

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 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. However, previous studies conducted at the Powell River Project by Dr. Ozzie Abaye demonstrated that goats have no effect on autumn olive seed production. 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 to 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 establishment and performance;
2. Characterize the effect of reclamation vegetation cover on autumn olive establishment and performance;
3. Determine if a single-year mechanical removal is sufficient to control autumn olive preceding a hardwood planting.



Figure 1. Location for autumn olive performance study.

Methods and Procedures:

Objectives 1 and 2: We have identified sites at the Powell River Project that vary 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 establishment and performance.

At a second location, one portion of the site was compact graded and seeded with the conventional reclamation mix, while the adjacent area was loosely graded and seeded with the tree-compatible ground cover. In both locations we will set up three replications (blocks) of plots to test the effects of ground cover composition and substrate material on autumn olive establishment and growth. We will establish the following four ground cover treatments:

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

These will be achieved through herbicide application in 3x3m plots. Within each plant community type we will sow 40 seeds of autumn olive. Within each replicate we will have 10 plots of each plant community type. Throughout 2014 (seeded year) and 2015 (establishment year) we will record seedling emergence, survival, and height, and at the end of 2015 we will harvest all aboveground biomass, dry and weigh. We will also collect soil samples at each site and replication to characterize substrate chemistry. We will also collect soil samples at the conclusion of the study both within and adjacent to seeded autumn olive plots to determine the amount of plant available nitrogen to test whether autumn olive is adding nitrogen to the system. This will allow us to determine if certain plant community/substrate types hasten autumn olive growth. The plots will be sprayed with herbicide to eradicate the autumn olive in 2016.



As of August 2014 we have established the plots as described above, but not a single autumn olive seed has germinated. We have had similarly poor germination in greenhouse germination trails. Therefore, we intend to repeat the autumn olive introduction in spring 2015.

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. We will plant bare root plants of yellow poplar, red maple, and black cherry into the following treatments:

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

We will plant one of each of the hardwoods above into a 3x3m plot with 10 replications per site. We have identified three locations at the Powell River Project suitable for this study. We will implement autumn olive management treatments in the fall of 2014 and plant the hardwoods in late winter/early spring 2015. Each spring and fall we will record autumn olive presence and cover, hardwood survival, height, and diameter at breast height.

Autumn olive management will occur on September 5, 2014.

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. This project seeks to address challenges to successful reclamation, which has direct implications for regulatory compliance, bond release, ecosystem services to local communities including fresh water and erosion reduction, and the social view of exotic plants always having a negative role in the landscape.