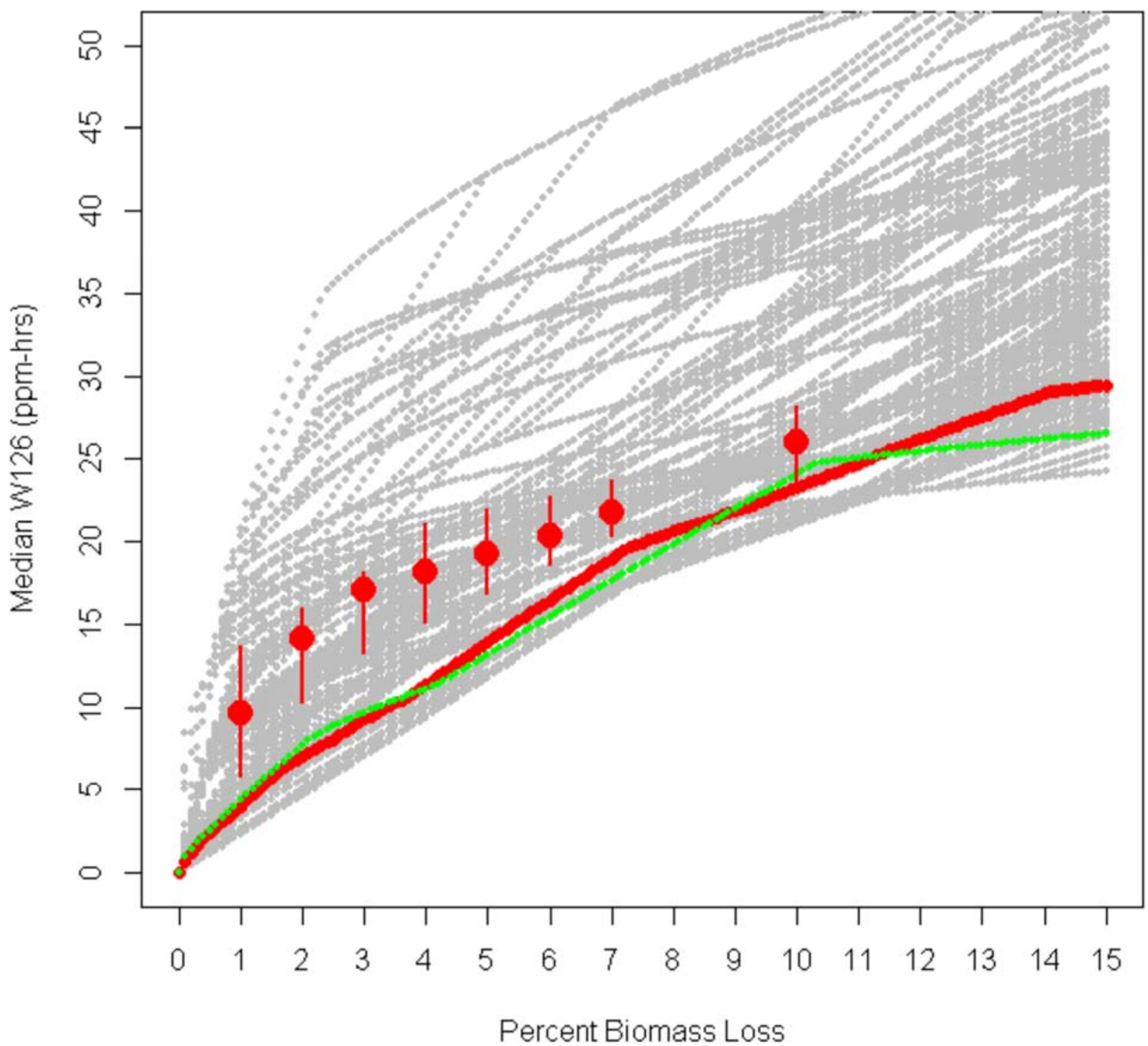
Additional Information from EPA on Biomass Loss function

The following pages were received from EPA's Office of Air Quality Planning and Standards in response to questions from panelists relayed by Holly Stallworth, Designated Federal Officer for the Ozone Review Panel. All of the information relates to Figure 5-2 of the Second Draft Policy Assessment which is the same as Figure 6-4 of the Second Draft Welfare Risk and Exposure Assessment.

