Lichen Biodiversity of Northwestern Polk County, Florida: Implications for Air Quality

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Abstract.— Lichens are excellent indicators of atmospheric air quality because even relatively low levels of common air pollutants can significantly alter the physiology, composition, growth, distribution, and reproduction of lichen communities. This long-lived, cosmopolitan group of symbiotic organisms is frequently used to monitor air quality throughout the World, yet few attempts have been made to survey lichens in upland habitats of central Florida. In this study, epiphytic lichen floras were surveyed in three distinct habitats: rural (Lakeland Highland Scrub Preserve), suburban (Florida Southern College), and metropolitan (downtown Lakeland). Lichen species were photographed and measured, then collected and preserved in the Florida Southern College herbarium. Surveyed specimens were then taxonomically identified using a North American species key. To spatially display results, a GPS point was recorded for each specimen and recorded in the digital database. Some of the common species collected in our region are: Bumpy Ramalina (*Ramalina complanata*), Candleflame Lichen (*Candelaria concolor*), Common Button Lichen (*Buellia stillingiana*), Dirinaria Lichen (*Dirinaria picta*), Southern Strap Lichen (*Ramalina stenospora*), Streaked Rosette Lichen (*Physcia atrostriata*), and White Fringe Lichen (*Heterodermia albicans*). In general, our results were consistent with previous studies; we found an increasingly diverse and abundant (i.e., healthy) lichen community as we moved further away from the urban center.

Key Words.— Central Florida; Lichen; Biodiversity; Air Quality; Indicator Species; Pollution;

INTRODUCTION

Lichens are the coexistence of two organisms living as a single entity in a mutual symbiosis (Jovan 2008). Each lichen species consists of a fungus (mycobiont) and algae or cyanobacteria (photobiont) within the thallus (Brodo et al. 2001; Blett et al. 2003). Lichens are found on both abiotic and biotic substrates, including living animals (Brodo et al. 2001; Walewski 2007)! There are between 14,000 and 20,000 species of lichens, each differing in color, shape, and chemistry (Walewski 2007). Lichens are cosmopolitan (found world-wide) and indicators of a healthy ecosystem (Brodo et al. 2001). These traits combined with their sensitivity to atmospheric pollutants make lichens wonderful organisms for studying air quality, biodiversity, and chemistry of different biomes.

Overall, there is little research devoted to these organisms compared to other fields of biology. While unfortunate for the knowledge of man, this makes lichens a good area of research as an upcoming graduate student and biologists alike. What were once considered the "poor trash of vegetation" by the founder of taxonomy (Carl Linnaeus), lichens are now seen as beautiful organisms that are "lovers of pure atmosphere".

Studies of lichen biodiversity have become increasingly common throughout the US as a tool to observe air quality, whether it be a county or a whole region of the US. The Department of Agriculture, specifically the Division of Forestry, has formulated a whole system dedicated to studying lichens and air quality called the Forest Inventory and Analysis (FIA) program (Jovan 2008; Will-Wolf 2010). The FIA collects data annually by performing surveys of epiphytic ("tree-dwelling") lichen communities conducted by specially trained field crews (Jovan 2008).

