Inventory of Select Invasive Species in Shenandoah National Park

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INTRODUCTION

The Nature Conservancy, in an effort to protect unfragmented forest regions within the Piedmont of Virginia, is interested in assessing the severity and distribution of invasive plant species within these regions. One of the best examples of these unfragmented forested lands is the Southern Shenandoah Forest Block, located in western Albemarle and Greene counties, and including portions of Shenandoah National Park. US Forest Service data indicate that numbers of *Ailanthus altissima*, an exotic tree from S.E. Asia, are increasing in Virginia's forests (Rose, 2009). A survey was undertaken in the summer and fall of 2010 to locate occurrences of *A. altissima* and other selected invasive species within Shenandoah National Park. The survey area is approximately 3,000 acres in western Albemarle County, roughly bounded by Sugar Hollow Reservoir to the south, Skyline Drive to the west, Pinestand Mountain to the north, and the park's eastern boundary to the east (Fig. 1). Abundance of selected invasive species was recorded at each survey point within the area, along with data on forest community type and disturbance patterns.

METHODS

Selected invasive species – Tree-of-heaven (*Ailanthus altissima*), Princesstree (*Paulownia tomentosa*), Japanese stiltgrass (*Microstegium vimineum*), Garlic mustard (*Alliaria petiolata*), Oriental bittersweet (*Celastrus orbiculatus*), and Wavyleaf basketgrass (*Oplismenus hirtellus*).

2,000 total sample points were surveyed using a grid pattern with 178 feet between transects and 330 feet between points within a transect. At each point, a 0.1 acre circular plot was used to survey for trees and a 0.01 acre circular plot to survey for herbs and vines. For the two tree species, abundance was estimated separately for trees and saplings, and for the herbs and vines the abundance estimate was based on percent ground cover.

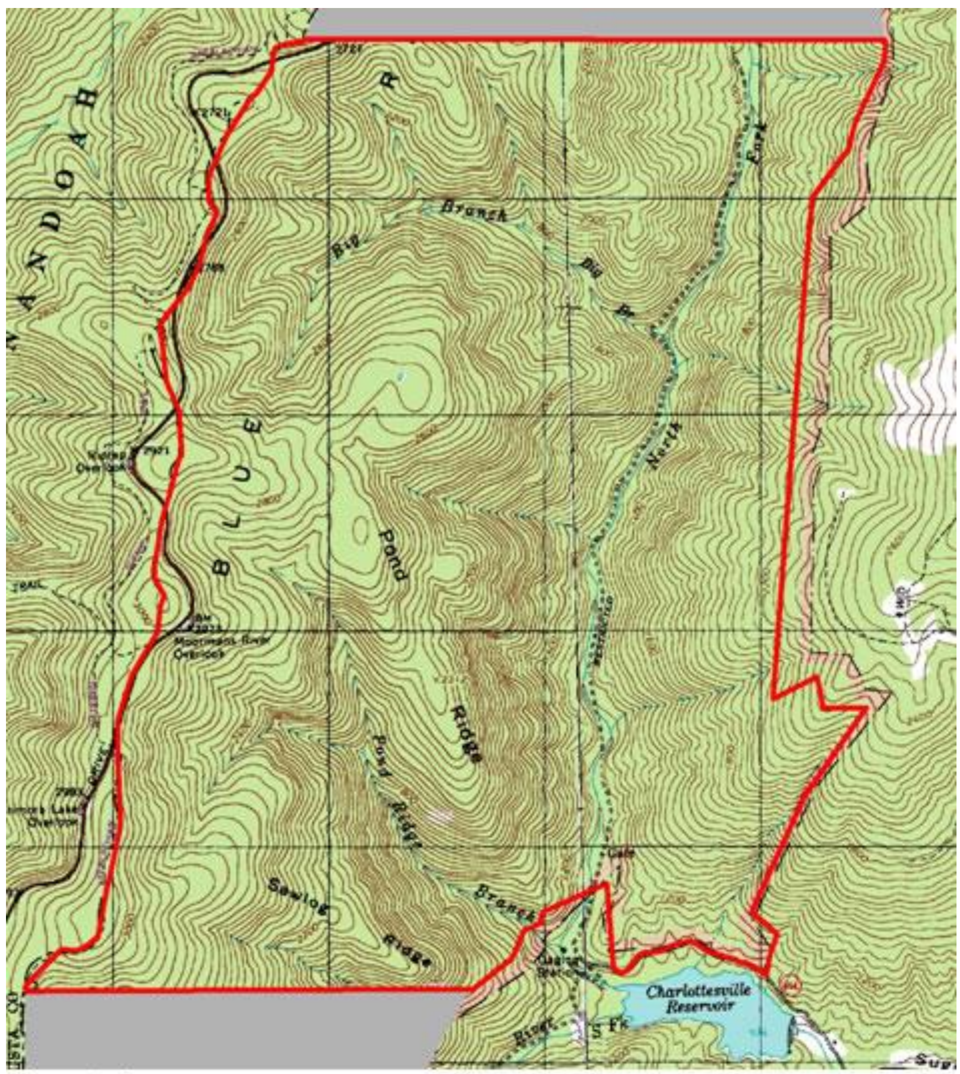

Figure 1. Survey area

GIS tools and aerial photographs were used to pinpoint exact locations of sample points prior to field work, and GPS coordinates were recorded for each point while in the field.

