The Lichens Indicator on the Allegheny National Forest

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Abstract

The Forest Inventory and Analysis Program (FIA) conducts a national inventory of all forestland in the US. A subset of the FIA inventory plots are sampled every year for numerous forest health indicators. Lichen community monitoring was included in FHM in order to address key assessment issues such as the impact of air pollution on forest resources, spatial and temporal trends in biodiversity, and the sustainability of timber harvesting. This long-term lichen monitoring program dates back to 1994, and is currently working in 32 states. These data from the intensified grid of 173 plots on the Allegheny National Forest were used to provide a baseline assessment of lichens that can be used for future monitoring. These analyses provide the ANF with a list of lichens species present on the forest, as well as spatial distributions of the most common species. In addition, lichen species richness was described spatially and for forest stand characteristics.

Introduction

The Allegheny National Forest (ANF) (Figure 1) is situated in the Allegheny Plateau in northwestern Pennsylvania. The ANF is dominated by mixed northern hardwoods including black cherry, red maple, sugar maple, beech, and oak species. It represents an important source of high quality veneer-grade logs, but it is also heavily used for recreation given its proximity to the densely populated mid-Atlantic region.

The National Forest Health Monitoring Program was implemented by the USDA Forest Service in 1990 to monitor, assess, and report upon the status and trends in forest health across the country. Forest managers on the ANF recognized the need for a comprehensive survey of forest health conditions. In collaboration with USDA Forest Service Forest Health Protection (FHP) and research staff, an intensified grid of 173 Forest Health Monitoring (FHM) plots was established in 1998. Methods developed by the National Forest Health Monitoring Program include the measurement of the lichens, soils, and vegetation forest health indicators.

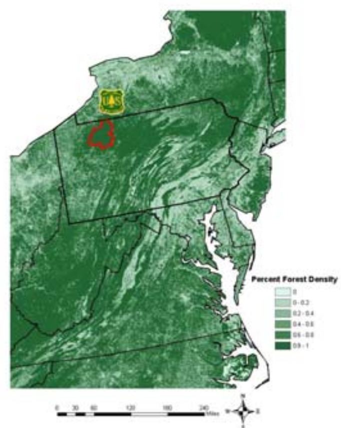

Figure 1. The Allegheny National Forest is located in northeastern Pennsylvania.

Methods

Lichens are composite, symbiotic organisms made up from members of as many as three kingdoms. The dominant partner is a fungus. Fungi are incapable of making their own food. They usually provide for themselves as parasites or decomposers. The lichen fungi (kingdom Fungi) cultivate partners that manufacture food by photosynthesis. Sometimes the partners are algae (kingdom Protista), other times cyanobacteria (kingdom Monera), formerly called blue-green algae. Some enterprising fungi exploit both at once (Brodo et al. 2001). Lichen community monitoring was included in FHM in order to address key assessment issues such as the impact of air pollution on forest resources, spatial and temporal trends in biodiversity, and the sustainability of timber harvesting. This long-term lichen monitoring program dates back to 1994, and is currently working in 32 states (USDA For. Serv. 2002).

A close relationship exists between lichen communities and air pollution, especially SO_2 and acidifying or fertilizing nitrogen- and sulfur-based pollutants. A major reason lichens are so sensitive to air quality is their total reliance on atmospheric sources of nutrition. In contrast, trees may be indicators of chronic air pollution, but all the other influences on tree growth make responses to pollutants difficult to measure (McCune 2000). Additionally, lichens are important components of biodiversity in forest ecosystems.

Results

A kriged surface of lichen species richness is shown in Figure 2. Showman and Long (1992) reported that lichen species richness was significantly less in high sulfate deposition areas than in low sulfate deposition areas in north-central Pennsylvania.

In an attempt to assess lichen pollution response across the ANF a pollution sensitivity was calculated for each FHM plot. This index was computed as the number of sensitive and intermediate species / total number of rated species. The pollution tolerance scale is a provisional and qualitative ordinal scale developed by Susan Will-Wolf and based on selected references (Showman 1997; McCune et al. 1997; Showman and Long 1992; Showman 1990; McCune 1988; Wetmore 1983; Nash 1975). A kriged surface of the pollution sensitivity index was generated (Figure 3) to display the spatial variation across the ANF landscape. The proportion of pollution sensitive lichen species was highest on the western edge and two areas in the central part of the ANF.