Since there are no known surveys on record of the Northwestern Central Florida region, our goal of this study was to perform a baseline assessment of three distinct habitats and establish a generalized opinion of the air quality for each.
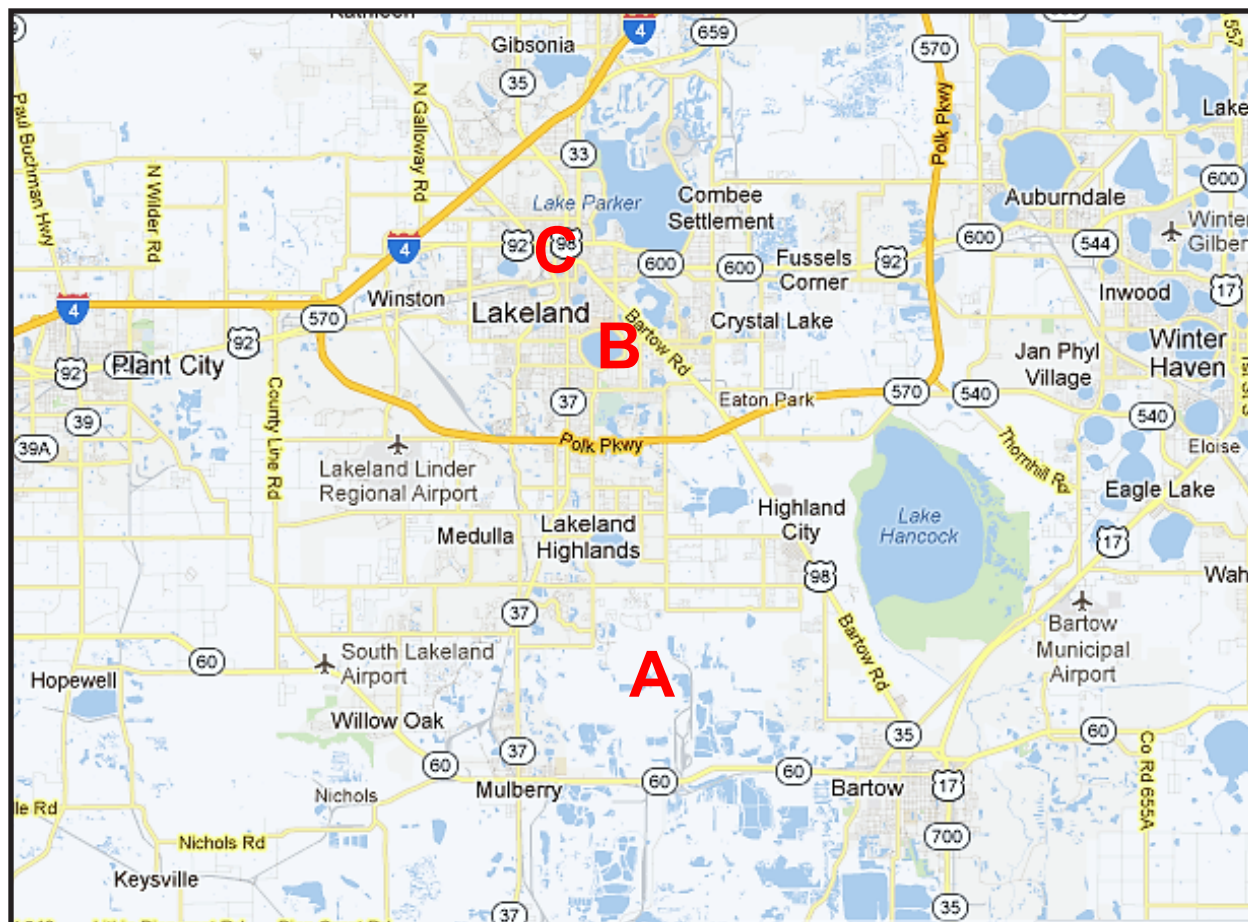
Figure 1 - This map indicates the three regions surveyed in the study. The Lakeland Highland Scrub (LHS) Preserve (A), the Florida Southern College (FSC) campus (B), and the Munn Park area of downtown Lakeland (C). Image coutesy of Google Inc.

This qualitative analysis will serve as a foundation for quantitative studies to arise, providing a list of species based on locality and their sensitivity rating.

MATERIALS AND METHODS

Study area.—During the months of January through April 2012, we conducted surveys in three regions of increasing human activity throughout Northwestern Polk County including the Lakeland Highlands Scrub (LHS) preserve, the Florida Southern College (FSC) campus, and the Munn Park area of downtown Lakeland (figure 1).

The Central Florida Ridges are unique in that they were formed by ocean currents depositing sand and marine deposits on old shorelines that existed in the center of our state long ago (Archbold Biological Station). The Lakeland Ridge is home to habitats including wetlands, longleaf pine savannah, oak hammock, and a unique ecosystem called "scrub". Although sometimes referred to as Florida's desert, scrub habitat is home to many endangered species including *Aphelocoma coerulescens* (Florida scrub-jay), *Falcosparverius paulus* (Southeastern American Kestrel) and pollution-sensitive lichens such as *Cladina evansii* (Powder-puff lichen) (Archbold Biological Station).

Field methods.—We surveyed and collected epiphytic ("tree-dwelling") lichen flora from three distinct habitats similar to experimental design previously used in other studies. Lichens were classified into three broad categories based on thallus structure: crustose (plate 1), foliose (plate 2), and fruticose (plate 3). Each habitat chosen was classified according to the level of

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Plate 1 - Herpothallon rubrocinctum (Christmas Lichen) is a good example of a crustose lichen, growing either within or directly on the substrate in its entirety.

Plate 2 - This is an example of a foliose lichen. It has a leaf-like thallus and is attached to the substrate by occasional stem-like rhizines.

