

Rapid Ecological Assessment of Forests and Associated Exotic Earthworms in the Laurentian Mixed Forest-Great Lakes Coastal Biological Network, Midwest Region, National Wildlife Refuge System, US Fish & Wildlife Service¹

FOREST COMMUNITY ANALYSIS: Seney NWR

Differences in Overstory Composition Among Stands. Using relative basal area (%) by species of the 112 plots sampled across 11 stands at Seney NWR as part of the Rapid Ecological Assessment (Corace et al. 2011), we used a Multi-Response Permutation Procedure (MRPP) to examine if there are differences in the *overall overstory composition* among the 11 stands. MRPP is a non-parametric technique that tests the hypothesis that there is no difference between groups of entities, in this case the overstory composition of stands at Seney NWR.

We conducted a MRPP using Euclidean distance and PC-ORD (ver. 5.0) software. Prior to analysis, we transformed the data using an square root arc sin transformation as is appropriate with percentage data. As several plots across a variety of stands had no overstory trees sampled, we included a dummy variable to indicate this fact (i.e., NONE).

Overall, there is a statistically significant difference in the overstory composition among the stands ($T = -18.765$; $A = 0.227$; $P < 0.001$). The results of the MRPP support the data as described in the SUMMARY TABLES & FIGURES document for Seney NWR that suggest differences in the overstory composition (Corace et al 2011).

Indicator Analyses. In order to predict if there are significant overstory indicator species for each stand at Seney NWR, we used Indicator Species Analysis following the procedure outlined in Dufrene and Legendre (1997). We used PC-ORD (ver. 5.0) to conduct the Indicator Species Analysis using the transformed relative basal area of all species as with the MRPP analysis.

Based upon the Indicator Species Analysis, we found the following species were significant indicators ($P < 0.05$) of the following stands:

Stand	Species	Stand	Species	Stand	Species
CHF-TXA	none	DRR-CUT	none	SHN	none
CHF-TXB	black ash	DRR-PINE	balsam fir, red pine	SHRNA	paper birch
COF	none	HARD-PUN	bigtooth aspen	W-HARD	red maple
DRR-C2O	no overstory	HEM	white pine, hemlock		

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Gradient Analysis. Using relative basal area by species (%) of the 112 plots sampled across the 11 different stands at Seney NWR as part of the Rapid Ecological Assessment (Corace et al. 2011), we examined the distribution of overstory species across sampled stands using Non-Metric Dimensional Scaling (NMDS). NMDS is a non-parametric ordination analysis that maximizes the rank-order correlation between distances. Unlike other indirect (e.g., principal components analysis) or direct (e.g., canonical correspondence analysis) ordination techniques, NMDS does not make any assumptions about the nature of the data, including assumptions about the linear relationship among variables. As a result, it is often viewed as an appropriate multivariate analysis for ecological data (McCune and Grace 2002).

Prior to the analysis, the relative basal area data by species were transformed using an arcsin squareroot transformation as is appropriate with percentage data. NMDS was then run using PC-ORD (ver. 5.0) software using a Sorenson distance measure. A four-dimensional solution was determined to be the most appropriate (Monte Carlo test, $n = 200$ runs).

The results of the NMDS ordination support the results outlined in the previous sections that there are distinct forest communities at Seney NWR. However, the NMDS also suggests that there is some within-stand heterogeneity in overstory relative basal area as indicated by the overlap of plots representing the different stands in the NMDS ordination (Figure 1). For example, the plots that represent the W-HARD stand are closely grouped and characterized by several species typical of northern hardwood forests, including sugar maple, American basswood, paper birch, yellow birch, and black cherry. Likewise, the SHNRA, CHF-TXA, and SHN, and HEM stands all have relatively similar overstory composition. The other stands tend to have a wider distribution of plots indicating some difference in overstory composition. For example, both the DDR-PINE and DDR-CUT stands are characterized by areas dominated by jack pine or no overstory to other areas dominated by red pine and northern red oak (Figure 1). While this within-stand heterogeneity may be due to differences in environmental conditions, it is also likely that past land use history has played an important role in shaping the current composition of the forested stands sampled at Seney NWR.

Analysis Implications. These basic results confirm the summary information developed by Corace et al. (2011). Specifically, there are for the most part unique forest communities at Seney NWR, however, some stands exhibit considerable within-stand variability associated with overstory composition that are most likely due to past land use histories. In areas where there appear to be important differences in overstory composition within individual stands, more information on the specific factors responsible for these differences is needed. Such information will provide a framework for future management, including forest ecosystem restoration.

References:

Corace, R.G., III, H. A. Petrillo, and L.M. Shartell. 2011. Rapid ecological assessment of forests and associated exotic earthworms in the Laurentian Mixed Forest-Great Lakes Coastal Biological Network, Midwest Region, National Wildlife Refuge System, US Fish and Wildlife Service: Summary tables and figures, Shiawassee NWR. Seney National Wildlife Refuge, Seney, MI. 16pp.

Dufrene, M., and P. Legendre. 1997. Species assemblages and indicator species: the need for a flexible asymmetrical approach. *Ecological Monographs* 67:345-366.

McCune, B., and J.B. Grace. 2002. *Analysis of Ecological Communities*. MJM Software Design, Gleneden Beach, OR. 300 pp.



Fig. 1. NMDS ordination of overstory species based upon relative basal area for 11 stands at Seney National Wildlife Refuge. Species acronyms correspond to first two letter of genus and species (e.g., QuRu = *Quercus rubra*).