Detail on the Plot-Level Index for the Ozone Indicator.

Note: *The formulation of the ozone indicator plot-level index was completed with the assistance of David Randall, Statistician for the NE Area, Washington Office.*

Notes on the formulation:
There are 3 components to the formulation: (1) the amount of injury, (2) the severity of injury, and (3) the incidence of injury on the site. The formulation selected associates these three components at the individual plant level. This suggests that the ozone injury response of each individual plant is important. This is biological reality, better than lumping all species together. The calculation is intuitive. A mean value is calculated that truly represents a proportion of the population at both the plant level and the species level. An arithmetic mean is then taken for the "n" species on the plot.

Notes on method:
Each plant observed by the field crew is rated for the percent of the plant that is injured (i.e., injury amount) and the average severity of injury (i.e., injury severity) using a modified Horsfall-Barrett scale with breakpoints at 6, 25, 50, 75, and 100 percent. This information is used to calculate an injury value for each plant, a mean value for each species, and an overall plot mean. The incidence of injury on the plot is also considered. The formulation is based on the fact that each individual plant has a unique response to ozone that is dependent on the genotype and micro-habitat at the time of exposure.

For each plant:

AMT = injury amount
SEV = injury severity

For each species:

N_1 = the number of injured plants
N_2 = the number of evaluated plants
A = N_1) N_2
B = 3(AMT (SEV)) N_1

Species_Index = A (B

For each Hexagon (or Biosite):

N_3 = the number of evaluated species

Plot_Index = 3(Species_Index)) N_3

Notes on transforming crew values from the nominal scale to the percent scale:

In the field, the crews estimate the percent injury to the plant and then assign nominal values that reflect 5 broad classes of injury as follows: 0 = no injury; 1 = 1-6% injury;
2 = 7-25% injury; 3 = 26-50% injury; 4 = 51-75% injury; and 5 ≥75% injury.

In the office, the nominal codes recorded by the field crews are converted to percentage values representing the midpoint of each injury class as follows:
0 = 0; 1 = 3.5%; 2 = 16%; 3 = 38%; 4 = 63%; and 5 = 88%.
Theoretically, the plot-value has a range from zero to 100. In reality, the highest values are less than 25 and most are less than 5. A plot with no injury has an index of zero.

The problem lies with the fact that measurement intervals on the two scales are different. The intervals on the nominal scale are equal, those on the percent scale are not.

The rationale for using midpoint values rather than nominal values for the plot-level index were threefold: (1) The midpoint percentage values bring the reader back to the original scale used by the field crew to rate the injured plants; (2) The percentage values have some intuitive biological relevance, unlike the nominal scale which was developed largely as a matter of convenience for the field crews; and (3) Readers relate more easily to the percentage values than the nominal scale.

It is understood that the data transformation introduces some error or misrepresentation into the reporting of the plot mean. Nevertheless, as long as the reader knows how the plot-value was calculated, the mid-point percentage is still preferable as it provides a more meaningful image of ozone injury than would be provided by the nominal scale.

Maximum Amount of Injury (amount_maximum)

The maximum amount of injury for a given biological species at a hexagon equals the maximum value of all the injury amounts for that species. If there are no injured plants within the species, the maximum amount of injury for the species equals zero.

amount_maximum = maximum(injury amounts for a given species at a hexagon)

Minimum Amount of Injury (amount_minimum)

The minimum amount of injury for a given biological species at a hexagon equals the minimum value of all the injury amounts for that species. If there are no injured plants within the species, the minimum amount of injury for the species equals zero.

amount_minimum = minimum(injury amounts for a given species at a hexagon)

Number of Damaged Plants

The number of damaged plants in a given biological species at a hexagon equals the number of plants that have injury amounts greater than zero and non-null injury severity amounts.

number of damaged plants = count(plants within a given species at a hexagon that have an injury amount greater than zero and a non-null injury severity amount)

Mean Amount of Injury (amount_mean)

The mean amount of injury for a given biological species at a hexagon equals the arithmetic mean of all the injury amounts greater than zero. If there are no injured plants within the species, the mean amount of injury for the species equals zero.

amount_mean = summation(injury amounts for a given species at a hexagon that are greater than zero) / number of damaged plants

Maximum Amount of Severity (severity_maximum)

The maximum amount of injury severity for a given biological species at a hexagon equals the maximum value of all the injury severity amounts for that species. If there are no injured plants within the species, the maximum amount of injury severity for the species equals zero.

severity_maximum = maximum(injury severity amounts for a given species at a hexagon)

Minimum Amount of Severity (severity_minimum)

The minimum amount of injury severity for a given biological species at a hexagon equals the minimum value of all the injury severity amounts for that species. If there are no injured plants within the species, the minimum amount of injury severity for the species equals zero.

severity_minimum = minimum(injury severity amounts for a given species at a hexagon)

Number of Injured Plants (plants_inj_cnt)

The number of injured plants for a given biological species at a hexagon equals the number of plants that have injury severity amounts greater than zero.

plants_inj_cnt = count(plants within a given species at a hexagon