Plate 3 - Ramalina stenospora is a fruticose lichen. It is characterized by the fruiting bodies and raised structure coming off of the substrate.

human activity (via automobile emissions) as "low-disturbance", "moderate-disturbance", and "high-disturbance". Surveyed trees within each site were selected at random according to species. Each tree assessed was at least 25cm in diameter at the base of the trunk and had colonized lichens present. Each tree surveyed was catalogued as a data point with a site specific ID using a Garmin eTrex Legend HCx GPS. Individual data points consisted of a 2-3-2 code, where each code denoted region, tree number, and individual species in respective order from left to right (plate 4).

Each surveyed specimen was photographed, labeled, and placed in an acid-free herbarium packet for the formation of a herbarium collection. A 2-inch wood chisel and hammer were used to remove crustose species, and a spray bottle was used to moisten foloise and fruticose species to prevent cracking during storage. This process continued for each new species discovered, until an approximate height of two meters was reached per tree (due to lack of time and resources preventing canopy analysis).

Following the field surveys, each species was then identified using a North American lichen key with a stereomicroscope and/or photographs. Information regarding each species was entered into a table for each region, and a biodiversity index was formed.

Results

We surveyed and collected over 60 individuals of approximately 30 species from all three regions. Of the three plots, the Lakeland Highland Scrub (LHS) preserve had the most diverse and abundant (i.e. – healthy) lichen community. There was a fairly

well-balanced amount of lichens from each category (crustose, foliose, fruiticose) and the sheer amount of lichens present at the scrub was overwhelming. Due to the high diversity and time constraints on this study, the scrub plot could not be fully surveyed, and therefore only an estimate for the number of species can be made. We estimate there are 20+ species based on our findings in the field. We successfully identified approximately 18-20 and accounted for possible duplicates (table 1).

The Florida Southern College (FSC) campus had the second best rating for air quality based on the surveyed species. There was a large presence of crustose species, a moderate amount of foliose species, and a sparse number of fruiticose species present. A majority of the species surveyed on campus seemed to be in a healthy condition (without doing chemical analysis). A total of 15 species were found in the FSC plot (table 2).

Munn Park of the downtown Lakeland area yeilded the worst results of all three plots surveyed. Unhealthy crustose lichens were the dominant species present, with very few foliose. No fruiticose lichens of any kind were found (keeping in mind that this study does not include a canopy assessment). The findings at Munn Park consisted of lichen with severe discoloration (plate 5), shrunken

Plate 4 - This shows the 2-3-2 code and measurements for a specimen. The ruler is used to measure overall thalli length/height and size of distinct features.

Plate 5 - This lichen is severely discolored compared to the same species in the other two plots due to the harsh effects of automobile emissions.

Plate 6 - This lichen has a shrunken thalli and much smaller reproductive structures compared to the same species found at FSC and LHS.

thalli (plate 6), smaller reproductive structures, and lack of species diversity. Only a total of 8 species were found in the Munn Park plot (table 3).

Figure 1 is a line graph that illustrates the correlation between the biodiversity and distance away from an urban area.

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DISCUSSION

Our study provides the first lichen biodiversity survey of Northwestern Polk County and shows a generalized estimate of air quality for each of the assessed plots. We observed the greatest diversity and health in the LHS preserve lichen community, leading us to classify the air quality there as "excellent". However, we did not label this area "pristine" due to proximity to the major cities Tampa and Orlando.

The FSC campus contained a reasonable level of automobile traffic, but not as much as the metropolitan district. There was a good amount of forest to help alleviate the effects of automobile emissions, making it an adequate location for lichen diversity. The quality of the FSC campus was considered fair, given the proximity to downtown Lakeland and major highways.

Due to the longevity of age and ability to thrive in the harshest of environments, these organisms can be studied anywhere in the world with the same methods applied universally. Thus, by creating a standard procedure in which these surveys follow, we can create a powerful tool to aide in assessing air quality and overall ecosystem health (due to the keystone species nature of lichens).

Some of the hurdles that we encountered were overcome by revamping our methods throughout the duration of the study. At the beginning of the study we were using 1.5mL micro test tubes to collect specimens, and only collecting a portion of each species. After consulting a lichenologist, they suggested we collect the whole specimen rather than just part, in order to start a proper herbarium and be able to reference them easier. Following this advice, we designed and created acid-free herbarium packets with acid-free cardstock inserts and protective tissue paper. This revised method proved much more beneficial for organizing in the field, cataloging in the lab, and referring back to specimens when needed.

