

Invasive Species Distributions and Impacts on Tree Regeneration, Piedmont and Mountain Provinces, Maryland



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Executive Summary:

Maryland DNR Forest Service surveyed invasive plants under a mature forest canopy in 2010 to investigate invasive species patterns and relate them to density of tree seedlings. The survey compared sites in two forests, Green Ridge State Forest in Western Region, Ridge and Valley (Mountain) province and Baltimore City's Liberty Reservoir Forest in Central Region, Piedmont province. Canopy closure, basal area, and trees per acre were also measured to capture overstory forest conditions that might influence tree regeneration and invasive plant distribution. To better understand the overall patterns of invasive plants statewide, data on invasive plants from the Maryland Biological Stream Survey were summarized to determine how often common species occurred and what regional patterns were present.

Levels of invasive plants were much lower at the Mountain sites than at the Piedmont sites, which correlates with greater deer density in the Piedmont. Tree regeneration was consistently lower on invaded sites, usually below desired levels of seedling density. At the Mountain site, tree seedlings of desired native species like oaks and hickories were present even on the invaded sites, although at lower levels than at the non-invaded site. Invaded sites in the Piedmont region had very low levels of native tree regeneration. Canopy closure varied from 56% to 86%, a range that did not appear to influence level of invasion, and differences among sites were not significant. Basal area and trees per acre also played minimal roles in the level of invasion and were not significantly different, allowing ready comparison among sites.

Areas with elevated deer populations experienced higher levels of non-native invasive species and less desirable regeneration. Management of the invasive species is important if a healthy vigorous forest is desired after disturbances. If a harvest is planned for the forest, getting the invasives under control early is key to allow regeneration to establish itself and get a head start on future invasives that will be introduced to the area.

Introduction:

Competition between non-native and native species is causing forests to shift towards species compositions that generally diminish economic, wildlife, and ecosystem benefits. Non-native invasive species reduce the available resources for desirable native species that are an integral part of the food web and a resilient ecosystem. Invasive species have been raised as a threat to forest management and desired regeneration. Land managers have noted that invasive species abundance varies greatly across different regions of Maryland. The Maryland Forest Service (MDFS) wanted to assess patterns in tree regeneration at different levels of invasion from non-native plants. Efforts included 1) summary of existing statewide data and 2) data collection in contrasting regions. Work was completed in Central Region with generally greater levels of exotic plants and in Western Region with less land disturbance and fewer exotic plants.

Summary of Maryland Biological Stream Survey Data:

MDFS summarized invasive plant data from the Maryland Biological Stream Survey (MBSS) to better understand statewide distribution of invasive species. Riparian areas can have greater levels of invasive species than some upland areas because of more frequent disturbance from flooding or erosion, connection to water-borne distribution pathways (seeds and roots float downstream), and moist, productive nature of the soils that can support a variety of plants. While the data are not necessarily exactly representative of adjacent upland areas, they do reveal the extent and regional patterns of exotic invasive species. Some moisture-loving invasive plants like Japanese hops or knotweed may tend to limit distribution to riparian or wetland areas. However, many exotic plants like Japanese stiltgrass and Canada thistle are generalists and likely to be found in similar abundance outside of the riparian zone.

The Maryland Biological Stream Survey has conducted statewide stream surveys since 2000. The MBSS procedures include a wide array of information on stream condition, aquatic habitat, and aquatic species, but also collect data on adjacent riparian condition. The presence and extent of common invasive plants are routinely collected. The MDFS used the following MBSS data categories: plant name, site identifier, abundance, site uniqueness, and location. In all there were 1910 site visits for data between 2000 and 2009. MDFS analyzed the data on a statewide scale and by physiographic regions. The regions were Coastal, Piedmont, and Mountain. The Mountain category was generalized to contain the Appalachian Plateau, Blue Ridge, and Ridge & Valley physiographic provinces. The Mountain category contains the Western Region and the Piedmont category intersects the Central Region.

Findings from the data analysis showed that majority of the sites across the state showed 1 to 3 invasive species present (Figure 1). At a regional level, the Mountain and Piedmont categories occupied the ends of the spectrum. Sites in the Mountain area typically had no more than 1 or 2 invasive species present (Figure 2), while most Piedmont sites had 3 or

4 invasive species, up to 13 on a single site (Figure 3). Coastal Plain sites generally had three or fewer species on a site (Figure 4).

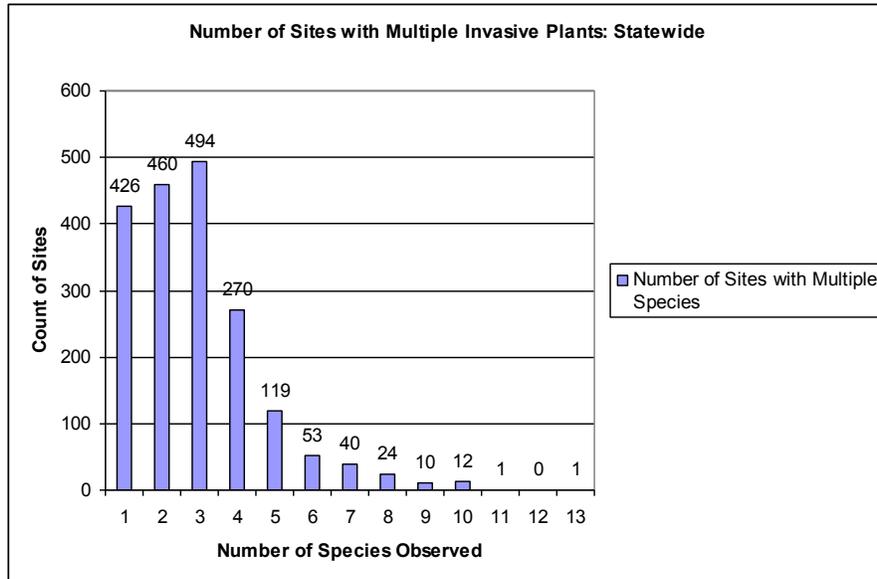


Figure 1: Count of Invasive Species Present at MBSS Riparian Sites across Maryland, 2000-2009 (1893 sites)

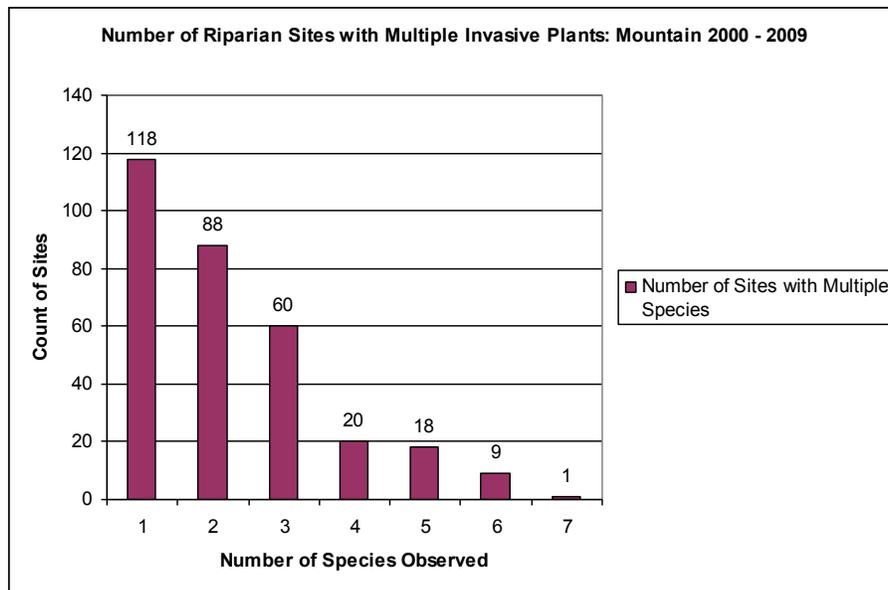


Figure 2: Count of Invasive Species Present at MBSS Riparian Sites in the Mountain Region of Maryland (314 sites)

