

Plant Injury Caused by Ozone at Acadia National Park

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Symptomatology attributable to tropospheric ozone effects on foliage of eastern white pine in Acadia National Park was noted in 1982. A program has been developed to assess impacts of ozone on Acadia vegetation. The program includes fumigation of native plant species, identification of indicator species for use in trend plots based on visible injury, and assessment of ozone effects on plant growth processes through analysis of photosynthesis by CO₂ uptake and fluorescence emissions. Spectral reflectance parameters are being measured to assess chlorophyll levels and damage at the cellular structural level. Analysis of ozone effects on genetic diversity of eastern white pine are being studied by determining heritability of visible ozone response and assessing the correlation between heterozygosity and ozone symptom expression.

Ozone levels at the fumigation site in 1991 had an hourly average of approximately 40 ppb from May to September, but natural events of 4-6 hour duration with high ozone levels occurred several times from May to July. Ambient ozone from May 16 to September 12, 1991 was greater than 80 ppb for 149 hours and greater than 120 ppb for eight hours. Peaks from 180-210 ppb have been recorded in the park.

Screening of plants native to Acadia is now underway using open-topped chambers and the following diurnal ozone treatments: 50% reduction in ambient ozone, ambient air (+/- chamber), and ozone additions of 1.5 and 2.0 x ambient ozone. Representative plant species from the canopy, shrub, and herbaceous layers were propagated and ozone-exposed in 1990-92. Tree species observed to be sensitive to ozone are black cherry, red maple, paper birch, grey birch, jack pine, and trembling aspen. Herbaceous species which are sensitive include big-leaf aster, spreading dogbane, small sundrops, and bunchberry. Rates of net photosynthesis were assessed on black cherry, big-leaf aster, red maple, and northern red oak. Significant reductions in net photosynthesis were observed in black cherry and big-leaf aster. For black cherry, the effects were significant in September, but not in August. Ozone reduced rates of photosynthesis in aster primarily in uninjured tissue. Red maple developed some foliar injury, but the treatments had no effects on photosynthesis. Northern red oak showed no foliar injury or photosynthetic response. Big-leaf aster, black cherry, and spreading dogbane were injured by exposure to ambient levels of ozone.

Our research shows that there are several species of plants which grow in Acadia National Park that are sensitive to ozone and are being injured at ambient levels of ozone currently occurring there. The most sensitive of these (black cherry, big-leaf aster and spreading dogbane) are suitable indicator species for use in trend plots. Work planned for 1993 includes the establishment of trend plots for detection of ozone damage to natural vegetation in the park.

Characteristics of the ozone treatment exposure regimes at the Sand Beach research site, Acadia National Park for 1990 and 1991.

<u>Year</u>	<u>Treatment</u>	<u>Mean ambient conc (ppb)</u>		<u>Maximum 1-hr concentration</u>	<u>Number of hr</u>	
		<u>24-hr</u>	<u>12-hr</u>		<u>>80</u>	<u>>120</u>
1990	Filtered	18	17	105	4	0
	Non-filtered	34	27	142	37	3
	1.5 x ambient	38	48	177	152	23
	2.0 x ambient	46	62	240	327	104
1991	Filtered	17	14	107	10	0
	Non-filtered	37	40	149	120	9
	1.5 x ambient	44	54	212	235	58
	2.0 x ambient	52	68	267	527	133

Species of trees used in open-top chamber studies at Acadia National Park,
1990-1992

Scientific Name	Common Name	Year(s)
<i>Acer pensylvanicum</i> *	striped maple	1991
<i>Acer rubrum</i>	red maple	1991
<i>Betula populifolia</i>	gray birch	1990
<i>Betula papyrifera</i>	paper birch	1990
<i>Fraxinus americana</i>	white ash	1992
<i>Picea rubens</i>	red spruce	1990,1991
<i>Pinus banksiana</i>	jack pine	1990
<i>Pinus rigida</i>	pitch pine	1990
<i>Pinus strobus</i>	eastern white pine	1990, 1991, 1992
<i>Populus tremuloides</i>	quaking aspen	1992
<i>Prunus serotina</i>	black cherry	1991, 1992
<i>Quercus rubra</i>	northern red oak	1990, 1991
<i>Salix</i> spp.	willow	1992
<i>Thuja occidentalis</i>	northern white cedar	1990, 1991

* indicates species that grew poorly or in limited numbers

Other species of plants used in open-top chamber studies at Acadia National Park, 1990-1992

Scientific Name	Common Name	Year(s)
<i>Apocynum androsaemifolium</i>	spreading dogbane	1992, 1992
<i>Aralia nudicalis</i>	wild sarsaparilla	1991
<i>Asclepias syriaca</i> *	common milkweed	1990
<i>Aster macrophyllus</i>	big-leaf aster	1990, 1991
<i>Calamagrostis canadensis</i> *	Canada blue-joint grass	1990, 1991
<i>Cornus canadensis</i>	bunchberry	1990
<i>Impatiens capensis</i> *	jewelweed	1991, 1992
<i>Maianthemum canadense</i>	Canada mayflower	1991
<i>Montia lamprosperma</i> *	blinks	1990
<i>Nemopanthus mucronata</i> *	mountain holly	1992
<i>Oenothera perennis</i>	small sundrops	1992
<i>Potentilla tridentata</i>	3-toothed cinquefoil	1992
<i>Raphanus raphanistrum</i>	wild radish	1991
<i>Rhus typhina</i>	staghorn sumac	1992
<i>Vaccinium angustifolium</i> *	lowbush blueberry	1990

* indicates species that grew poorly or in limited numbers

Species of plants that were found to have foliar injury at ambient levels of ozone exposure at Acadia National Park and which can be used as bioindicators of ozone in the field.

<u>Scientific name</u>	<u>Common name</u>	<u>Year(s)</u>
Betula populifolia	Gray birch	1990
Prunus serotina	Black cherry	1991, 1992
Apocynum androsaemifolium	Dogbane	1991, 1992
Asclepias syriaca	Milkweed	1990
Aster macrophyllus	Big-leaf aster	1990, 1991
Oenothera perennis	Small sundrops	1991, 1992

Characteristics of the ambient ozone exposure regimes at the Sand Beach research site, Acadia National Park for 1990, 1991, and 1992. Data for 1992 are estimates and will be revised when the monitoring data are analyzed.

<u>Year</u>	<u>Mean ambient conc (ppb)</u>		<u>Maximum 1-hr concentration</u>	<u>Number of hr</u>	
	<u>24-hr</u>	<u>12-hr</u>		<u>>80</u>	<u>>120</u>
1990	32	35	140	41	3
1991	40	41	140	149	8
1992	--	est. 35	est. 117	--	0