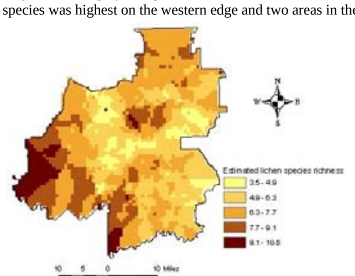

Figure 2. Kriged surface of lichen species richness on the ANF .

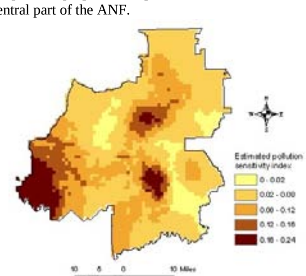

Figure 3. Kriged surface of the lichen pollution sensitivity index.

The most common lichen species (i.e. present on at least 10 percent of plots) are shown in Figure 4. Bars represent the percent of plots a species was present in each abundance class. The abundance classes are defined as follows: none; rare, less than 3 individuals; uncommon, 4-10 individuals; common, greater than 10 individuals but less than half of boles and branches have that species present; and abundant, more than half of boles and branches have that species present.

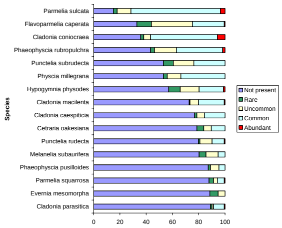

Figure 4. Lichen distribution by abundance class for the 16 most common species in the ANF .

Results Continued

Kriged surfaces of the probability of presence were generated for the four most common lichen species on the ANF (Figure 5). These four species have different spatial distributions across the ANF possibly representing different ecological/habitat preferences.

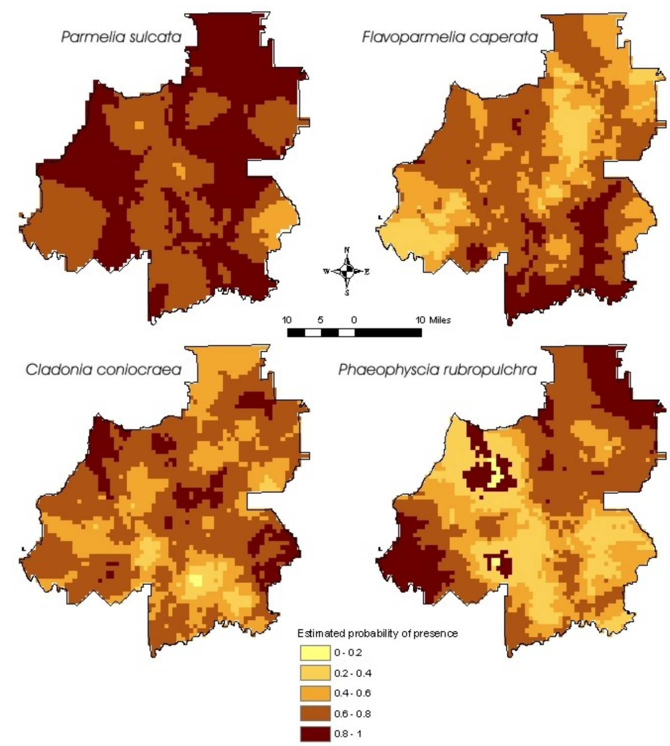

Figure 5. Kriged probability surfaces of the four most common species on the ANF.

Mean species richness of lichens was calculated by forest type (Table 1) and stand development stage (Table 2). The white oak/red oak/hickory forest type had the highest mean number of lichen species. Lichen species richness was similar among the other forest types. The mean number of lichen species was much lower on sites in the stand initiation phase.

Forest Type	Mean Species Richness	# of plots
White oak/red oak/hickory	11.4	7
Sugar maple/beech/yellow birch	7.4	12
Eastern hemlock	7.4	14
Mixed upland hardwoods	6.5	14
Black cherry	6.5	52
Red maple/upland	6.1	60
Other	5.6	14

Table 1. Species richness of lichen species by forest type.

Stand Age	Mean Species Richness	# of plots
Stem exclusion (15-49 years)	6.6	14
Understory reinitiation (>49 years)	7.0	142
Stand initiation (0-14 years)	3.6	15
Unknown	0.5	2

Table 2. Species richness of lichen species by stand development phase.

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