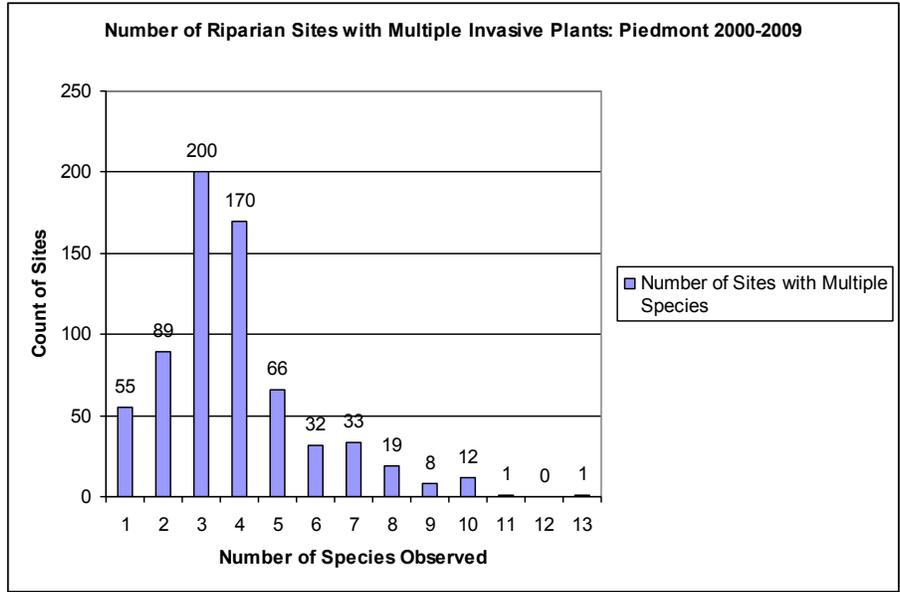


Figure 3: Count of Invasive Species Present at MBSS Riparian Sites in the Piedmont Region of Maryland (687 sites)

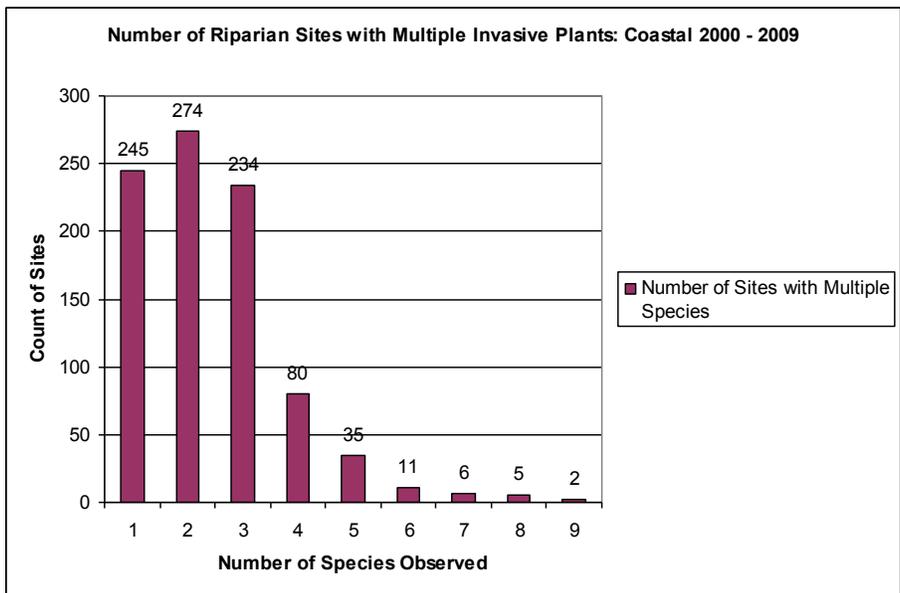


Figure 4: Count of Invasive Species Present at MBSS Riparian Sites in the Coastal Region of Maryland (892 sites)

The three most commonly seen species between 2000 and 2009 were multiflora rose, Japanese honeysuckle, and Japanese stiltgrass (Figure 5). These three species were the most common in each region, although regional differences were apparent in the mix of other species (Figures 6, 7, 8). Mile-a-minute was almost as common as stiltgrass in the Piedmont, and was the fourth most frequent exotic plant in the Coastal Plain as well.

Canada thistle and garlic mustard were the next most common exotic plants in the Mountain sites, and mile-a-minute was much less frequent.

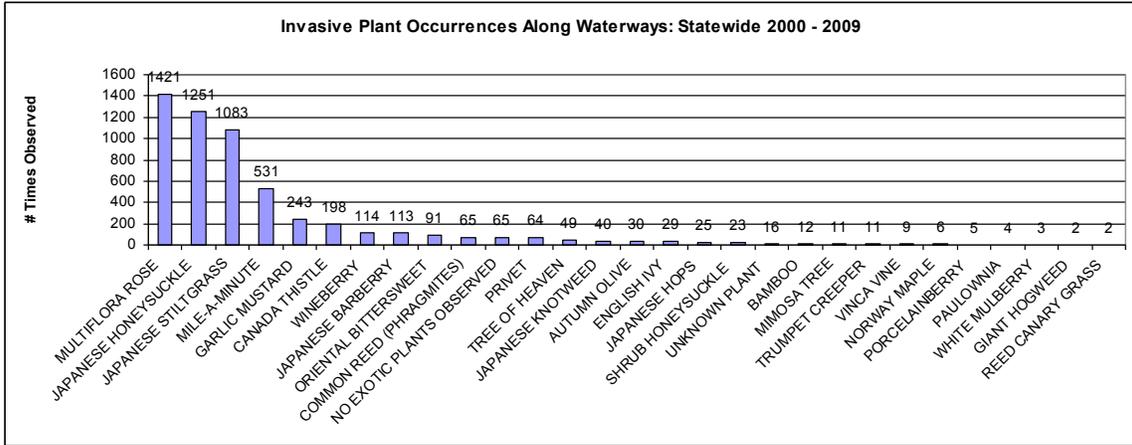


Figure 5: Frequency of invasive plants by species in riparian areas, Statewide 2000-2009, MD Biological Stream Survey data (1910 sites)

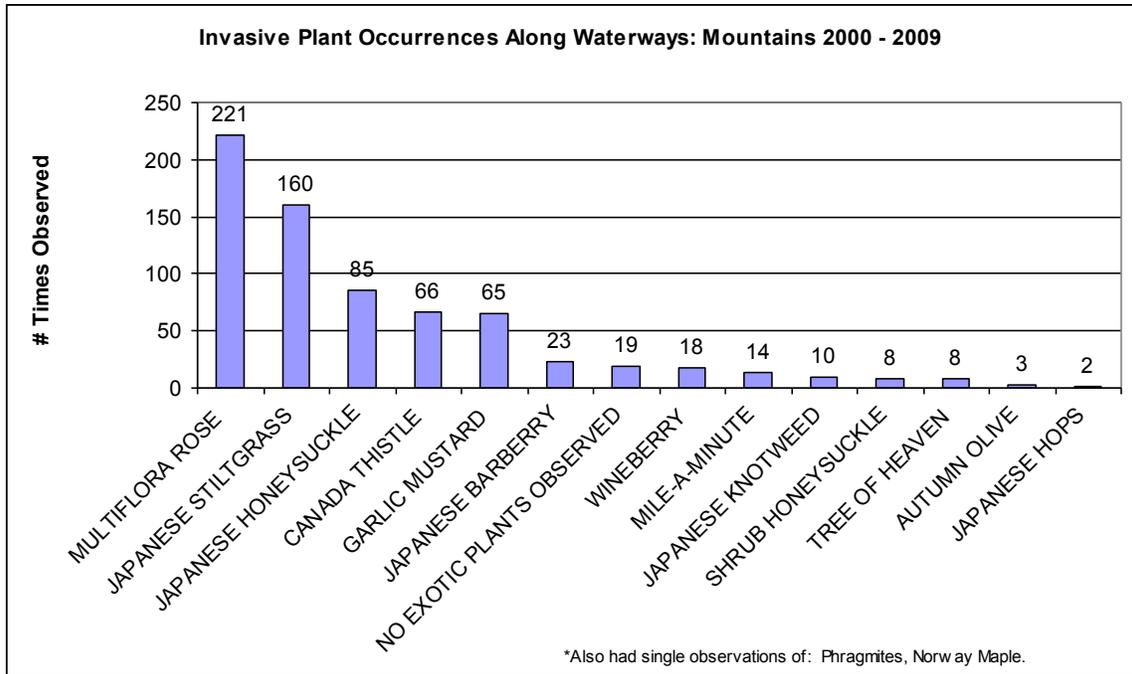


Figure 6: Frequency of invasive plants by species in riparian areas, Mountain sites, 2000-2009, MD Biological Stream Survey data (314 sites)