Disturbance type (none, path, wind/ice damage, mortality, other) and forest community type (mixed hardwood, poplar, mixed oak, xeric oak, scrub/barrens, pine, pine/hardwood, and other) were recorded for each point.

RESULTS AND OBSERVATIONS

Data – Survey data have been transferred to the Nature Conservancy for detailed analysis. Approximately 300 additional points remain to be surveyed in the northwest portion of the survey area.

Occurrences – Several large-scale occurrences of the two selected tree species were located. *A. altissima* and *P. tomentosa* were sometimes found coexisting in these regions. Perhaps more challenging from a management perspective were numerous isolated and random occurrences (i.e., ones not associated with obvious disturbance or larger infestations) (see Fig. 2). Of the herbs and vines, *A. petiolata* was encountered most frequently, and *M.vimineum* was abundant in local patches. *C. orbiculata* was rarely encountered, and *O. hirsutella*, not at all.

Figure 2. Isolated *Paulownia tomentosa* on south and east facing slope above tributary to Big Branch, SNP.

Habitat – A wide array of forest community types exist within the study area. No one forest type was associated exclusively with high incidence of invasives. Forest types include:

Montane Oak-Hickory Forests and Dry-Mesic Calcareous Forests - Two of the most commonly encountered communities, classified as mixed hardwood in the data code, and containing infestations. These community types were found throughout the survey area.

Rich Cove and Slope Forests - Another common forest type, most often characterized by extensive stands of *Liriodendron tulipifera* and thus classified as poplar in the data code, seemed less vulnerable to invasion, but not completely free of infestations, with at least one large-scale occurrence east of the Moorman's River.

Eastern White Pine/Hardwood Forest and Pine/Oak/Heath Woodlands - Eastern White Pine/hardwood forests mostly in the northeastern section of the survey area, and the Pine-Oak/Heath woodlands in areas west of and atop Pond Ridge. These were classified as Pine or Pine/Hardwood. These areas, especially the Pine-Oak/Heath woodlands, were not prone to infestation. Most other points characterized as Pine or Pine/Hardwood in the forest type data code generally consisted of very localized areas where Pine was dominant or co-dominant enough to warrant that classification, but were not part of extensive stands, such as in the Tulip Poplar or Oak-Hickory forests.

Oak/Heath Forests - Large areas west and south of the Pine-Oak/Heath woodlands of Pond Ridge and grading into them, characterized as xeric oak in the forest type data code. These areas were overwhelmingly dominated by *Quercus montana* with an understory of deciduous to evergreen ericads. Very few if any invasives were encountered in this forest type.

Habitat notes:
Occasionally, 'other' was used to denote forest type. An example would be when the sample point and the majority of the 0.1 acres around it fell in the Moorman's River, or when stands of hemlock, albeit unhealthy, were dominant enough to exclude other forest types.
Although mixed oaks were often present in the overstory, the data code for 'mixed oaks' was seldom used because of the presence of other non-oak species.
Often, when the canopy trees were absent or sparse through disturbance, forest type was inferred from the understory species. A common phenomenon in the southwestern portion of the survey area, for instance, was plots with many downed trees and thick patches of *Hamamelis virginiana* or *Acer spicatum*, or both. This would have been marked 'mixed hardwood'.

Disturbance – Certain types of disturbance noted at each point had a clear positive correlation to presence of invasive species, whereas for others the relationship between the disturbance and invasives was not as straightforward. Disturbance types:

Road, trail, path – This type of disturbance is most reliably associated with invasives in the survey. Paths within the area include Skyline Drive, North Fork Moorman's River Trail, and the Appalachian Trail. *Microstegium vimineum* is common along the Moorman's River Trail. Howard notes that it prefers moist to mesic, shaded, disturbed areas and roadsides, and readily establishes in floodplains (2005). The presence along the Moorman's River Trail could indicate its association with the floodplain as much as with the path, since the trail hugs the river for large sections. The same could be said to be true of patches of *Ailanthus* and *Paulownia*, which occur along the river and floodplain. Portions of the survey area include the roadside of the Skyline Drive which is artificially maintained and can be expected to therefore contain exotic and weedy herbs. There were not enough points along the Appalachian Trail to discern a pattern.

