

TITLE: Evaluating Environmental and Disturbance Conditions Associated with Invasive Plants Using the Allegheny National Forest FHM Intensive Plot Data

LOCATION: Morgantown, WV

DURATION: Year 1 of 2-year project

FUNDING SOURCE: Base

PROJECT LEADER: Cynthia Huebner, Research Botanist, NE Research Station, 304-285-1582, chuebner@fs.fed.us

COOPERATORS: Dan Twardus, Group Leader, Forest Health Specialist, NE Area State and Private Forestry, Randall Morin, Research Forester, Forest Inventory and Analysis, April Moore, Ecologist, Allegheny National Forest, and Robert White, Silviculturist, Allegheny National Forest

PROJECT OBJECTIVES:

1. Compare species abundances and distribution of native tree, sapling, seedling, shrub, vine, and herbaceous species to the abundances and distribution of invasive exotic and native species (e.g., ferns).
2. Evaluate the abundance and distribution of exotic and native invasive plant species by forest type and age.
3. Evaluate the distribution of invasive plant species using physiographic data.
4. Evaluate the distribution of invasive plant species using defoliation events and indicators of disturbance.
5. Evaluate the abundance and distribution of invasive plant species using landscape features.
6. Determine change over time of the presence or absence (and, where possible, abundance) of invasive plant species and if an increase or decrease can be attributed to a disturbance or environmental event or forest type stability.
7. Develop a forest health indicator of potential invasion using the results of 1-6 and test this indicator using other FHM plot data from the state.

PROGRESS TO DATE (Time period: February 2005 – September 2005):

1. Upon request, Katherine Johnson sent me a portion (approximately 100 specimens) of the 2004 unknowns for identification in order to help speed up the readiness of the 2004 data. I completed these by May 1 and gave them to Ann Zurbruggen to help finalize the 2004 data.
2. Ann Zurbruggen was hired April 18, 2005 for a 30 day appointment to finish checking 2003 and 2004 data. She completed the 2003 data (which was in bad shape) except for a few species identification confirmations and completed half of 2004. It may not be possible to use 2004 if it is not completed soon. During a Morgantown visit, Ann left several 2003 specimens for further identification confirmation. I have approximately 20 more to complete, which should be done by mid-October.
1. Further data cleaning of most of the FHM files for all years was necessary but has been completed. Errors in terms of missing column labels, differences in reporting of variable parameters, hexagon plot number changes, and missing data (some corrected and some cannot be corrected) have for the most part been updated at this time by contacting Barbara O'Connell, Randy Morin, and Ann Zurbruggen. Some undocumented information concerning protocol has also been

- confirmed after speaking further with Ann (who did the actual sampling). The latter includes whether or not non-forest plots were sampled and the fact that plots that were sampled but had no vegetation cover cannot be determined because of the way the data were entered. Other important errors that needed correcting before any analysis included the inconsistent use of some scientific names and codes. In most cases where an error was found, more than one name was used within years (mostly 1999) and among years (mostly between 1999 and the other years). An overall evaluation of the data confirms that differences in species composition among years could be due to an evident learning curve from 1999 to 2004 as well as differences in protocol.
2. Upon request, Randy Morin provided data on coarse woody debris and distance to the nearest road, which was not available in the FHM data files. He will also be providing UTM coordinate data.
 3. April Moore provided files on the defined ecological land types (ELT) for each subplot. The large number of different land types may make it difficult to show any patterns.
 4. Based on the available data and variables, all analyses will be conducted at the hexagon plot level. Environmental variables that have been available and that will be used include all surface data (e.g., percent cover of litter/duff, percent cover of moss etc.; though the reliability appears somewhat questionable), ecological land type, standing dead tree volume, average crown vigor, coarse woody debris volume, forest type, forest age, and percent non-forest land. I would like to include slope aspect, slope inclination, and elevation of each hexagon plot (averaged from subplot measures). It may still be possible to obtain this information once I receive the UTM coordinates for each hexagon plot. I would also like to include soil data. No densiometer or light measurements appear to have been taken. Disturbance variables that are available and appear reliable include distance to road (gravel and paved) and defoliation by the native cherry scalloped moth and elm spanworm. Other defoliation past or current events (e.g., by gypsy moth or hemlock woolly adelgid) were not recorded at the hexagon plot scale and cannot be used to differentiate the plots. One additional indicator of disturbance that I may be able to incorporate into these analyses is the lichen sensitivity index.
 5. Relative importance values for all understory species have been calculated for each year. Species have been categorized by mutually exclusive types (exotic invasive, native invasive, native, and exotic).
 6. Preliminary analyses on quadrat level data (averaged for each hexagon) using canonical correspondence analysis have been conducted for each year (1999 – 2002) to see if there are any within year patterns.