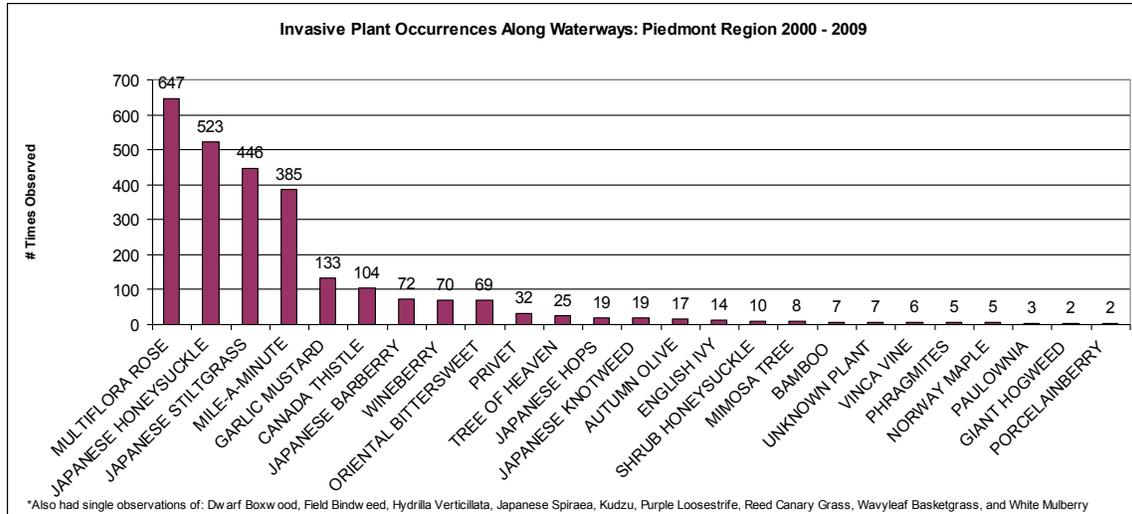


Figure 7: Frequency of invasive plants by species in riparian areas, Piedmont sites, 2000-2009, MD Biological Stream Survey data (687 sites)

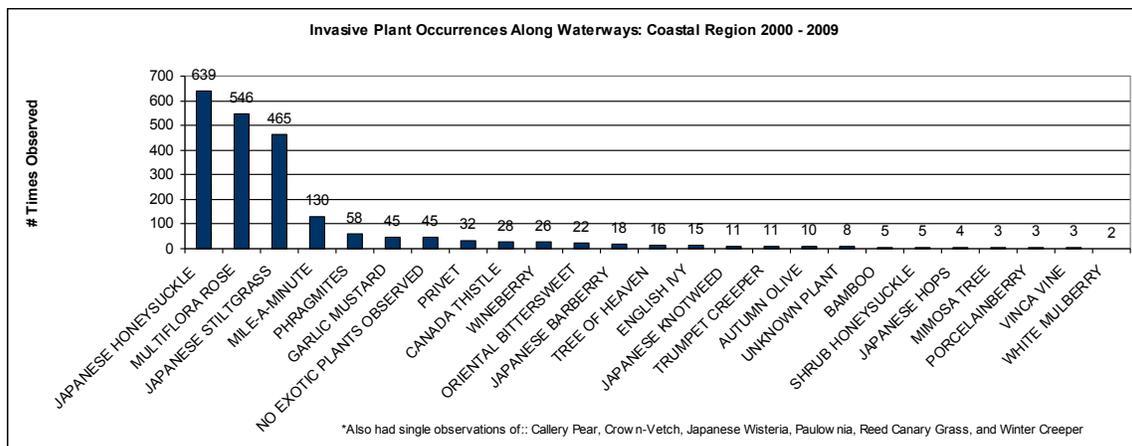


Figure 8: Frequency of invasive plants by species in riparian areas, Coastal Plain sites, 2000-2009, MD Biological Stream Survey data (892 sites)

Tree Regeneration at Invaded and Non-invaded Sites, Mountain and Piedmont:

The MBSS data make it clear that exotic invasive species are common and widely distributed throughout the State, at least in riparian areas. Most of these exotic species also are found widely distributed in upland areas as well, and trends point to further increases in the future. A critical question for forest management and our ability to maintain healthy forests into the future is how much the presence of invasive species interferes with tree regeneration. To this end, MDFS collected data on forest regeneration and overstory characteristics in the least and most invaded areas of the State, Mountain and Piedmont.

The study is based on observational data, and does not isolate effects of invasive plants separately from other major stressors like deer browse and fire exclusion that can affect species distributions. High levels of deer browse, in particular, have been found to be associated with increased extent of exotic invasive plants (Eschtruth and Battles 2009, Côté et al. 2004). Forest management occurs in the same matrix of mixed and related stresses, and these stresses will not be isolated from each other in the normal course of management practices. Consequently, the study was designed to assess conditions associated with invaded sites as would be encountered for forest management. Additional studies would be needed to distinguish effects of exotic plants (e.g., competition, shading, or allelopathy) from herbivory (e.g., preferential browsing by deer).

Study Areas:

Data were collected on Baltimore City Liberty reservoir lands for the Piedmont in Central Region and Green Ridge State Forest for the Mountain area in Western Region. Liberty Reservoir's 9,200 acre property is located in Baltimore and Carroll Counties, and owned and managed by the Baltimore City Department of Public Works. The reservoir land is surrounded by agriculture, low density residential development and a few high-density areas. The 46,000 acres of Green Ridge State Forest lies in eastern Allegany County where it is surrounded by agriculture and forest. Once dominated by apple orchards it has grown into a mixed hardwood forest.

Two sets of control and invaded plots were located at each forest. Locations of the study sites were chosen in consultation with local forester managers who work in and are familiar with the areas of interest. Although every attempt was made to locate contrasting plots close to each other, some distance was necessary to find the desired range of conditions. Numerous potential sites were reviewed in the field for suitability. Sites were chosen to represent the spectrum of plant invasion while keeping landscape and canopy conditions as similar as possible.

The Liberty invasive plots were primarily located on Glenelg loam and Mt. Airy channery loam soils ranging from moderately to severely eroded. Glenelg soils in the conditions present at the sample plots are best suited to hay, pasture, orchard or woodland. The control plots at Liberty were located on Manor very stony loam soils. Unless significant work is done to remove stones, these soils are usually left to woodland.

The invasive plots at Green Ridge were located on Calvin channery and Calvin-Weikert shaley silt loams. As a whole, Calvin soils are better suited to woodlands than crop or pasture land due to erosion hazard and low moisture content. The control plots at Green Ridge were located on Gilpin series soils. This particular series of soil can be productive for crops if well managed. The limiting factor for Gilpin soils usually is the abundance of rocks and steep slopes. The slopes where the study sites were located were rather steep, 20 to 30%.

Methods:

Grids that measured 2.5 chains by 4 chains were established in each study area. Two grids were located in invaded areas and two grids were located in control areas. The grids were laid out in rectangles with six plots along the perimeter; three plots equally spaced down the lengths of each side. The grids were oriented to follow transects which would run them through either the worst invasion areas or the best control areas, respectively.

| | Sites | Liberty | | Sites | Green Ridge | |
|-----------------------|--------|---------------|---------------|--------|---------------|---------------|
| | | X | Y | | X | Y |
| Control Plots | Ctrl 1 | 408594.23899 | 190185.453626 | Ctrl 1 | 271710.611543 | 216655.311878 |
| | Ctrl 2 | 408837.135254 | 189866.092918 | Ctrl 2 | 270619.471137 | 214404.105875 |
| Invasive Plots | Inv 2 | 408006.945618 | 190676.640131 | Inv 1 | 270086.228175 | 213274.421458 |
| | Inv 1 | 408488.435188 | 190821.426566 | Inv 2 | 270067.692607 | 213025.565025 |

Table 1: Locations of the A-1 plot for each study grid in Maryland State Plane.

