Powell River Project Annual Report (2014 – 2015)

How do reclamation conditions affect the invasion success of the exotic autumn olive?

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Introduction:

Post-mining landscapes are currently reclaimed using the Forestry Reclamation Approach (FRA) developed at Virginia Tech that seeks to achieve high hardwood tree canopy cover following the establishment of "tree-compatible groundcover". FRA has been successful in advancing development of ecosystem structure (e.g., ground cover, species diversity, stem density). However, as Dr. Burger and colleagues pointed out in 2010, FRA results in more bare ground, which "allows more invasion by plant species from nearby areas." They point out this is often from adjacent native species from natural dispersal or by animals. However, the gaps left by FRA leave much of the ground open to invasion by exotic plants as well, that may have negative impacts to desirable vegetation. Exotic invasive plants are known to have negative impacts to ecosystem structure and function in a wide range of systems. However, the effect of these exotic plants can be especially problematic on reclaimed mine sites due to the harsh growing environment. One of the most common exotic invaders of the Powell River Project is autumn olive, and is problematic for mine operators during bond release.

Autumn olive (Elaeagnus umbellata) is a large shrub to small tree native to Pakistan, China, and Eastern Asia that has been widely introduced throughout North America, especially in disturbed habitats such as road rights-of-way. Autumn olive fixes atmospheric nitrogen through an association with a bacterium in the roots. This association is speculated to allow autumn olive to successfully colonize disturbed sites, especially those that are nutrient limited, like reclaimed coal mines. Thus, autumn olive is considered a pioneer species that may alter the successional trajectory of the community (i.e., it may suppress hardwood plantings). Additionally, autumn olive produces a tremendous amount of red berries annually (up to 30lb) that are dispersed by birds across the landscape, making management difficult, as limiting berry production is the key to successfully eliminating autumn olive. The negative ecological effects associated with autumn olive has resulted in it being listed as an invasive species in several states.

Autumn olive is widespread at the Powell River Project, and throughout the coal-mining region of Appalachia. Autumn olive interferes with bond release by inhibiting success of post-mining land uses by invading both pastures and hardwood plantings. Potentially, the most cost-effective management of autumn

olive would be to prevent its establishment and success in the first place – "an ounce of prevention".

Several substrate types and vegetation mixes are used in reclamation at the Powell River Project that may vary in their susceptibility to autumn olive invasion. It would be advantageous to mine operators to identify the best combination of substrate material and vegetation to achieve post-mining land use goals, as well as preventing (or slowing) autumn olive invasion.

In many reclaimed sites autumn olive has already become a major invader, and dominates much of the land area, often outcompeting desirable tree species. Thus, operators are faced with removing autumn olive to achieve the post mining land use to get bond release. Since autumn olive fixes nitrogen, there may be higher plant available nitrogen in locations where autumn olive was versus adjacent areas with autumn olive. It would be valuable to understand if single year mechanical removal is sufficient ot both control autumn olive and establish productive hardwoods.

Objectives:

To address whether autumn olive establishes better or grows more quickly under some reclamation conditions than others, as well the effect of autumn olive management on hardwood establishment, we will utilize several locations at the Powell River Project that differ in reclamation conditions. The objectives of this proposal are to:

1. Characterize the effect of substrate (weathered sandstone vs. unweathered mudstone) on autumn olive survival and performance.

2. Characterize the effect of reclamation vegetation cover on autumn olive survival and performance.

3. Determine how autumn olive management affects hardwood establishment.

Methods and Procedures:

Objectives 1 and 2: We identified sites at the Powell River Project that varied in either substrate material (with the same vegetation) or vegetation cover (with the same substrate). One site was graded with weathered sandstone with an adjacent area graded with coarser unweathered mudstone. This site has nearly identical vegetation allowing us to test for the effect of substrate on autumn olive survival and performance.

At the second location, one portion of the site was compact graded and seeded with conventional reclamation mix, while the adjacent area was loosely graded and

seeded with the tree-compatible ground cover. In both locations, we set up three replications (blocks) of plots to test the effects of ground cover composition and substrate material on autumn olive survival and growth. We established the following four ground cover treatments:

1) standing community
2) grasses only
3) broadleaves only
4) no plant community (bare ground)

These were achieved and maintained through herbicide applications in 1x2m plots. Within each replicate, we created 10 plots of each plant community type. In 2014, we sowed 40 seeds of autumn olive into each plot with the intention of monitoring germination and growth. However, we saw no germination from any of the 6,800 seeds total we sowed. Therefore, in 2015, we decided to use transplants, and transplanted 3 autumn olive seedlings into each plot, for a total of 480 autumn olive seedlings transplanted. We have been monitoring their survival and growth throughout the summer by measuring their height and basal diameter.