Description of approaches used to calculate median tree biomass loss values

WREA Figure 6-4



Exposure-response functions for biomass loss are available for 12 species of tree. Eleven of the 12 species (6 deciduous and 5 coniferous) were studied between 1989 and 1992 by the EPA's National Health and Environmental Effects Research Laboratory-Western Ecology Division. With the exception of red maple and Virginia pine, each species was studied multiple times: aspen (14 cases); Douglas fir (7 cases); ponderosa pine (11 cases); red alder (6); black cherry (2); tulip poplar (3); loblolly pine (2); sugar maple (2); Eastern white pine (2) for a total number of 51 cases. In order to derive a common model across these multiple species, multiple genotypes within species, and multiple locations, a two-parameter Weibull model of relative biomass loss

(RBL) was used (see 1996 and 2006 O_3 AQCDs). In this review, an exposure-response function for an additional species, cottonwood, has been added (see Table 6-1 and the ISA U.S. EPA, 2013 for the exposure-response functions used in this review and a more extensive review of the calculation of these functions), making the number of cases 52. In order to examine this information in greater detail, three different statistical approaches were used to estimate mean tree seedling RBLs at different W126 exposures.

The first approach (depicted by the red line in the figure) applies the same approach used in the last several reviews (with cottonwood added) which combines all 52 tree seedling study cases together and then determines the median percent biomass loss associated with different W126 index values. The benefit of using this approach is that all of the available data is included. However, there is also the potential that species that have been studied more, and thus contribute more exposure-response functions, could bias the results toward that species' sensitivity.

The second approach (depicted by the green line in the figure) uses separate species-specific composite functions that are generated for each species that has more than one study case. These composite functions had already been generated in previous reports and were used again here. These 12 species-specific composite functions are then combined and the median composite RBL value associated with different W126 values are identified. The value of this approach is that it weights each species the same, so that those species which have been studied more don't unduly influence the results. On the other hand, it potentially masks within species variability and may put too much weight on species for which there is greater uncertainty regarding within species variability, due to the limited number of study cases.

The third approach (depicted by the red dots and **grey lines**) is included as a sensitivity analysis to assess the effect of within-species variability on the median RBL. This analysis was run 1,000 times and each time a single exposure-response function was randomly selected for each of the 12 species from all the available study cases. For example, for ponderosa pine which has 11 study cases, one of the 11 exposure-response functions would be selected during each of the 1,000 random runs. On the other hand, for red maple, which has only one exposure-response function, the same red maple exposure-response function would be used in each of the 1,000 runs. Each resulting grey line thus represents the composite function of the 12 species specific exposure-response functions, randomly selected for each species. There is clearly a lot of overlap among the randomly generated exposure-response functions since it is not possible to distinguish 1.000 separate grey lines in the figure. The median value of all 1,000 functions is plotted as the red dots for biomass loss values of 1% to 7%, and 10%. The error bar associated with the points represents the 25th and 75th percentiles. Visually, it appears that there are more functions above the median values than below, but this is likely because there is significant overlap in functions near the lower bound for sensitivity and greater variability in tolerance at higher levels of W126. The benefit of this approach is that it shows you the potential range of all possible combinations of composite functions for the 12 tree species, including the combinations made up of all of the most sensitive and all of the most tolerant functions for each species.

This figure thus shows that the median W126 index values are similar, when using all of the studies or just the composite C-R function for each species; however, the median values are higher when within-species variability is included.

EPA RESPONSE:

These comments primarily refer to Figure 6-4 of the Welfare REA (though the same approach would also apply to Figure 6-5).[1] Lee and Hogsett (1996) reported concentration-response (C-R) functions for eleven tree species using data from 51 individual studies. In that same report, Lee and Hogsett (1996) also developed composite C-R functions for each of the eleven tree species. These species composite functions were developed using the underlying individual study measurement data. Included in our analysis was another study that developed C-R functions for an additional species, i.e., cottonwood (Gregg et al., 2006). The O3 ISA (2014) developed the C-R function for cottonwood based on the data reported by Gregg et al. (2006). Thus, for the tree species, there were a total of 52 available C-R functions (with some species having greater than one C-R function)[2] and 12 composite C-R functions, one for each of the twelve species.