At each point, vegetative data in a 1/100 acre plot with a radius of 11.78 feet were collected. Vegetative data included species of plant, ground or shrub designation, percent cover, and count of stems. Basal area was also taken over plot center using a 10 BAF prism. Other general observations were made for the entire plot including; the presence or absence of deciduous shrubs, coniferous shrubs, ericaceous shrubs, wetland shrubs, and wetland ground vegetation. Estimates of percent cover for shrub, ground, moss, litter, rock, other fern, regeneration of sprout origin, and grass and sedge were also part of the general observations.

Collected data was entered into NED-2, a vegetation and forest analysis program developed by the USDA Forest Service which allows for adaptation to user needs. Once output tables were generated by NED-2, the data were exported into Excel where charts and statistics were generated. Paired t-tests were conducted on the data to see which variables played significant or non-significant roles in invaded vs. control sites.

Canopy closure was calculated by pacing twenty feet out from plot center and taking canopy readings at 36 degree intervals starting from 0 using a canopy densometer. Ten readings per plot were taken with a recording of present/not present for canopy in the view finder.

Comparison of Stand Canopy Data:

Canopy closure did not appear to be related to level of invasion (Figure 9). At Green Ridge State Forest (GRSF), the Mountain location, lower canopy cover was associated with the invaded plots (56% at invasive plots to 86% at control plots). The Liberty forest exhibited the opposite trend, where the control plots had the lower canopy closure of 60% and invasive plots had a canopy closure of 83%. At least for these sites and under substantially closed canopy, canopy closure was not significantly related ($p < 0.05$) to the level of invasive species.

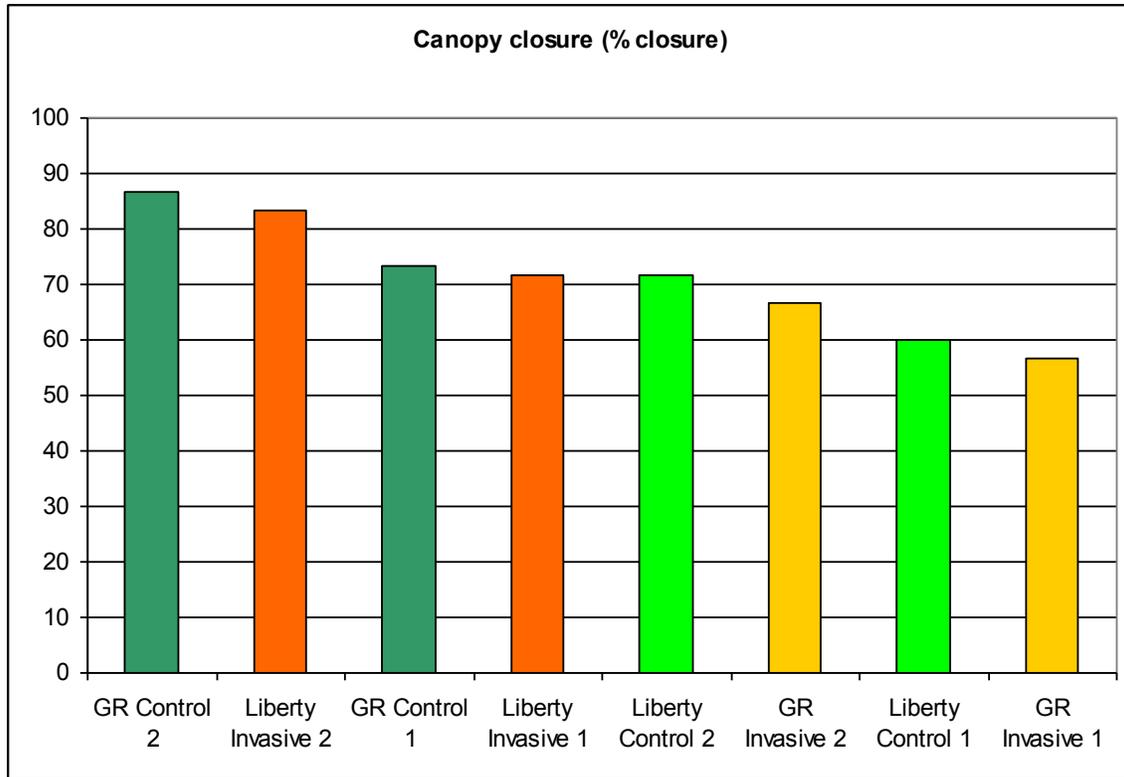


Figure 9: Canopy Closure Measurements at Control and Invaded Sites at Green Ridge State Forest and Liberty Reservoir Lands.

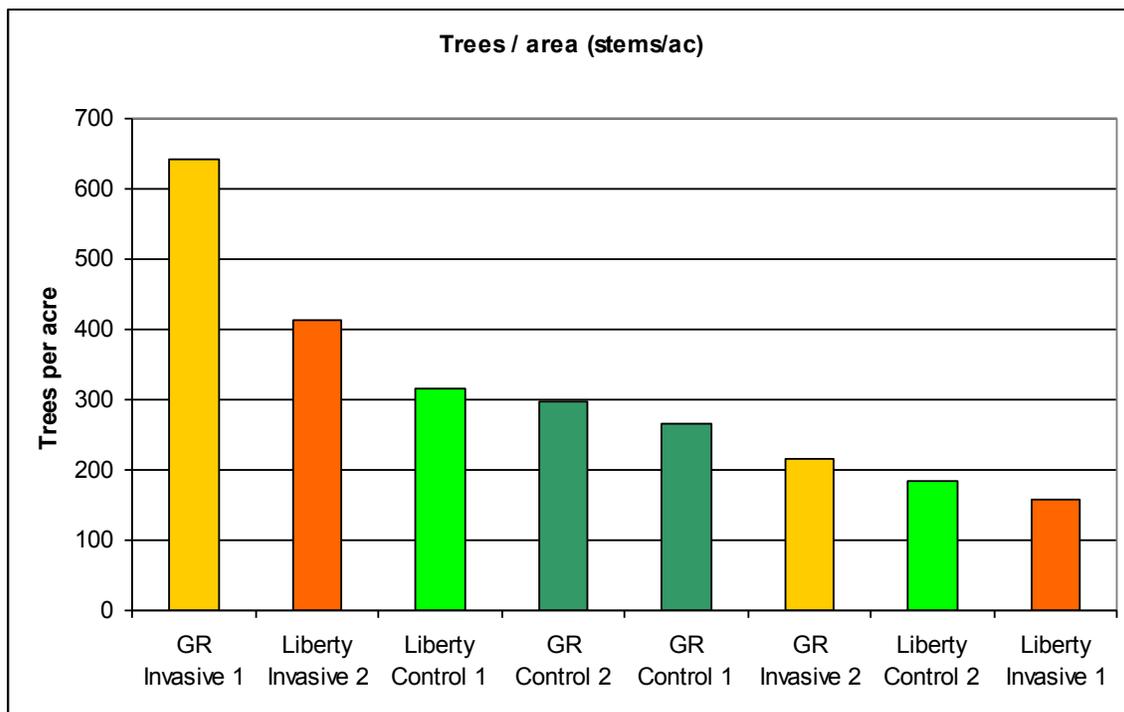


Figure 10: Trees per Acre Count at Control and Invaded Sites at Green Ridge State Forest and Liberty Reservoir Lands

Basing invasiveness on stems per acre is difficult due to the distribution of the data. The highest and the lowest trees per acre counts occurred on invasive sites. One of the invasive sites at Green Ridge had a thick midstory of tree-of-heaven which explains the high stem count at GR Invasive 1. Stems per acre ranged from 157 to 641, and did not differ significantly between control and invaded sites.

