey's method with α = 0.05. Error bars represent one standard error.

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