~ABSTRACT~

Ambient ozone (O₃) concentrations can cause visible foliar injury on a number of plant species. Currently, the USDA Forest Service is monitoring for O₃-induced foliar injury across the United States. The occurrence and severity of foliar injury, throughout 11 southern states, on O₃-sensitive species was determined on a total of 876 plots, 252 of which had some evidence of O₃ injury. On these plots, a total of 57,029 plants were examined, of which 2,589 had some degree of damage. A bioindex index was developed from the amount and severity of injury recorded at each plot. Bioindex varied both spatially and temporally. For GA and VA (N=6), 1998 had the highest average index (23.4 ± 19.6 S.E.M. and 22.1 ± 18.7 S.E.M., respectively). Bioindices varied significantly (ANOVA) by year for: GA (N=6, N=148) (p=0.0923), LA (N=2, N=43) (p=0.0573), SC (N=4, N=92) (p=0.0001), and VA (N=6, N=130) (p=0.0263); state was significant for: 1999 (N=6, N=80) (p=0.0001), 2000 (N=6, N=175) (p=0.0074) and 2002 (N=11, N=316) (p=0.0009). Blackberry (Rubus allegheniensis, Porter) and Sweetgum (Liquidambar styraciflua, L.) had the highest species indices (9.6 ± 1.3 S.E.M. and 6.2 ± 1.0 S.E.M., respectively), and were the most frequently tallied (N=19,325 and 11,639, respectively). Sensitivity to O₃ varied by species (p=0.0001), indicating that plant distribution, selection, and evaluation of individual species could have an effect on the calculation of bioindices.

~INTRODUCTION~

Ozone has been identified by the EPA as the most significant air pollutant affecting vegetation (U.S. EPA, 1996). Research has shown that ozone can cause foliar injury on a number of plant species (fig. 1).

Ozone injury varies according to a complex set of factors including, exposure, rates of stomatal uptake and sensitivity to ozone.

Ozone is formed when volatile organic compounds (VOCs) mix and react with nitrogen oxides (NOx) (fig. 2).

~METHODS~

O₁ injury was tallied on open areas (Biosites), at least 1 acre in size, within or alongside forested areas (USDA Forest Service, 2000).

At each bioindex plot 30 plants of 2 indicator spp. were inspected for amount and severity of ozone injury.

Amount % of leaves on plant with injury (all leaves)

Severity % of leaf area with injury (injured leaves)

Bioindex (B. I.) (Smith et al. 2003) (table 1) was calculated as:

B. I. = avg. score (amount * severity) for each species, averaged across all species on site.

~CONCLUSIONS~

O₁-induced foliar injury was detected in all 11 states included in this time period, with the exception of AL, and was highly variable spatially and temporally.

The average bioindex was very low for GA and VA in 1999, a year of high O₁ exposure. This finding agrees well with Smith et al. (2003) who found that for 1999, average bioindices were low across the northeastern U.S., corresponding to mild to severe drought conditions across much of this region.

An analysis of variance showed a statistically significant affect of both year and state on bioindices at the p<0.01 level, illustrating the high degree of temporal and spatial variability that exists in this measurement. However, the effect of the small sample size (small number of plots per year of data) is unknown.

Bioindicatior species were not equally sampled and showed significantly different sensitivities to O₁ injury. Ultimately, this could mean that the distribution and selection of species could affect the resulting Bioindex.

At present, the effect of ozone on forest health is still poorly understood. Few studies exist that show a direct relation between foliar injury and plant physiological response to elevated levels of ozone. More importantly, is the uncertainty that exists in extrapolating from controlled seedling studies to large forest trees (Samuelson and Kelly 2001).

The high degree of injury noted in some areas of some states may be cause for more intensive evaluation and monitoring. Further research is therefore needed in order to scale this foliar injury to individual species, ecosystem, and / or regional level response.

~LITERATURE CITED~


USDA Forest Service: 2000, ‘Forest Inventory and Analysis, National Core Field Guide’, Northeast Forest Experiment Station, New Town Square, PA and Pacific Northwest Research Station, Portland, OR.


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~LITITATION~


Fig. 1. Yellow Poplar leaf showing ozone-induced injury.

Fig. 2. Ozone formation and sources of pre-curors.

Fig. 3. Average B. I. for each state and year. TX, AL and FL not included.

Fig. 4. Average species index across all years and states.

Fig. 5. Number of times species were tallied vs. number of times tallied with injury.

Fig. 6. SUM60 O₃ exposures (top), based on monitoring data, and krigged Bioisde Indices (bottom), based on plot-level data.