TO DO (and estimated time):

1. Calculate the average standing dead volume and crown vigor per hexagon plot from the tree data and add to environmental data file (1 week).
2. Calculate relative importance values all species for the combined data set (1 week).
3. Combine 1999-2003 data (possibly 2004) (1 day).
4. Obtain lichen, soil and topography data, if available (time unknown).

5. Analyze the combined data set as described in the Methods of the proposal. There are no changes anticipated at this time except that the legitimacy of comparing year to year results of re-sampled plots will be considered suspect (6-8 weeks).
6. Paper/talk preparations (2-3 weeks).

All of the above will be ready by June 2006, completing objectives 1-6. Completion of objective 7 (at least the second part) is dependent on the availability of the new FHM data from other parts of the state and the condition of those data files. The relatively poor condition of the 1999-2003 data sets did slow down the process, which may hold true for any new FHM data from Pennsylvania. Instead, I may attempt to test the indicators using 2003 or 2004 data (if available).

PRELIMINARY RESULTS:

Despite differences in forest types sampled, protocol, and data quality, overall richness per hexagon plot and total numbers of understory species found in select categories, including exotic invasive species, appear to be similar year to year (Table 1). *Berberis thunbergii* (Japanese barberry), *Rosa multiflora* (multiflora rose), *Lonicera x bella* (bush honeysuckle), *Anthoxanthum odoratum* (sweet vernal grass), *Coronilla varia* (crown-vetch), *Lotus corniculatus* (birdsfoot-trefoil), and *Rumex acetosella* (sheep sorrel) were the exotic invasive species found in the quadrats (as well as the subplots), indicating that these were relatively common.

For 1999 data, there was a strong positive correlation between distance to the nearest dirt road (Pearson $r^2 = 0.968$) and Axis 1, a strong negative correlation between stand age (Pearson $r^2 = 0.703$) and Axis 2, and a weaker negative correlation between amount of coarse woody debris (Pearson $r^2 = 0.406$) and Axis 3. Distance to the nearest paved road was positively correlated with Axis 3 (Pearson $r^2 = 0.313$) and Axis 2 (Pearson $r^2 = 0.311$) (Figures 1 and 2). While there was some separation based on forest type (more red maple stands were younger and more mixed upland and black cherry stands were older), the separation was weak. *Anthoxanthum odoratum*, *B. thunbergii*, and *R. acetosella* were most closely associated with (negative correlation, Pearson $r^2 = 0.027, 0.031, 0.031$, respectively) with Axis 2 (defined by distance to paved roads and stand age). *Coronilla varia* was most closely associated with Axis 2 (Pearson $r^2 = 0.361$) except that the correlation was positive. Thus, with the exception of one species, the younger stands that were closer to paved roads were more likely to have exotic invasive species. Separating out the distance to road variables helped explain the different behavior of *C. varia* (Figure 3). Here, *C. varia* was more likely to be found in areas closer to paved roads (Pearson $r^2 = 0.059$), which was a divided variable in terms of its correlation with a particular axis in the ordination with all variables. ELT, stand size, and presence/absence of a defoliation event were not important variables.

The surface data were analyzed in a separate ordination because of the number of variables involved. Percent cover of litter/duff was positively correlated with Axis 3 (Pearson $r^2 = 0.335$; Figure 4), whereas all the exotic invasives had a negative correlation with this Axis 3, especially *C. varia* (Pearson $r^2 = 0.225$). In contrast, percent cover of bare soil showed a negative correlation with Axis 3 (Pearson $r^2 = 0.734$) and a positive correlation with the exotic invasive species. These analyses will help define which variables to use in the regression and ANOVA analyses. The other years (2000-2002) showed similar results.

