National Capital Region Network

National Park Service
U.S. Department of the Interior

Lichens & Air Quality *Resource Brief*

Importance

Lichens are a paradox. They're durable enough to grow on tree bark and bare rock, yet sensitive to pollution and air quality. And while lichens may look like small plants, they're actually composites of a fungus and an algae.

The algae in lichens photosynthesize (create food from sunlight energy), and both the algae and fungus absorb water, minerals, and pollutants from the air, through rain and dust.

Some sensitive lichen species develop structural changes in response to air pollution including reduced photosynthesis and bleaching. Pollution can also cause the death of the lichen algae, discoloration and reduced growth of the lichen fungus, or kill a lichen completely. Over time, sensitive species may be replaced by pollution-tolerant species. Hence the species of lichens present in a location and the concentration of pollutants measured in those lichens can tell us a lot about air quality.

Inventory

A baseline inventory of bark-dwelling lichens was conducted in nine parks of the National Capital Region (NCR) from 2004 to 2006 and in 2009. Species were recorded and samples of the pollution-tolerant lichen *Flavoparmelia caperata* were taken at each site and analyzed for levels of pollutants (noted below).

Samples of the lichen species *Flavoparmelia caperata* from each site were analyzed for levels of:

• mercury (Hg)	• zinc (Zn)	• chromium (Cr)
• copper (Cu)	• nickel (Ni)	• sulphur (S)
• lead (Pb)	• cadmium (Cd)	

Exactly 102 permanent lichen study plots were established in CATO*, CHOH, GWMP, HAFE, MANA, NAMA, NACE, ROCR, and PRWI. Some of the plots were located where samples have been collected in the past, some as long ago as the early 1900s.

Results

Forty-five species of bark-inhabiting lichens were identified during the NCR inventory. Relatively pollution-tolerant lichen communities have developed over time in the region, probably the result of poor air quality in the past century and only slight improvement since. Other outcomes of the inventory are:

Photos: Paul Diederich

Left: The pollution-tolerant lichen *Flavoparmelia caperata*
Right: The pollution-sensitive lichen *Usnea ceratina*

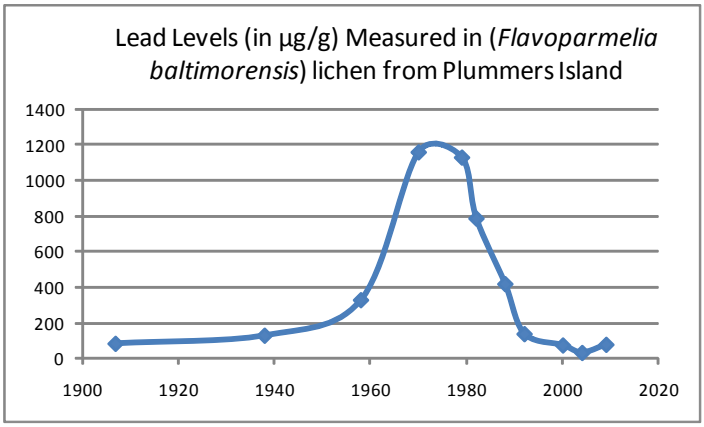
• NCR's bark-inhabiting lichen communities are dominated by nitrogen-loving, pollution-tolerant species. Pollution-sensitive species are found infrequently in most parks.

• Lichen communities in urban parks closest to Washington, DC are lowest in species diversity and coverage, and have no pollution-sensitive species.

• Lichens in PRWI are consistently higher in species richness, highest in coverage of pollution-sensitive species, and lower in element concentration than those from other parks.

•Though moderate variation exists between urban and rural parks, there are no significant pollution "hot spots" in the NCR. Concentrations of sulphur and metals in samples of *F. caperata* in NCR overall, are not unusually elevated compared to the rest of the U.S. and chromium concentrations are generally low compared to values measured in other studies.

However, lichens from Plummers Island, Maryland (part of CHOH), where lichens were collected early in the 20th century, show the dramatic rise in atmospheric lead (Pb) deposition prior to the early 1980's. The highest lead values were observed after the completion of the American Legion Memorial Bridge that carries Interstate 495 traffic over the island. At about this time, leaded gasoline was also phased out in the U.S. and subsequent measurements of lead concentrations in lichens declined sharply.



* full park names and park abbreviations are listed on reverse.

Additionally, present-day lichen communities are far less diverse and contain fewer sensitive species than communities that existed at the same sites in the past century. For example, on Plummers Island, the list of lichens once collected includes many pollution-sensitive species that are no longer found in the mid-Atlantic region.

To find out more:

Lawrey, J.D. 2011. A lichen biomonitoring program to protect resources in the National Capital Region by detecting air quality effects. Natural Resource Program Center, Fort Collins, CO. NRTR NPS/NCRN/NRTR -- 2011/450. https://nrinfo.nps.gov/Reference.mvc/DownloadDigitalFile?code=428476&file=Lawrey_2011_Lichen_Bioindicators_Final_Report.pdf

NPLichen, A Database of Lichens in the U.S. National Parks. http://www.nbii.gov/nplichen

NPElement, A Database of Lichen Elemental Concentrations in the U.S. National Parks. http://www.nwhc.usgs.gov/our_research/np_element.jsp

The NPS National Capital Region Network's Air Monitoring homepage, http://science.nature.nps.gov/im/units/ncrn/monitoring_air.cfm

NCRN Park Abberviations

ANTI- Antietam National Battlefield
CATO- Catoctin Mountain Park
CHOH- Chesapeake and Ohio Canal National Historical Park
GWMP- George Washington Memorial Parkway
HAFE- Harpers Ferry National Historical Park
MANA- Manassas National Battlefield Park
MONO- Monocacy National Battlefield
NACE- National Capital Parks – East
NAMA- National Mall and Memorial Parks
NCRN- National Capital Region Network
PRWI- Prince William Forest Park
ROCR- Rock Creek Park
WOTR- Wolf Trap National Park for the Performing Arts