Results:

There were no differences among any treatments in autumn olive survival at the substrate sites, but we did see a significant difference in growth of autumn olive, where it grew substantially more in the sandstone than in the mudstone (Figure 1). However, the differences in plant community types had no significant difference on autumn olive growth (Figure 2).

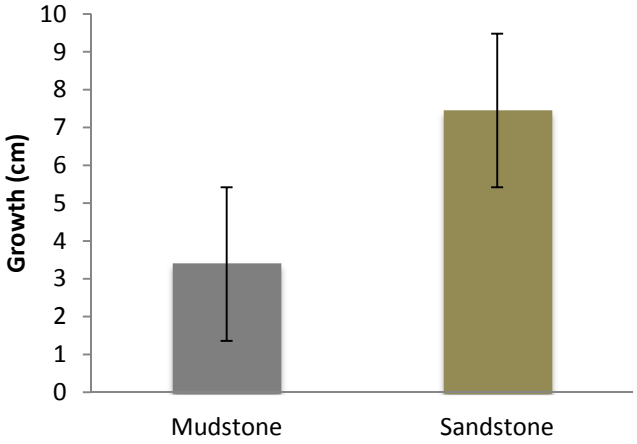

Figure 1. Autumn olive growth (cm) in mudstone vs. sandstone, with significant differences between them ($p = 0.014$).

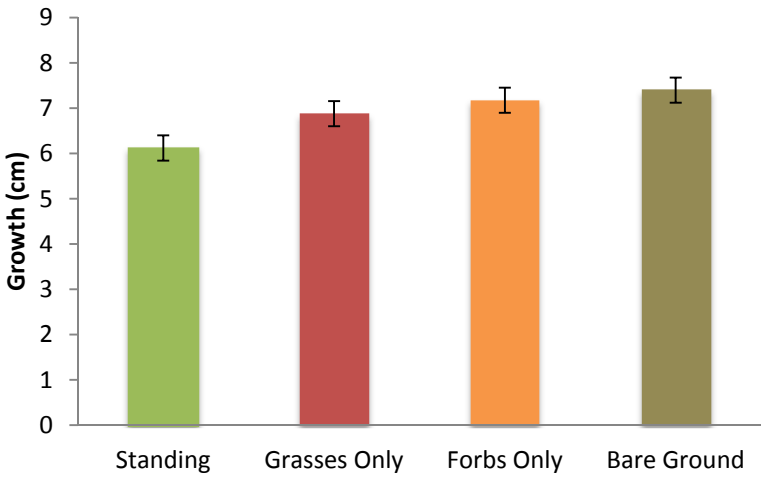

Figure 2. Autumn olive growth (cm) among community types, with no significant differences (p = 0.172).

In the sites with different vegetation mixes, we also did not see any differences among treatments in autumn olive survival, nor did we see a significant difference in autumn olive growth between the tree compatible mix versus the conventional mix (Figure 3). However, there was a difference in autumn olive growth between the community types, with autumn olive growing significantly more in the bare ground plots versus the standing community plots (Figure 4). Due to this finding, we believe that the amount of ground cover available is more influential in autumn olive growth than the species used.

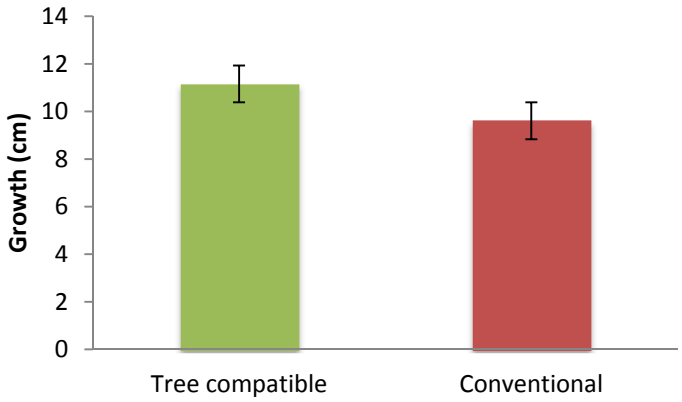

Figure 3. Autumn olive growth (cm) between tree compatible and conventional mixes, with no significant differences (p = 0.418).

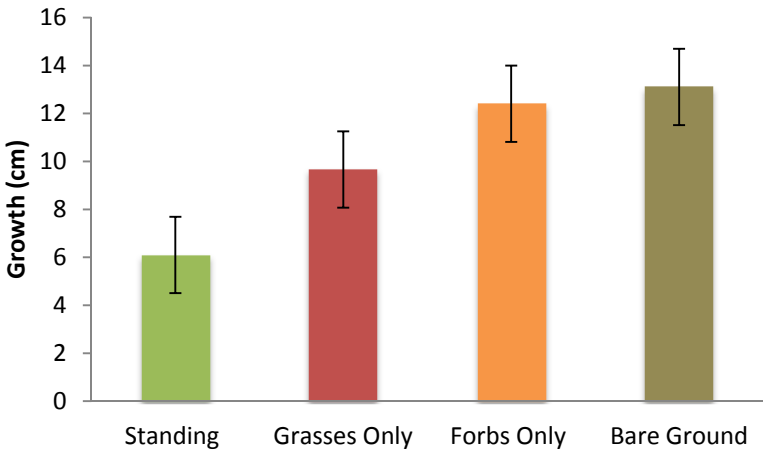

Figure 4. Autumn olive growth (cm) among community types, with a significant difference between the standing and bare ground communities ($p = 0.0464$).