1) To develop the green line in the WREA Figure 6-4: first we used each of the composite C-R functions developed for the twelve species (Lee and Hogsett, 1996; O3 ISA, 2014) to calculate a W126 value at a particular biomass loss across the range reported in the figure (0 through 15%, by increments of 0.1%). Then the median response (i.e., median W126 value of the 12 predictions) for each percent biomass loss value was retained and plotted in the WREA Figure 6-4.
2) To develop the red line in the WREA Figure 6-4: first we used each of the individual C-R functions developed for the twelve species (i.e., the 52 C-R functions from Lee and Hogsett, 1996 and the O3 ISA, 2014) to calculate a W126 value at a particular biomass loss across the range reported in the figure (0 through 15%, by increments of 0.1%). The median response (i.e., median W126 value of the 52 predictions) for each percent biomass loss value was retained and plotted in the WREA Figure 6-4.

As both of these approaches are designed to approximate the central tendency, the green and red lines in either Figure 6-4 and 6-5 are similar. It is also important to note that the composite C-R functions used in calculating the green line are the C-R functions that were used for all of the biomass loss analyses in Chapter 6.

3) To develop the grey lines in the WREA figure 6-4: We randomly sampled from all 52 of the C-R functions available for each species, selecting one C-R function for each the twelve species, and as described in 1) above, calculated W126 values given associated with a biomass loss, then selecting the median W126 value. This process was repeated 1,000 times, thus generating new 1,000 median values. The median of these 1,000 median values was plotted as the "red dot" in Figure 6-4, along with vertical bars representing the 25th and 75th percentile value of this distribution of median values.

To explain why the "red dot" median value is above that of the green and red lines, six plots are included below as Figure 1 illustrating the within species C-R function variability. The grey lines in each of these represent the exposure-response functions base on the individual study C-R functions reported in Lee and Hogsett (1996) and the red line is the species composite C-R function developed by Lee and Hogsett (1996). The reason for the shift upward in the median value represented by the "red dots" in each of the WREA Figures 6-4 and 6-5 is that for most of the species, while most individual C-R functions clustered near the composite function or slightly below, a few to several species have non-sensitive C-R functions. In some random samples, there will be more of the non-sensitive C-R functions selected relative to sensitive C-R functions. In those cases, the median W126 values

[1] These two figures illustrate the W126 index values for alternative percent biomass loss for tree species (WREA, Figure 6-4) and crop species (WREA, Figure 6-5), respectively.
[2] Only one C-R function was available for Cottonwood, Red Maple, and Virginia Pine.

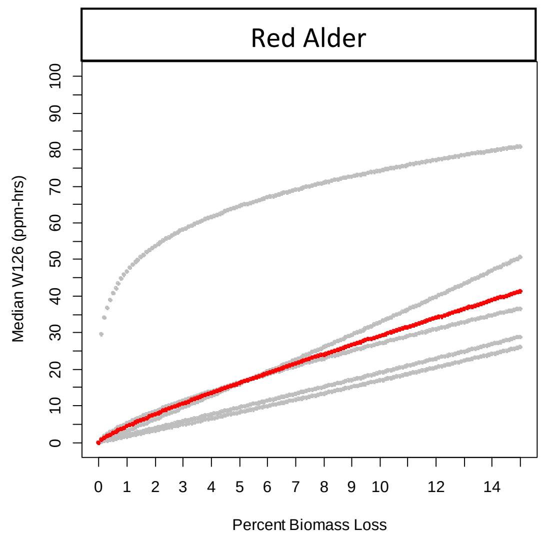
of the resulting samples will be higher compared with the composite functions that use all of the data. The end-result was that in Figure 6-4, the random sampling of these non-sensitive C-R functions, and used in deriving the 1,000 new W126 predictions, drives the median value upwards above both the green and red lines.

