



Ozone and Foliar Injury Summary, 2015

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.

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 (which is outlined in CUPN's ozone concentration and foliar injury protocol).

This brief summarizes data collected from April 2015 to October 2015 at Fort Donelson National Battlefield (FODO, Fort Donelson). Ozone and foliar injury reports are available upon request or at <http://go.nps.gov/cupn>.

There were four data collection sites at Fort Donelson in 2015. Ozone concentration data were collected at the FODO portable ozone monitoring station (POMS) that was located near the Graves Battery wayside exhibit. The relatively low elevation of the site, 518 feet (ft) or 158 meters (m), should result in higher ozone concentration during the day and lower concentration during the night. Foliar injury sampling was also conducted at Buckner's Defense (elevation is 582 ft or 177 m), Graves Water Quality Site (elevation is 382 ft or 116 m) and River Battery (elevation is 503 ft or 153 m).

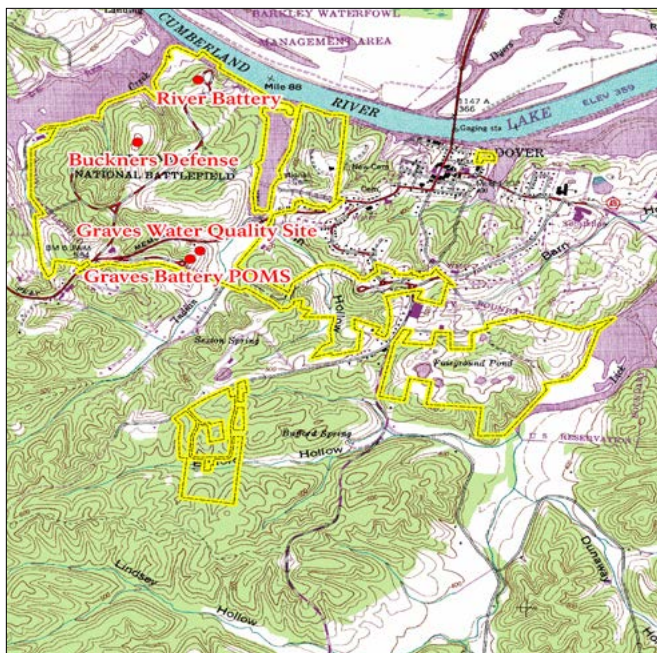


Figure 1. Map of ozone and foliar injury sites at Fort Donelson National Battlefield. NPS map by Lillian Scoggins.



Figure 2. Buckner's Defense.



Figure 3. Graves' Battery POMS.



Figure 4. Graves' Water Quality Site.



Figure 5. River Battery Site.

NPS photographs by Sammi Jo Eubank and Clare Bledsoe.

Significant Findings

Foliar injury

In 2015, 905 plants at four CUPN parks were inspected for foliar injury. Of the 266 plants examined at FODO on 4 August 2015, no plants were suspected to have foliar injury. The results for FODO are summarized in Table 1.

Table 1. Results of foliar injury surveys at Fort Donelson National Battlefield in 2015.

Site Name	Species	Inspected	Injured	Ozone-Caused?
Buckner's Defense	Blackberry	4	0	N/A
Buckner's Defense	Eastern Redbud	8	0	N/A
Buckner's Defense	Flameleaf Sumac	20	0	N/A
Buckner's Defense	Sweetgum	30	0	N/A
Buckner's Defense	White Ash	3	0	N/A
Graves Water Quality Site	American Sycamore	1	0	N/A
Graves Water Quality Site	Blackberry	10	0	N/A
Graves Water Quality Site	Eastern Redbud	30	0	N/A
Graves Water Quality Site	Flameleaf Sumac	2	0	N/A
Graves Water Quality Site	Sassafras	15	0	N/A
Graves Water Quality Site	Sweetgum	19	0	N/A
Graves Water Quality Site	White Ash	30	0	N/A
Graves Water Quality Site	Yellow Poplar	3	0	N/A
River Battery	Black Cherry	3	0	N/A
River Battery	Blackberry	11	0	N/A
River Battery	Eastern Redbud	7	0	N/A
River Battery	Flameleaf Sumac	2	0	N/A
River Battery	Pin Cherry	1	0	No
River Battery	Sassafras	2	0	N/A
River Battery	Sweetgum	30	0	N/A
River Battery	White Ash	30	0	N/A
River Battery	Yellow Poplar	5	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 2015, the value for the primary standard was 0.075 parts per million. The 8-hour average never exceeded 0.075 ppm in 2015.

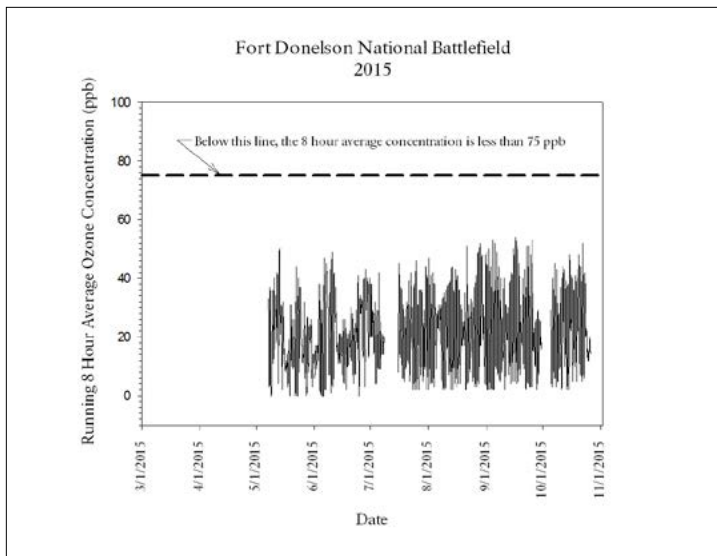


Figure 6. Running 8-hour average ozone concentration at Fort Donelson National Battlefield in 2015.

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 FODO in 2015, the W126 was 1.4 ppm-hrs.

Future Monitoring

Ozone concentration and ozone-induced foliar injury will be monitored by CUPN per its one year on/five year off panel design.

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://science.nature.nps.gov/im/units/cupn/index.cfm>

CUPN Reports & Publications:

<http://science.nature.nps.gov/im/units/CUPN/publications.cfm>

About the NPS Inventory & Monitoring Division:

<http://science.nature.nps.gov/im/index.cfm>

Data Downloads via the Natural Resource Information Portal:

<http://irma.nps.gov>