Mortality and Wind/Ice damage – At most sample points, there were some downed trees within the 0.1 acre circular plot. In general, if there were only 1 or a few, or none, it was not deemed to be a disturbance event that caused it. Most of the downed trees that indicated a disturbance event were attributed to wind/ice damage. Clues included downed trees 'pointing' in the same direction, sagging branches, healthy overturned trees with intact roots. Mortality was rarely noted as a disturbance. Though there are many dead trees, there were rarely discreet groups of dead trees, or many dead trees of the same species, indicating pollution or disease, etc.

Other – The most common reason for classifying a disturbance as 'other' was indication of a past fire event. Evidence of fire was often noted with evidence of wind/ice or other damage, in which case the code for wind/ice damage was usually used.

Figure 3. Aerial photograph showing numerous debris flow chutes west of and leading downslope to the Moorman's River. Areas like these have high occurrence of the two targeted invasive trees.

Flood – According to Demarest, a flood determined (by magnitude) to be a 400 to 2000 year occurrence took place in June of 1995, dramatically altering the North Fork of the Moorman's River (2005). The watershed was characterized by significant soil slippage from surrounding hills and some debris flow. Photographs from 1996 show *A. altissima* and *P. tomentosa* already colonizing most of the area around the river (Demarest, 2005). Evidence of this type of disturbance is frequent in the surrounding mountains, either of the 1995 event or other less dramatic ones. Figure 3 shows debris flow chutes resulting from a flood or landslide in the study area through an aerial photograph. These disturbance events are marked as 'other' in the data sheets or are misidentified. It is possible that at least some of the disturbances deemed wind/ice damage are actually from flood damage. In the hills surrounding the river, damaged areas which indicate flood, especially along tributaries, are often home to at least moderate infestations of the selected invasive species, especially the two tree species.

Unknown – Some areas that are overrun with invasives don't show any other signs of disturbance. An infested site to the east of the river, for instance, has downed trees, but no more than many other areas that are lacking invasives. In areas like this it could be that the damaging event occurred long enough ago that the only sign of disturbance remaining is the large infestation itself. Also, it's possible that a neighboring area outside of the survey plot, a debris pile, for instance, allowed for initial colonization, which then spread. It may be that the mechanism for invasion is not dependent upon disturbance, though the large-scale infestations of the two tree species along the river and in soil washouts suggest that disturbance at least helps establishment.

Other Invasive Species – Invasive species encountered that were not targeted for this survey include: *Lespedeza spp.*, *Elaeagnus spp.*, *Ligustrum sinense*, *Symphoricarpos orbiculata*, *Rubus phoenicolasius*, *Rosa multiflora*, and *Polygonum spp.*

CONCLUSIONS

Notes on selected species –
Alliaria petiolata - A habitat generalist. The least likely species of those that were surveyed for to require disturbance. Akerson notes that they thrive under undisrupted canopy as long as soil conditions are right (2005).
Microstegium vimineum - Most often found in wet areas, around streams or in floodplains. Occasionally in open and drier sites, usually associated with disturbance or a watercourse.
Celastrus orbiculata - Rarely encountered. (I have seen it since in the winter. It was possibly overlooked or misidentified, especially around the river)
Oplismenus hirtellus - Not encountered. It was possibly sighted by park staff around the river. Some big-leaf *Dichanthelium sp.* and very large *Microstegium* were by the river, perhaps closest in appearance to *Oplismenus*, but no *Oplismenus* was found.
Ailanthus altissima - Found in dry to wet situations. Often but not always associated with apparent disturbance, usually at least in an area with a canopy gap. Often found near watercourses, but isolated clumps or individuals found throughout a wide range of habitat types.

Paulownia tomentosa - Similar to *Ailanthus altissima* in habitat. Possibly slightly less shade-tolerant.

Notes on habitat -

As mentioned, habitat type is not 100% predictive of presence of invasive species, but some habitats in the survey area proved highly unlikely to contain invasive species. In a 2005 invasive species study in Shenandoah National Park, Akerson noted that exotics were rarely found in very dry sites with healthy understories (2005). Similarly, in the current survey, dry habitats such as Oak/Heath Forest and Pine/Oak/Heath woodlands were the most likely not to contain invasives. This information could be useful for habitat modeling for invasive species in future searches. Habitat modeling presumably works best for species with the narrowest range of environmental variables that support it. Invasive species in general, and the two tree species in the current survey in particular, have wide ranges of environmental variables under which they can thrive. Targeting areas to search for such adaptable species might prove difficult. However, though habitat modeling is normally used to target areas likely to contain species (Cass, 2005), it could be used in the case of invasives, not to target areas for search, but to exclude low-probability areas from the study. Modeling for dry, healthy communities could indicate potentially large areas to avoid when searching, and therefore focus the resources on areas more likely to have infestations.

It is hoped that the data from this survey can be used to not only help with future surveys, but to aid in the ultimate goal of restoring the natural communities within this survey area.

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