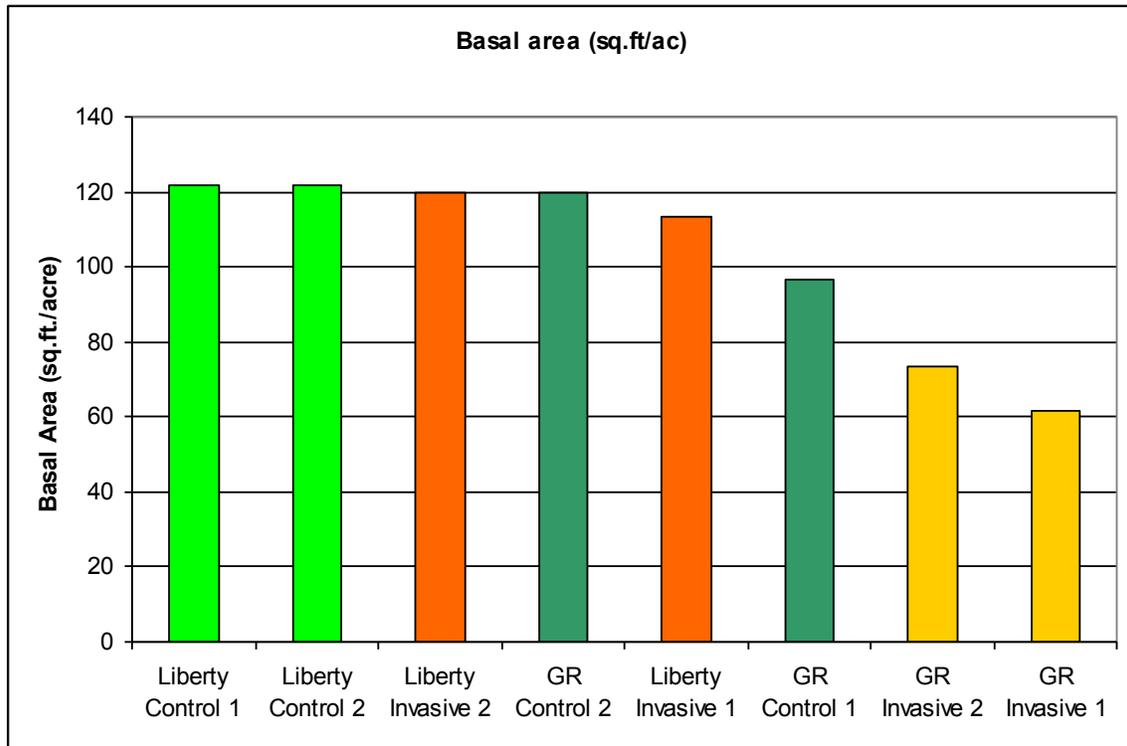


Figure 11: Basal Area of Invaded and Control Sites at Green Ridge State Forest and Liberty Reservoir Lands

At Green Ridge, basal area of the sites ranged from 62 square feet per acre for invaded sites to 120 square feet per acre for control sites. Liberty’s basal area ranged from 113 square feet per acre for invasives to 122 square feet per acre for control. For these sites, basal area did not differ significantly ($p = 0.19$) between control and invaded sites.

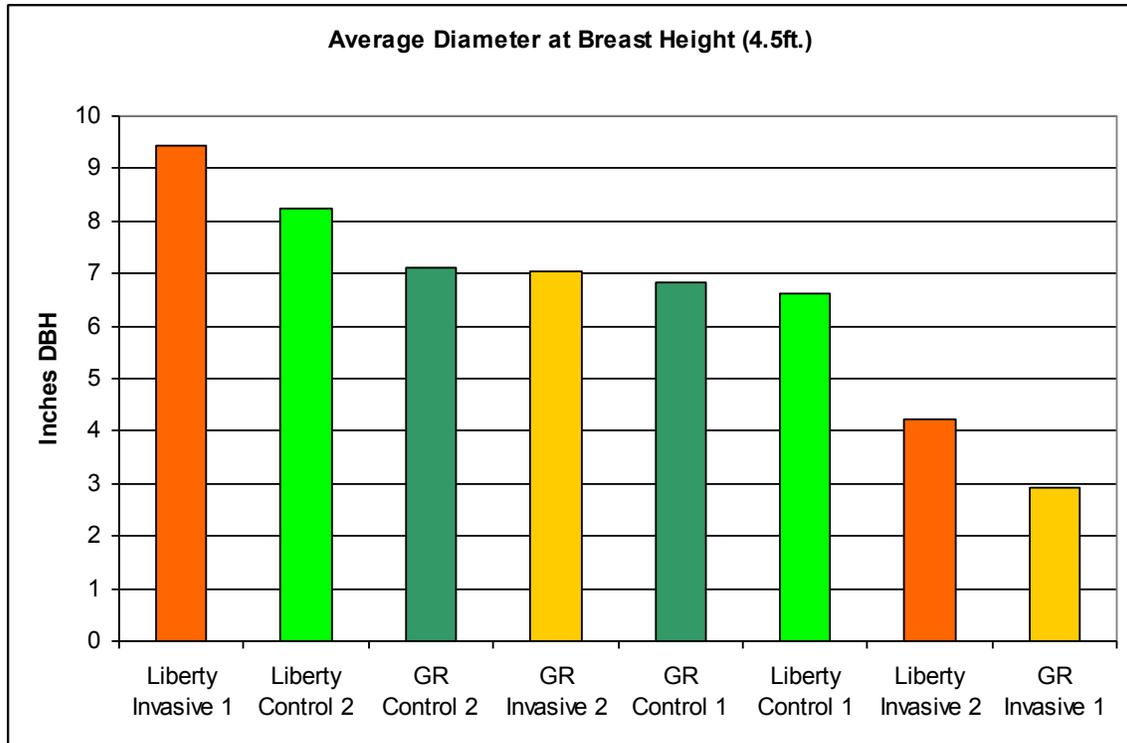


Figure 12: Average DBH of Invaded and Control Sites at Green Ridge State Forest and Liberty Reservoir

Invasiveness as a whole was slightly higher in stands where they were relatively young based on the average DBH. Invasive sites had the highest and lowest average diameter at breast height. Green Ridge had the lowest average DBH at 2.9 and Liberty had the highest average DBH at 9.4. Overall, the sites selected to compare invasive species metrics did not differ significantly in canopy closure, tree density, or average DBH.

Discussion:

Invasive stems per acre:

A count of stems per acre is useful in having an idea of how many individual plants there are in an acre. In terms of invasive species, the higher the stem count, the worse the invasion.

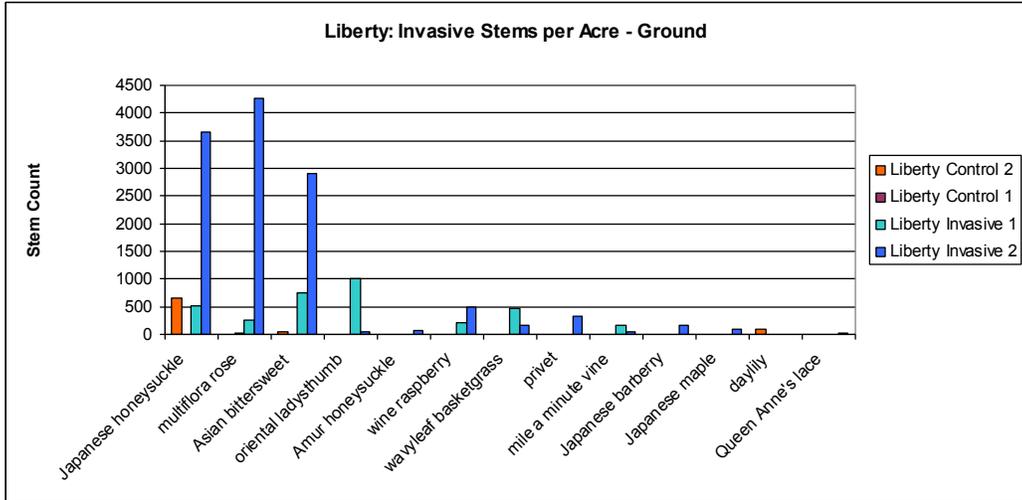


Figure 13: Invasive Stems per Acre from Ground Surveys at Liberty Reservoir.

Multiflora rose, bittersweet, and Japanese honeysuckle were the species with the highest presence at Liberty. Control sites showed relatively little invasion when compared to levels shown at the invasive sites.