Objective 3: When autumn olive gets out of control, mine operators are faced with managing the invasion followed by reseeding or planting of hardwoods. Often a single mechanical removal is used to control autumn olive. However, autumn olive aggressively resprouts when cut. Thus, we will test hardwood establishment in areas where a single mechanical removal was applied versus areas where autumn olive was mechanically removed followed by herbicide application to prevent resprouting. The treatments were implemented in September of 2014 and are as follows:

1) autumn olive not removed
2) single mechanical removal
3) mechanical removal followed by cut-stump herbicide application
4) no autumn olive present

There were 8 total of each treatment plot. We used bare root seedlings of red maple, black cherry, and pin oak, and planted 3 of each species into each type of treatment in March 2015. We have been monitoring the hardwood trees survival and growth by measuring height and basal diameter.

Results:

There were no differences between the 3 tree species and their growth rate, but all three species had a higher survival in the plots where autumn olive was mechanically removed and then sprayed with herbicide versus the plots where there was no autumn olive present (Figure 5). We also saw a significant difference in the hardwood growth, where they grew more in the plots where autumn olive is present versus the plots where there is no autumn olive (Figure 6).

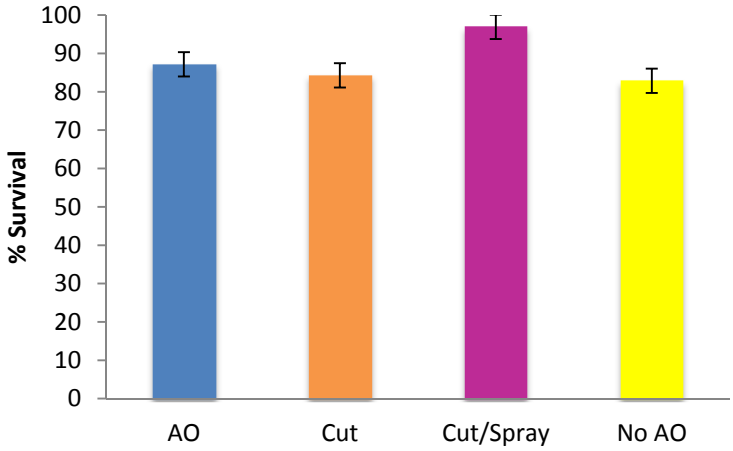

Figure 5. The survival (%) of all hardwood tree species were highest in the cut/spray management treatments than any other management treatments.

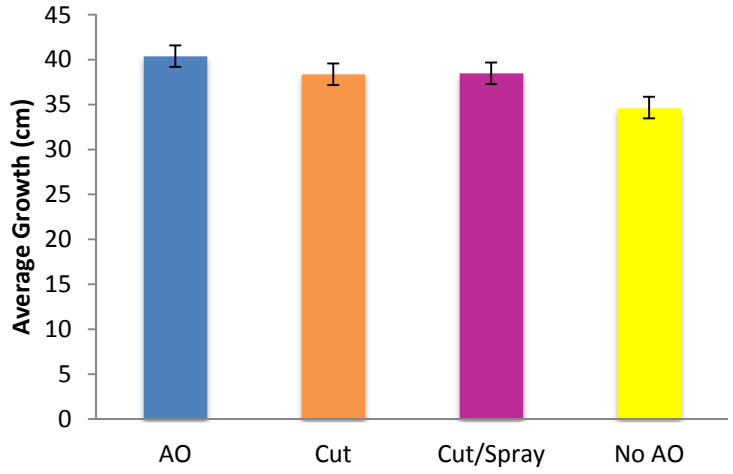

Figure 6. Hardwood tree species growth (cm) was higher in areas where autumn olive is present than in areas where autumn olive was not present ($p = 0.0187$).

Benefits:

The benefits of this study are directly in line with the overall mission of the Powell River Project, which seeks to enhance reclamation of coal-mined lands. Exotic plants are common in reclamation sites across the Appalachian coalfields, and this project seeks to understand the causes and consequences of autumn olive invasion on reclamation. We only have one year of data, so we aren't able to give concrete

management suggestions, but overall, this project seeks to address challenges to successful reclamation, which has direct implications for regulatory compliance, bond release, ecosystem services to local communities, and the social view of exotic plants always having a negative role in the landscape.