



Ozone and Foliar Injury Summary, 2018

Overview

Ozone is a gas that occurs naturally in the lower levels of the earth's atmosphere. However, human-produced pollution can become an unnatural source of additional ozone that results in injury to humans and plants. The Cumberland Piedmont Network (CUPN) has been monitoring ozone and its injury to plants since 2008 to fulfill the National Park Service (NPS) mandate to protect its resources and preserve the enjoyment of these resources. In 2017, ozone concentration sampling was discontinued but foliar injury sampling continues.

The CUPN Ozone and Foliar Injury Program is designed to provide a network-wide assessment of status and trends in ozone concentration and foliar injury levels. All 14 CUPN park units are sampled on a rotational schedule (outlined in CUPN's ozone concentration and foliar injury protocol). This brief summarizes data collected in August 2018 at Mammoth Cave National Park. Additionally, Mammoth Cave NP and its cooperators collect ozone concentration data. Data for the 2018 growing season is also presented here. Ozone foliar injury reports are available upon request or at <https://www.nps.gov/im/cupn/reports-publications.htm>

Two foliar injury surveys were conducted at the Great Onyx Job Corps site, located in the northwestern portion of the park (Figure 1). One survey was conducted by the principal investigator while the other was completed independently and simultaneously by a network employee. The second was completed as quality assurance and quality control (QA/QC) for the first one. In both cases, ozone-sensitive plants were examined along the mown boundary of the field (Figure 2). Site elevation is about 650 feet (198 meters).

Ozone concentration data are collected at the Mammoth Cave air quality site at Houchin Meadow. Located near the park's western boundary (Figure 1), Houchin Meadow is the primary of multiple air-quality sites within Mammoth Cave operated by the park and its cooperators. The site's ozone analyzer is an Environmental Protection Agency (EPA)-equivalent method (EQOA-0880-047), so data are of sufficient quality for permit review. The relatively low elevation of the site (774 feet or 236 meters) should result in higher concentrations during the day and lower concentrations at night.

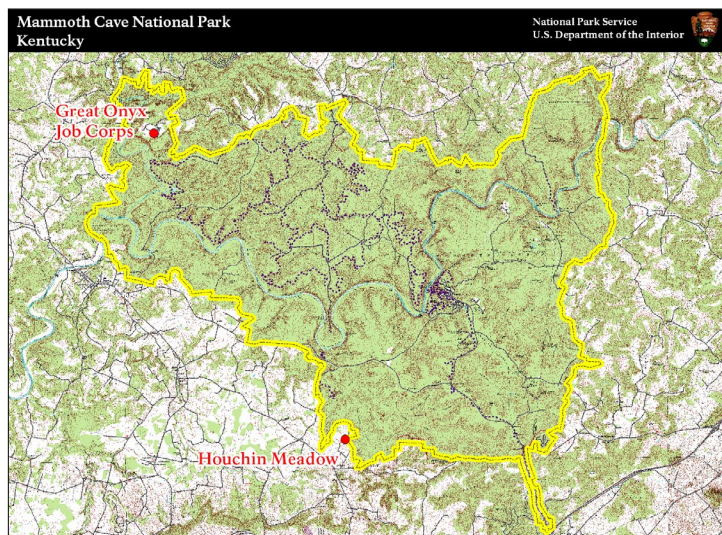


Figure 1. Map of ozone and foliar injury sites. NPS map by Lillian Scoggins.



Figure 2. Great Onyx Job Corps foliar injury site. NPS photograph by Tyler Binkley.

Significant Findings

Foliar injury

In 2018, 383 plants at three CUPN parks were inspected for foliar injury. Of the 163 plants examined at Mammoth Cave, no plants were suspected to have foliar injury. The principle investigator examined 75 plants and the QA/QC sampler examined 88 plants, totaling 163 plants. It is likely that some plants were examined by both the principle investigator and the QA/QC sampler, so that the number of unique plants examined was somewhere between 88 and 163. Foliar injury surveys were conducted at Mammoth Cave on 9 August 2018. The results are found in Table 1.

Table 1. Results of foliar injury surveys at Mammoth Cave NP in 2018.

Site Name	Species common name	Species or genus scientific name	Number Inspected	Number w/ Injury?	Ozone-Caused?
Great Onyx Job Corps / Primary	Dogbane	<i>Apocynum</i> sp.	7	0	N/A
Great Onyx Job Corps / Primary	Milkweed	<i>Asclepias</i> sp.	30	0	N/A
Great Onyx Job Corps / Primary	Sweetgum	<i>Liquidambar styraciflua</i>	7	0	N/A
Great Onyx Job Corps / Primary	Winged Sumac	<i>Rhus copallinum</i>	1	0	N/A
Great Onyx Job Corps / Primary	Blackberry	<i>Rubus</i> sp.	30	0	N/A
Great Onyx Job Corps / QAQC	Dogbane	<i>Apocynum</i> sp.	15	0	N/A
Great Onyx Job Corps / QAQC	Milkweed	<i>Asclepias</i> sp.	30	0	N/A
Great Onyx Job Corps / QAQC	Ash	<i>Fraxinus</i> sp.	2	0	N/A
Great Onyx Job Corps / QAQC	Sweetgum	<i>Liquidambar styraciflua</i>	10	0	N/A
Great Onyx Job Corps / QAQC	Black Cherry	<i>Prunus serotina</i>	1	0	N/A
Great Onyx Job Corps / QAQC	Blackberry	<i>Rubus</i> sp.	30	0	N/A

Significant Findings

Ozone Concentrations

The National Ambient Air Quality Standard (NAAQS) for ozone is set by the Environmental Protection Agency. Two standards exist. The “primary standard” is designed to be protective of human health while the “secondary standard” is designed to be protective of human welfare.