Another challenge we encountered was familiarizing ourselves with the anatomy and physiology of lichens in order to properly identify them using a species key. We studied the fundamental chapters within the book *Lichens of North America*, and were able to better identify species in the lab and out in the field after doing so.

The reliability and longevity of these organisms makes them a good long-term resource for studying the effects of atmospheric air pollutants on sensative environments. The ability to continuously collect data for enormous regions over a great duration is invaluable in itself. This data can be used to analyze our effect as humans on ecosystems, generate awareness of the impact we have on nature, and formulate plans for the future in order to improve the land that we have effected.

The true beauty of these organisms is the fact that they are cosmopolitan. One can go anywhere in the world from the tops of mountains to the desert, look around, and see lichens. It is this awareness that brings about a deeper connection with the environment around us. If we can learn become aware in this sense, and apply our ability to discover and change issues by using collected data from these organisms, then lichens may be one of the most influential organisms on the planet.

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Table 1 – Epiphytic Lichen Species List for the Florida Southern College Campus.

Data is sorted by sensativity rating (high to low), then alphabetically by species.

General Sensativity	Quality in the area	Species	Common Name	Type
High	Excellent	*Ramalina complanata*	Bumpy Ramalina	Fruiticose
High	Excellent	*Ramalina stenospora*	Southern Strap Lichen	Fruiticose
Medium	Excellent	*Candelaria concolor*	Candleflame Lichen	Foliose
Medium	Excellent	*Chrysothrix xanthina*	Gold Dust Lichen	Crustose
Medium	Adequate	*Dirinaria confusa*	Medallion Lichen	Foliose
Medium	Excellent	*Haematomma persoonii*	Sunken Bloodspot Lichen	Crustose
Medium	Excellent	*Heterodermia albicans*	White Fringe Lichen	Foliose
Medium	Adequate	*Leptogium austroamericanum*	Dixie Jellyskin	Foliose
Medium	Poor	*Ocellularia sp.*	n/a	Crustose
Medium	Excellent	*Parmotrema perforatum*	Perforated Ruffle Lichen	Foliose
Medium	Excellent	*Physcia atrostriata*	Streaked Rosette Lichen	Foliose
Medium	Adequate	*Trypethelium virens*	Trypelthelium Lichen	Crustose
Low	Adequate	*Amandinea punctata*	Tiny Button Lichen	Crustose
Low	Adequate	*Buellia stillingiana*	Common Button Lichen	Crustose

Table 2 – Epiphytic Lichen Species List for the Munn Park region of Downtown Lakeland.

Data is sorted by sensativity rating (high to low), then alphabetically by species.

General Sensativity	Quality in the area	Species	Common Name	Type
Medium	Poor	*Candelaria concolor*	Candleflame Lichen	Foliose
Medium	Poor	*Chrysothrix xanthina*	Gold Dust Lichen	Crustose
Medium	Poor	*Dirinaria picta*	Dirinaria Lichen	Foliose
Medium	Poor	*Haematomma persoonii*	Sunken Bloodspot Lichen	Crustose
Medium	Poor	*Heterodermia albicans*	White Fringe Lichen	Foliose
Medium	Poor	*Leptogium austroamericanum*	Dixie Jellyskin	Foliose
Medium	Poor	*Dirinaria confusa*	Medallion Lichen	Foliose
Medium	Poor	*Dirinaria picta*	Dirinaria Lichen	Foliose
Low	Adequate	*Amandinea punctata*	Tiny Button Lichen	Crustose
Low	Adequate	*Buellia stillingiana*	Common Button Lichen	Crustose

Table 3 – Epiphytic Lichen Species List for the Lakeland Highland Scrub Preserve.

Data is sorted by sensativity rating (high to low), then alphabetically by species.