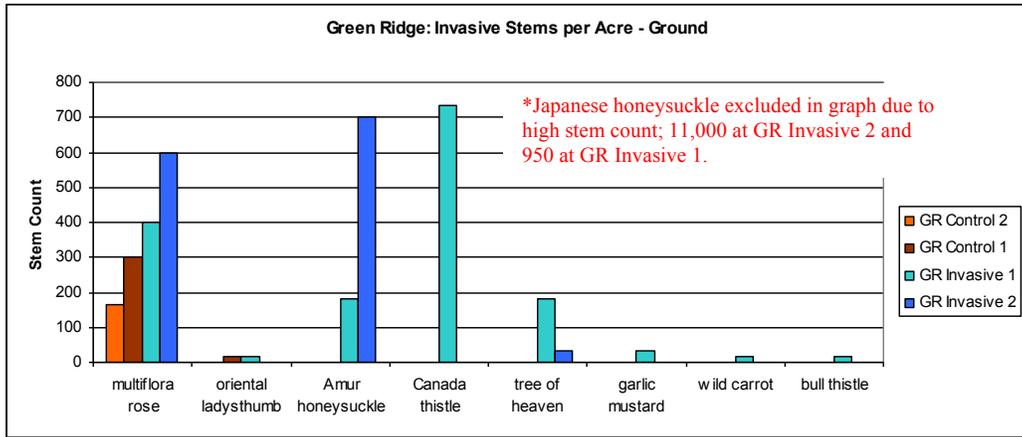


Figure 14: Invasive Stems per Acre from Ground Surveys at Green Ridge State Forest

Green Ridge had low invasive species diversity. Green Ridge had the highest stem count for invasive species at 11,000 stems of Japanese honey suckle at one of the invasive sites. As a whole, Liberty showed higher counts of invasive species and more invasive species diversity at sites. There was a significant difference between invaded and control sites ($p=.023$). This analysis did not include Japanese stilt grass, which was estimated only by percent cover.

Percent Cover of Plots:

Percent cover was calculated from estimates on ground covered by specific species in vegetation plots. If too much of a site is covered by invasive species, desirable tree regeneration has a hurdle to clear before it is able to establish itself.

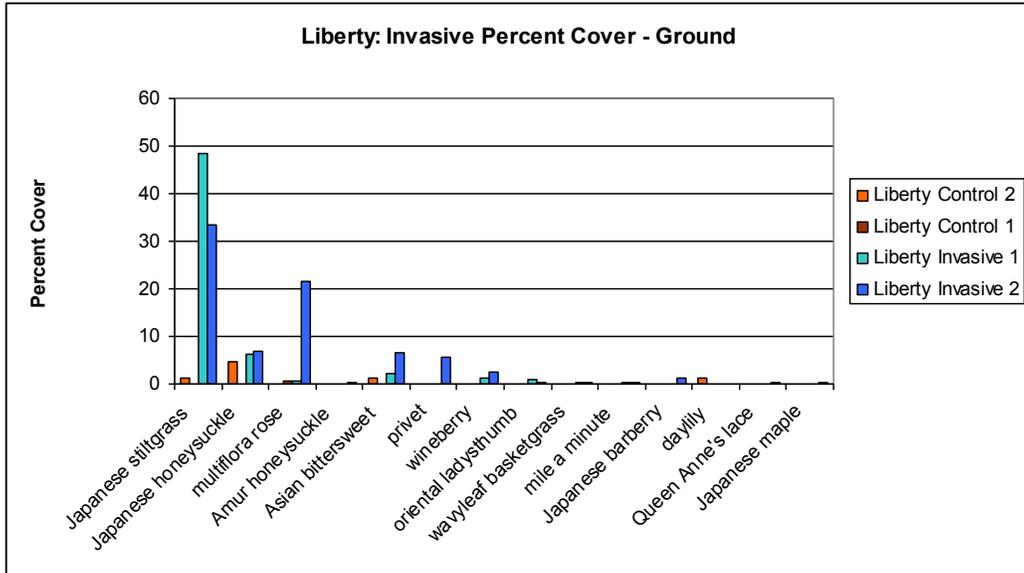


Figure 15: Invasive Species Percent Cover of Ground Plots at Liberty Reservoir

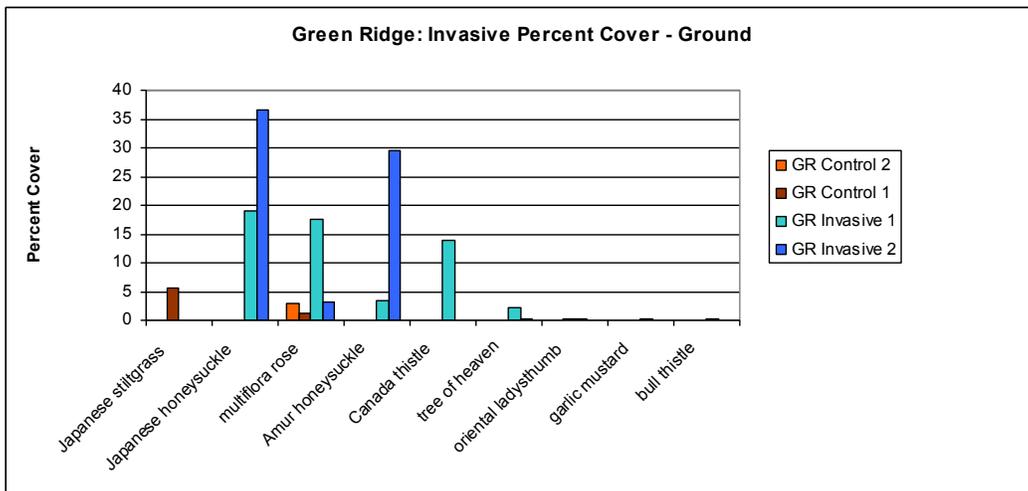


Figure 16: Invasive Species Percent Cover of Ground Plots at Green Ridge State Forest

Liberty showed the highest percent cover of invasive species at a single site with 48% of a site being covered by Japanese stilt grass. Stilt grass was present at 75% of Liberty sites while only being present at one Green Ridge site with 5% cover. There is a significant difference in invasive species percent ground cover between invasive and control sites ($p = .002$).

Tree Regeneration:

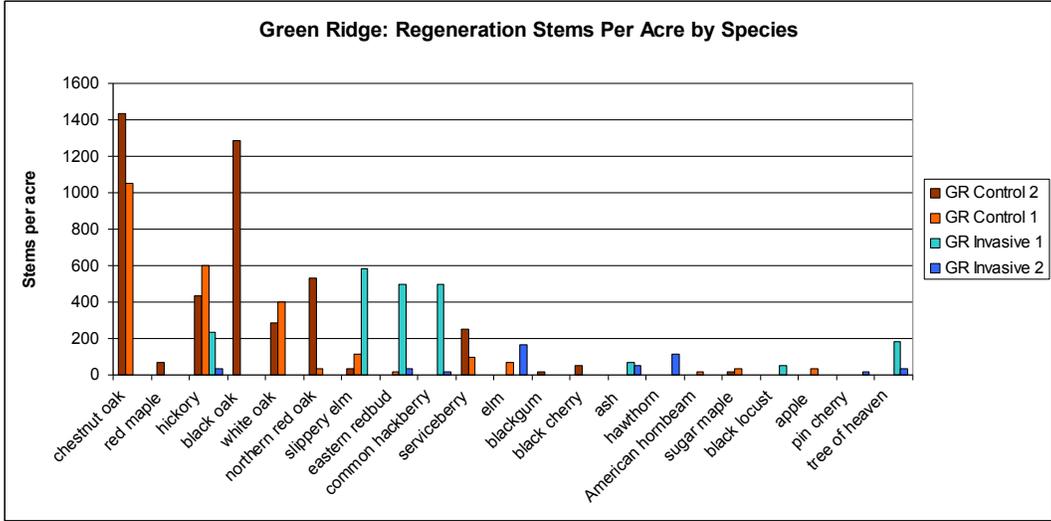


Figure 13: Desirable Tree Regeneration at Green Ridge State Forest

Green Ridge showed favorable regeneration for desirable species in many of the control study plots and a few invasive plots. Chestnut oak and black oak surpassed the desirable 1,000 seedlings/acre count in Control 2. Chestnut oak had a high stem count in Control 1 too. A strong oak/hickory mix was present at both control sites and hickory was present at all 4 sites.