Table 1.

Year	# Exotic invasive species for all hexagon plots	# Native invasive species for all hexagon plots	# Exotic species for all hexagon plots	Richness per hexagon plot	Diversity per hexagon plot
1999	5	3	9	20.7	1.77
2000	4	3	6	22.2	1.84
2001	5	4	12	22.4	1.89
2002	3	4	8	26.5	2.12

The increase richness and diversity over time is most likely due to improved species identifications of native species.

Fig1.

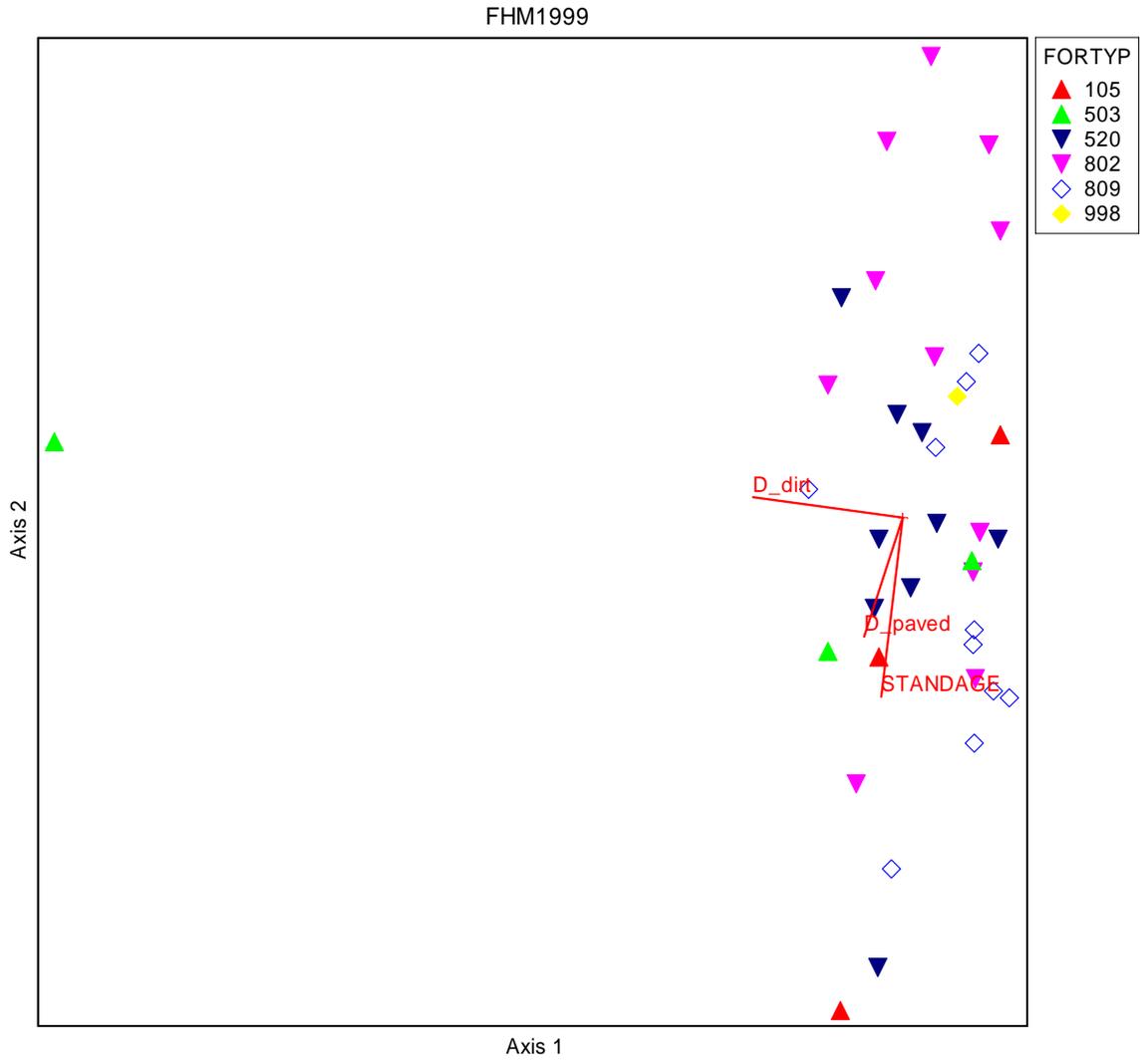


Fig.2

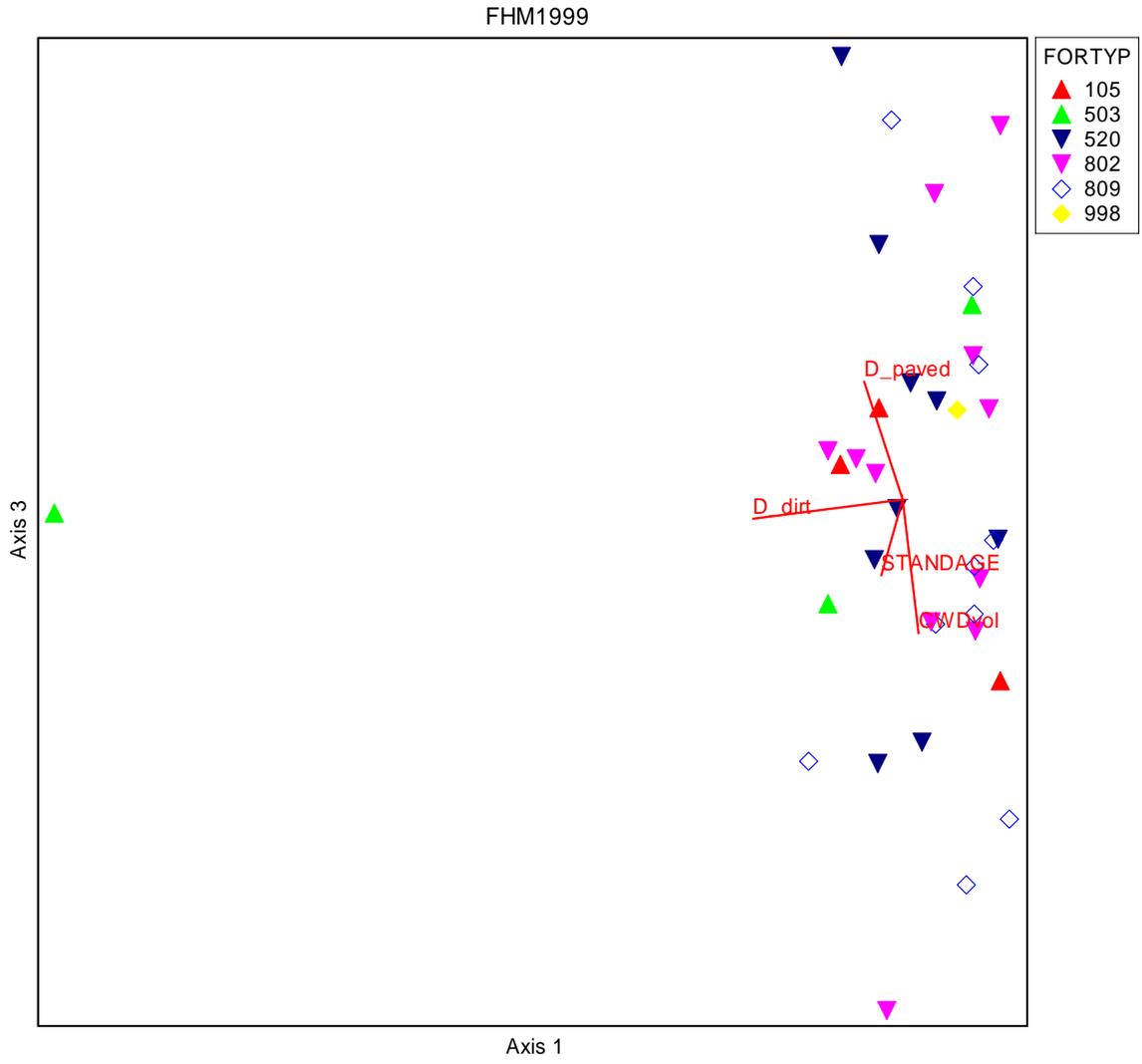


Fig.3

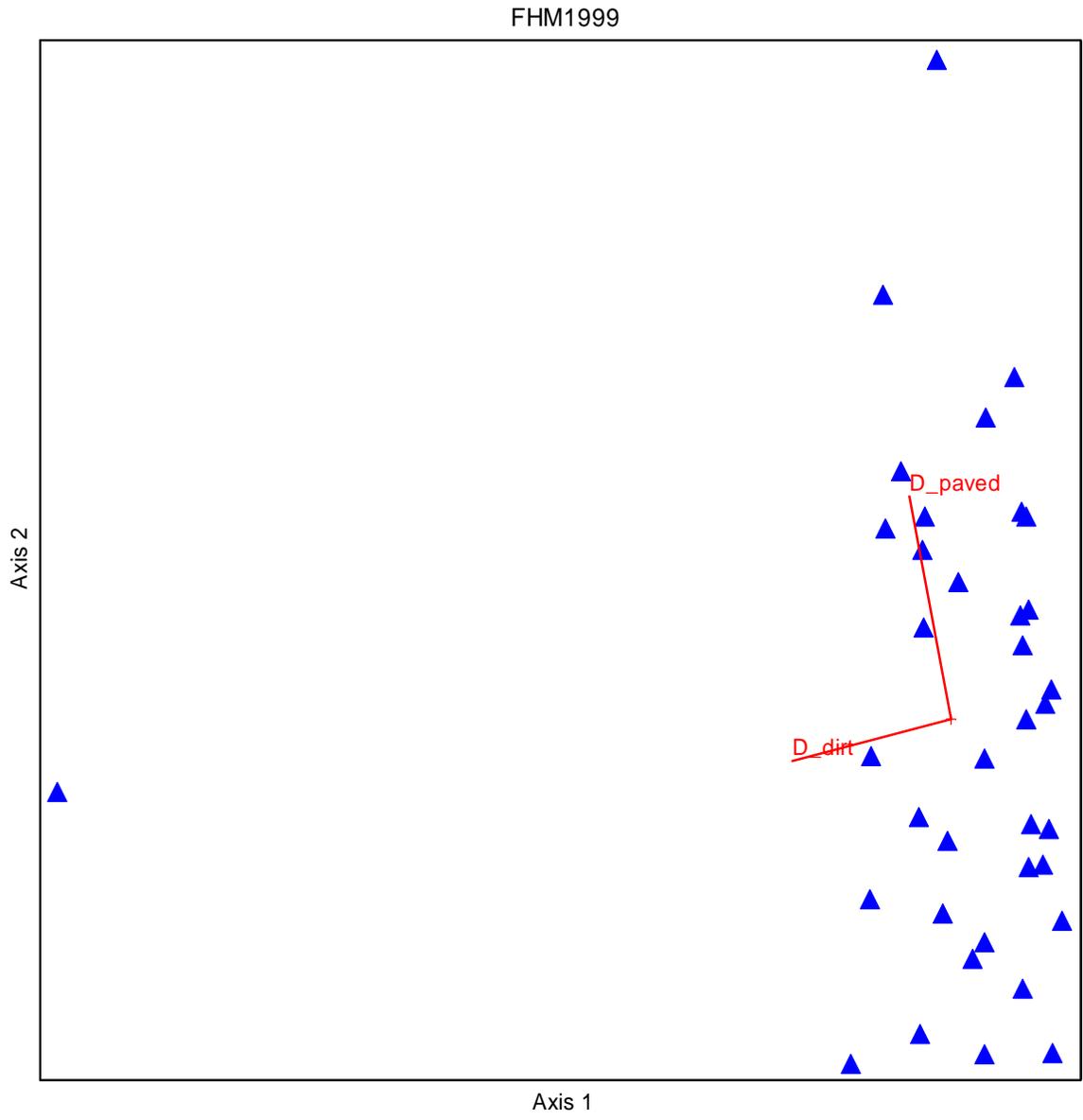


Fig4