The primary standard uses a metric defined by the EPA as the “annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years.” In 2018, the value for the primary standard was 0.070 parts per million (ppm). The 8-hour average never exceeded 0.070 ppm in 2017.

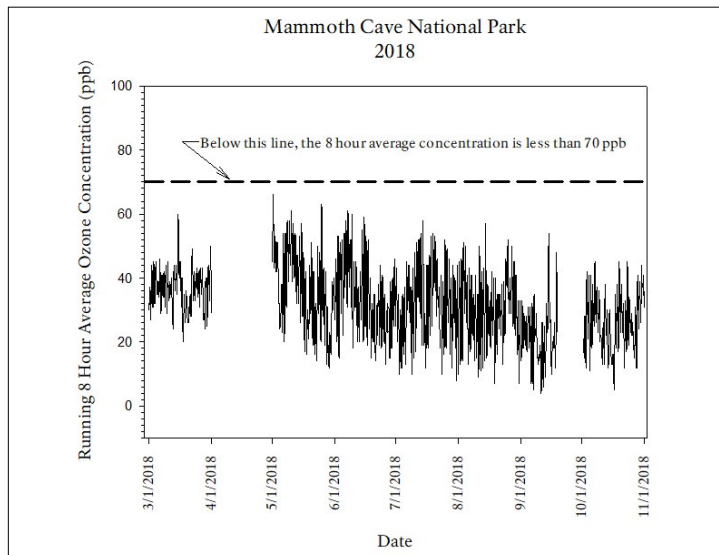


Figure 3. Running 8-hour average ozone concentration at Mammoth Cave NP.

Research suggests that many plant species are more sensitive to ozone than humans. Exposure to ozone is also cumulative in plants; the more the plant is exposed to ozone, the greater the injury to the plant. EPA’s secondary standard is set to be protective of human welfare, part of which is our need for and enjoyment of plants. Currently, that standard uses the same metric as the primary standard. Many scientists, however, argue that the W126 would be a better metric. The W126 metric is a biologically relevant measure that focuses on plant response to ozone exposure. This measure is a better predictor of vegetation response than the metric used for the human health standard. The W126 preferentially weighs the higher ozone concentrations most likely to affect plants and sums all of the weighted concentrations during daylight hours. The highest 3-month period that occurs during the growing season is reported in “parts per million-hours” (ppm-hrs). NPS-ARD recommends a W126 of less than 7 ppm-hrs to protect most sensitive trees and vegetation. At Mammoth Cave NP in 2018, the W126 was 5.0 ppm-hrs.

Future Monitoring

Ozone concentration is measured throughout the year by Mammoth Cave NP and NPS Air Resources Division. The Cumberland Piedmont Network conducts foliar injury sampling on an annual basis at Mammoth Cave NP.

About the Cumberland Piedmont Network

In 1999, the National Park Service initiated a long-term ecological monitoring program, known as “Vital Signs Monitoring,” to provide the minimum infrastructure to allow more than 270 national park system units to identify and implement long-term monitoring of their highest-priority measurements of resource condition. The overarching purpose of natural resource monitoring in parks is to develop scientifically sound information on the current status and long-term trends in the composition, structure, and function of park ecosystems, and to determine how well current management practices are sustaining those ecosystems.

The NPS Vital Signs Monitoring Program addresses five goals for all parks with significant natural resources:

- Determine the status and trends in selected indicators of the condition of park ecosystem,
- Provide early warning of abnormal conditions,
- Provide data to better understand the dynamic nature and condition of park ecosystems,
- Provide data to meet certain legal and Congressional mandates, and
- Provide a means of measuring progress towards performance goals.

Effective long-term management and stewardship of natural resources in the Cumberland Piedmont Network begins with baseline knowledge of these resources. To acquire this knowledge, an inventory program was established by the National Park Service with the goals of acquiring baseline information for a variety of resources, from bibliographic information to species occurrence and distribution.

For More Information

CUPN Home Page:

<http://www.nps.gov/im/cupn/index.htm>

CUPN Reports & Publications:

<https://www.nps.gov/im/cupn/reports-publications.htm>

About the NPS Inventory & Monitoring Division:

<https://www.nps.gov/im/index.htm>

Data Downloads via the Natural Resource Information Portal:

<http://irma.nps.gov>