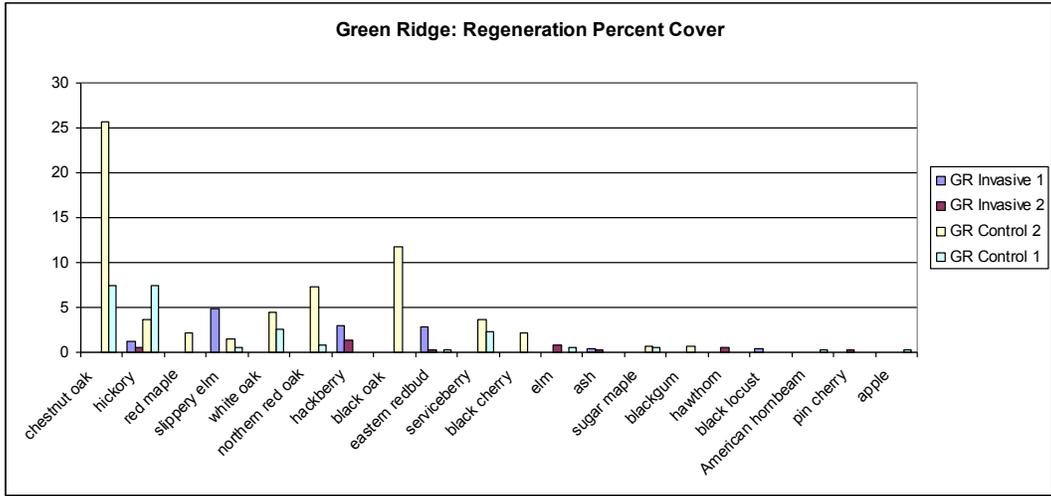


Figure 14: Regeneration by Percent Cover of Species at Green Ridge State Forest

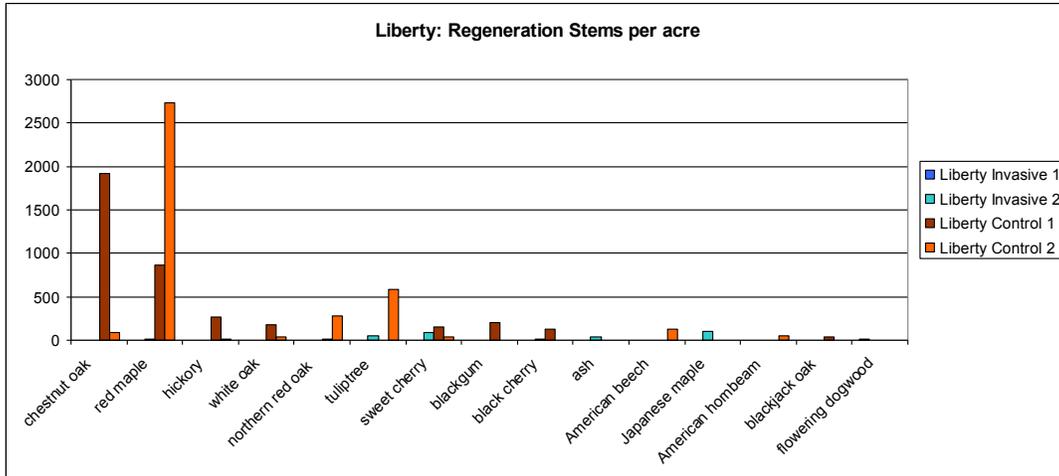


Figure 15: Regeneration by Seedlings per Acre of Species in Liberty Reservoir

Liberty had chestnut oak and red maple at extremely high stem counts for two sites. With a count of 1,900, chestnut oak was doing well at a single site at Liberty. Red maple had the highest count for regeneration of the entire study at 2,700 stems per acre. While red maple is native it lacks the beneficial wildlife and water quality traits that make oaks and hickories more desirable. The correlation between stems per acre and percent cover was strong for chestnut oak, but low for red maple.

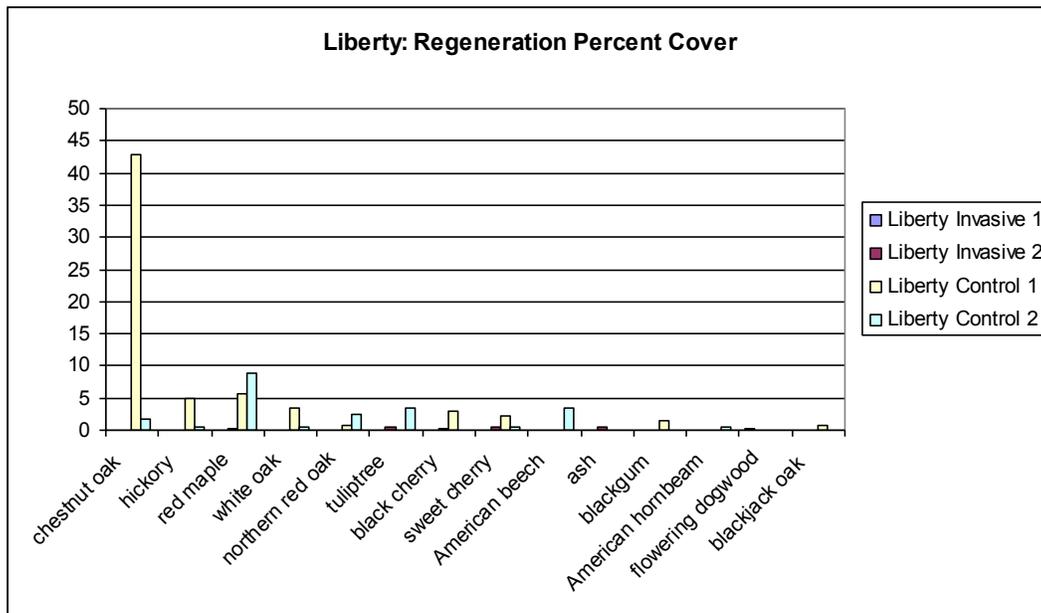


Figure 16: Regeneration by Percent Cover of Species at Liberty Reservoir

Liberty's regeneration ground cover at a single study site was dominated by chestnut oak seedlings with 43% of available space. The highest percent cover at specific sites for regeneration following chestnut oak were Red maple with 7% and hickory at 5%. There was a significant difference between invaded sites and control sites for percent cover of regeneration ($p = .003$).

Conclusion:

Regional differences became very apparent even during the data collection phase of the study. Western region levels of invasion are not as severe as Central Region in terms of concentrations or species present. Furthermore, in sites where invasives were present in Western Region, regeneration was still growing.

Identifying the variables that contribute to the variations in levels of invasion are difficult to pinpoint. Some of the more obvious differences between the two regions are: available water, deer population, and proximity to civilization. Allegany County is the driest county in Maryland; Carroll County on the other hand receives ample rainfall. Something that became apparent during the site selection process at Green Ridge was that the south-east aspect of the ridge had more invasive species present and fewer stems of desirable regeneration than the north-west facing aspect. It appears that the invasives in Western Region needed to exploit water stressed areas in order to establish themselves. Liberty lands showed signs of high deer populations. There were abundant deer scrapes and buck rubs. Green Ridge didn't show anywhere near the level of deer presence that Liberty did.

Sites did not differ significantly in basic stand attributes: canopy closure, basal area, trees per acre, and average DBH. When data was taken down to site specific data such as percent ground cover or stems per acre, there were significant differences between invaded and control sites. Liberty reservoir lands are badly invaded and have a high deer pressure. Few of the sites showed anything resembling a viable seedling population should a stand replacing disturbance occur. Even though two of the sites at Liberty showed ample regeneration of native species, only one of them offer substantial wildlife and water quality benefits. Green Ridge's levels of invasion were less severe and apparently had a lesser impact on desirable species. The species diversity among desirable regeneration was high along with the stem counts.