General Sensativity	Quality in the area	Species	Common Name	Type
High	Excellent	*Parmotrema rigidum*	Stiff Parmotrema Lichen	Foliose
High	Excellent	*Ramalina stenospora*	Southern Strap Lichen	Fruiticose
High	Excellent	*Usnea strigosa*	Strigose Beard Lichen	Fruiticose
Medium	Excellent	*Candelaria concolor*	Candleflame Lichen	Foliose
Medium	Excellent	*Chrysothrix xanthina*	Gold Dust Lichen	Crustose
Medium	Excellent	*Cryptothecia striata*	n/a	Crustose
Medium	Excellent	*Dirinaria confusa*	Medallion Lichen	Foliose
Medium	Excellent	*Graphis afzelii*	Powdered Script Lichen	Crustose
Medium	Excellent	*Graphis scripta*	Common Script Lichen	Crustose
Medium	Excellent	*Herpothallion rubrocinctum*	Christmas Lichen	Crustose
Medium	Excellent	*Heterodermia albicans*	White Fringe Lichen	Foliose
Medium	Excellent	*Leptogium austroamericanum*	Dixie Jellyskin	Foliose
Medium	Excellent	*Parmotrema cristiferum*	Unwhiskered Ruffle Lichen	Foliose
Medium	Excellent	*Parmotrema perforatum*	Perforated Ruffle Lichen	Foliose
Medium	Excellent	*Parmotrema tinctorum*	Palm Ruffle Lichen	Foliose
Medium	Excellent	*Physcia atrostriata*	Streaked Rosette Lichen	Foliose
Medium	Excellent	*Trypethelium tropicum*	n/a	Crustose
Low	Excellent	*Crocynia pyxinoides*	Lobed Cotton Lichen	Foliose
Low	Excellent	*Pyrenula pseudobufonia*	Eastern Pox Lichen	Crustose
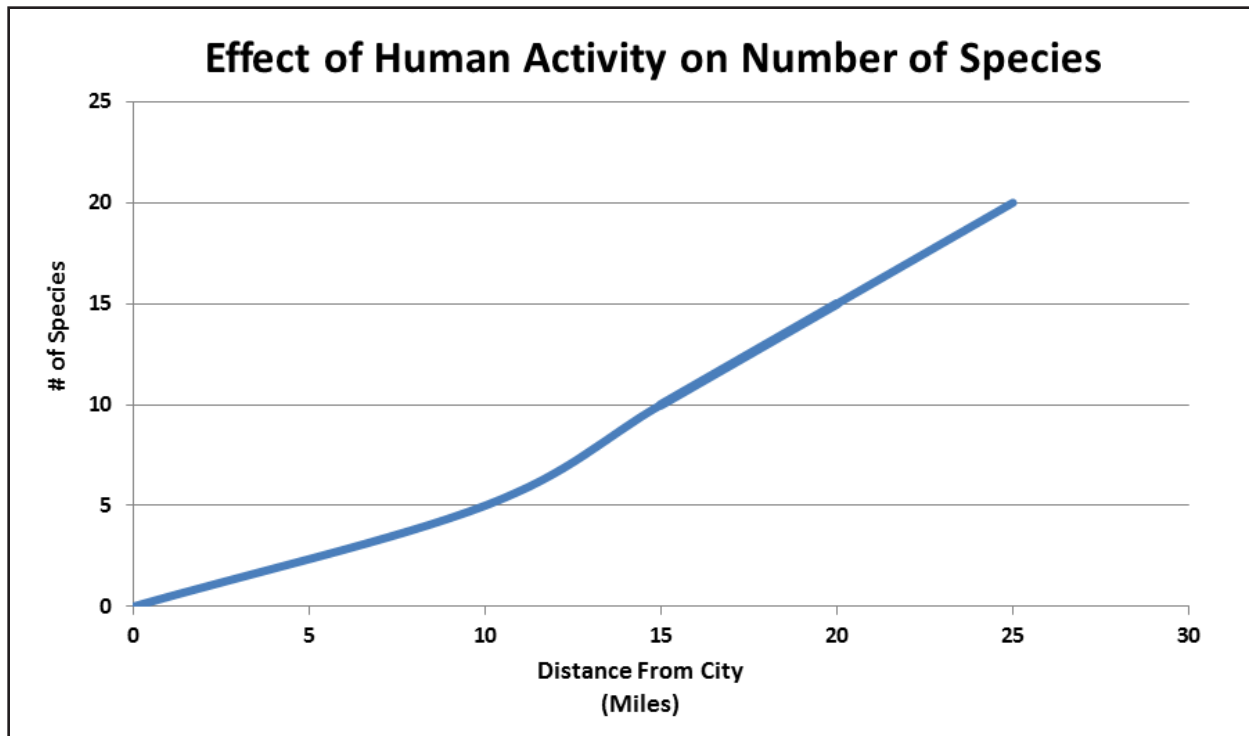
Figure 1 – This line graph illustrates the effect that human activity (i.e. – auto emissions, power plants, etc.) has on the diversity of epiphytic lichen species in the Lakeland region. Points were recorded according to this studies findings, and a projection was made to represent hypothesized increase in diversity as distance from human affected areas increases.