Management:

Since stand level data didn't show any significant differences on invaded stands vs. control stands. Shade tolerant invasive species appear to maintain or invade even without harvest disturbance. Deer may play a role in disturbance of the litter layer. The best thing to do is manage invasives as needed. Doing control measures before an overstory removal would be advisable to give regeneration a chance to establish itself and have a head start on the next round of invasives. Managing the deer herd is also important since control sites that showed healthy regeneration counts were located on uneven rocky ground, apparently deterring deer. Seedlings are a favorite food for deer. Deer, along with other wildlife have the ability to carry seeds and deposit new infestations in pristine areas.

References:

Côté, S.D., T.P. Rooney, J. Tremblay, C. Dussault, and D.W. Waller. 2004. Ecological impacts of deer abundance. *Annual Review of Ecology, Evolution, and Systematics* 35: 113-147.

Eschtruth, A.K. and J.J. Battles. 2009. Acceleration of exotic plant invasion in a forested ecosystem by a generalist herbivore. *Conservation Biology* 23(2):388-399.

Stand Level Data:

| stands | Avg. dbh (in) | Basal area (sq.ft/ac) | Canopy closure (% closure) | Trees / area (stems/ac) |
|--------------------|---------------|-----------------------|----------------------------|-------------------------|
| Liberty Invasive 1 | 9.45 | 113.3 | 71.7 | 157.45 |
| Liberty Control 1 | 6.61 | 121.7 | 60 | 316.58 |
| Liberty Invasive 2 | 4.21 | 120 | 83.3 | 412.2 |
| Liberty Control 2 | 8.24 | 121.7 | 71.7 | 184.28 |
| GR Invasive 1 | 2.91 | 61.7 | 56.7 | 640.95 |
| GR Control 2 | 7.13 | 120 | 86.7 | 296.45 |
| GR Control 1 | 6.82 | 96.7 | 73.3 | 267.1 |
| GR Invasive 2 | 7.05 | 73.3 | 66.7 | 214.85 |

Species Observed:

| Species | Overstory | Ground | Management Unit | |
|---|-----------|--------|-----------------|---------|
| | | | Green Ridge | Liberty |
| Virginia creeper (<i>Parthenocissus quinquefolia</i>) | | X | X | X |
| hickory (<i>Carya</i>) | X | X | X | X |
| sweet cherry (<i>Prunus avium</i>) | | X | | X |
| blueberry (<i>Vaccinium</i>) | | X | X | X |
| black locust (<i>Robinia pseudoacacia</i>) | X | X | X | X |
| false nettle (<i>Boehmeria</i>) | | X | X | X |
| hayscented fern (<i>Dennstaedtia</i>) | | X | X | X |
| greenbrier (<i>Smilax</i>) | | X | X | X |
| black raspberry (<i>Rubus occidentalis</i>) | | X | X | X |
| European larch (<i>Larix decidua</i>) | X | | | X |
| wine raspberry (<i>Rubus phoenicolasius</i>) | | X | | X |
| Christmas fern (<i>Polystichum acrostichoides</i>) | | X | X | X |
| flowering dogwood (<i>Cornus florida</i>) | X | X | X | X |
| American beech (<i>Fagus grandifolia</i>) | X | X | | X |
| eastern white pine (<i>Pinus strobus</i>) | X | | X | X |

| | | | | |
|--|---|---|---|---|
| American witchhazel (<i>Hamamelis virginiana</i>) | | X | | X |
| Japanese honeysuckle (<i>Lonicera japonica</i>) | | X | X | X |
| multiflora rose (<i>Rosa multiflora</i>) | | X | X | X |
| oriental ladythumb (<i>Polygonum caespitosum</i>) | | X | X | X |
| blackjack oak (<i>Quercus marilandica</i>) | | X | | X |
| northern red oak (<i>Quercus rubra</i>) | X | X | X | X |
| white oak (<i>Quercus alba</i>) | X | X | X | X |
| Indian strawberry (<i>Duchesnea indica</i>) | | X | X | X |
| sassafras (<i>Sassafras albidum</i>) | X | | X | X |
| slippery elm (<i>Ulmus rubra</i>) | X | X | X | |
| goldenrod (<i>Oligoneuron</i>) | | X | X | X |
| red maple (<i>Acer rubrum</i>) | X | X | X | X |
| tree of heaven (<i>Ailanthus altissima</i>) | X | X | X | |
| Queen Anne's lace (<i>Daucus carota</i>) | | X | | X |
| Japanese barberry (<i>Berberis thunbergii</i>) | | X | | X |
| trillium (<i>Trillium</i>) | | X | X | X |
| mockernut hickory (<i>Carya alba</i>) | X | | | X |
| Nepalese browntop (<i>Microstegium vimineum</i>) | | X | X | X |
| black cherry (<i>Prunus serotina</i>) | X | X | X | X |
| woodsorrel (<i>Oxalis</i>) | | X | X | X |
| chestnut oak (<i>Quercus prinus</i>) | X | X | X | X |
| Jack in the pulpit (<i>Arisaema triphyllum</i>) | | X | | X |
| Allegheny blackberry (<i>Rubus allegheniensis</i>) | | X | X | X |
| privet (<i>Ligustrum</i>) | | X | | X |
| scarlet oak (<i>Quercus coccinea</i>) | X | | | X |
| deertongue (<i>Dichanthelium clandestinum</i>) | | X | X | X |
| mapleleaf viburnum (<i>Viburnum acerifolium</i>) | | X | X | X |
| garlic mustard (<i>Alliaria petiolata</i>) | | X | X | |
| beggarticks (<i>Bidens</i>) | | X | X | X |
| loblolly pine (<i>Pinus taeda</i>) | X | | | X |
| wild celery (<i>Apium graveolens</i>) | | X | X | |
| mustard (<i>Brassica</i>) | | X | X | |
| blackgum (<i>Nyssa sylvatica</i>) | X | X | X | X |
| sugar maple (<i>Acer saccharum</i>) | X | X | X | |
| Canada thistle (<i>Cirsium arvense</i>) | | X | X | |

| | | | | |
|--|---|---|---|---|
| wavyleaf basketgrass (<i>Oplismenus undulatifolius</i>) | | X | | X |
| apple (<i>Malus</i>) | | X | X | |
| Virginia pine (<i>Pinus virginiana</i>) | X | | X | |
| pitch pine (<i>Pinus rigida</i>) | X | | X | |
| American hornbeam (<i>Carpinus caroliniana</i>) | | X | X | X |
| striped prince's pine (<i>Chimaphila maculata</i>) | | X | X | X |
| aster (<i>Aster</i>) | | X | X | |
| mile a minute vine (<i>Ipomoea cairica</i>) | | X | | X |
| eastern redbud (<i>Cercis canadensis</i>) | X | X | X | |
| black oak (<i>Quercus velutina</i>) | X | X | X | X |
| serviceberry (<i>Amelanchier</i>) | | X | X | |
| spicebush (<i>Lindera</i>) | | X | | X |
| eastern poison ivy (<i>Toxicodendron radicans</i>) | | X | X | X |
| elm (<i>Ulmus</i>) | X | X | X | |
| tuliptree (<i>Liriodendron tulipifera</i>) | X | X | | X |
| grape (<i>Vitis</i>) | | X | X | X |
| daylily (<i>Heemerocallis</i>) | | X | | X |
| ash (<i>Fraxinus</i>) | X | X | X | X |
| violet (<i>Viola</i>) | | X | X | X |
| bull thistle (<i>Cirsium vulgare</i>) | | X | X | |
| American elm (<i>Ulmus americana</i>) | X | | X | |
| pin cherry (<i>Prunus pennsylvanica</i>) | | X | X | |
| black walnut (<i>Juglans nigra</i>) | X | | X | X |
| mayapple (<i>Podophyllum</i>) | | X | X | |
| Amur honeysuckle (<i>Lonicera maackii</i>) | | X | X | X |
| Japanese maple (<i>Acer palmatum</i>) | | X | | X |
| viburnum (<i>Viburnum</i>) | | X | X | X |
| shagbark hickory (<i>Carya ovata</i>) | X | | X | |
| common hackberry (<i>Celtis occidentalis</i>) | X | X | X | |
| Table Mountain pine (<i>Pinus pungens</i>) | X | | X | |
| hawthorn (<i>Crataegus</i>) | | X | X | |
| Asian bittersweet (<i>Celastrus orbiculata</i>) | | X | | X |