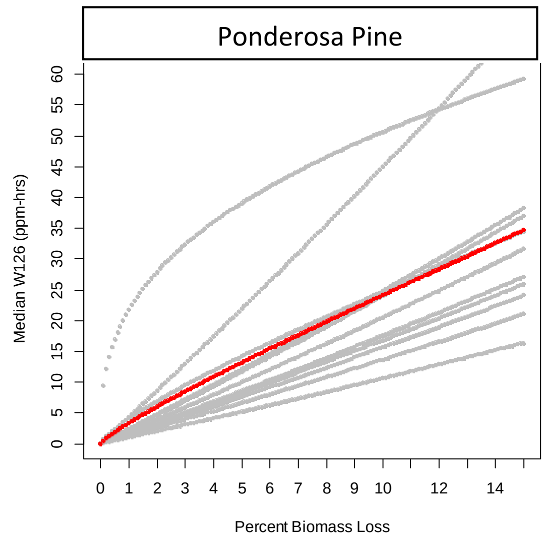
Species like Red Alder, Ponderosa Pine, and Aspen are examples of species that are moderately ozone sensitive based on the composite function, but do have individual study results that are relatively non-sensitive. Conversely, non-sensitive species like Loblolly do not have any studies which showed a much higher level of sensitivity or in the case of Virginia Pine, which is also a relatively non-sensitive species, there is only one study, which Dr. Neufeld alludes to above.

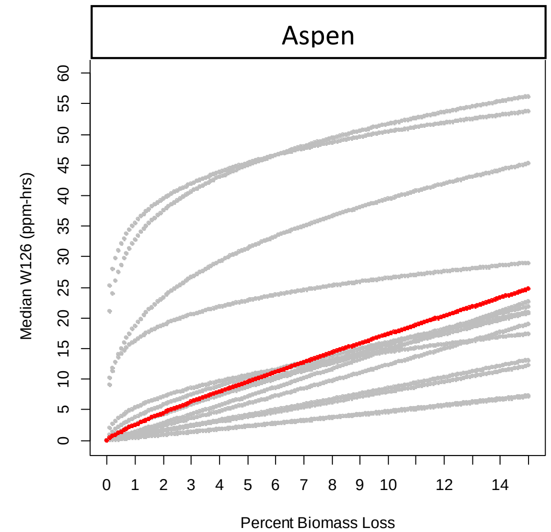
Gregg, JW; Jones, CG; Dawson, TE. (2006). Physiological and developmental effects of O3 on cottonwood growth in urban and rural sites. *Ecol Appl*. 16: 2368-2381.

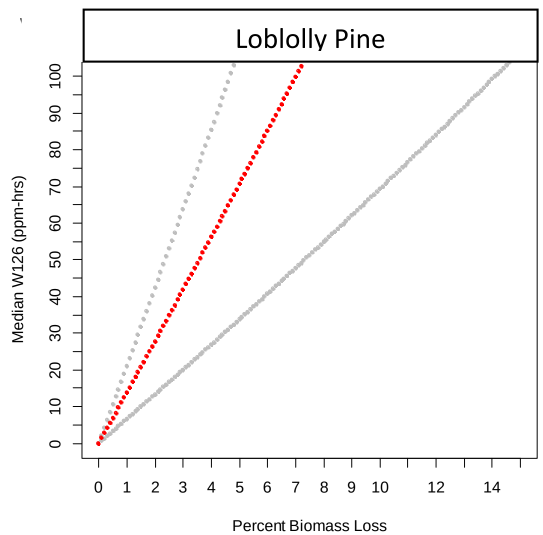
Lee, E.H.; Hogsett, W.E. (1996). Methodology for calculating inputs for ozone secondary standard benefits analysis: Part II. Report prepared for Office of Air Quality Planning and Standards, Air Quality Strategies and Standards Division, U.S. Environmental Protection Agency, Research Triangle Park, N.C.

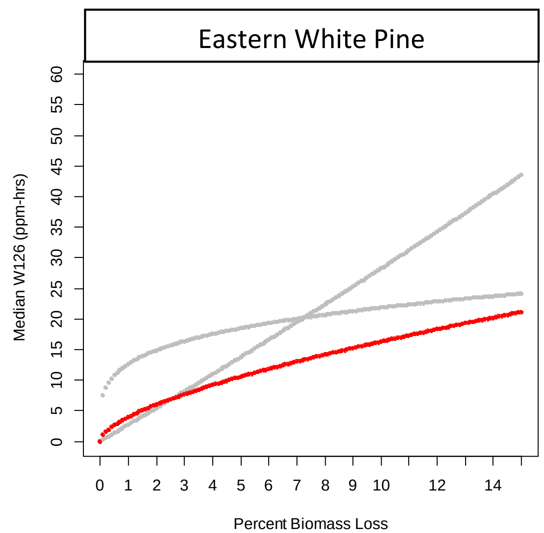
Attachment to E-mail from Bryan Hubbell to Holly Stallworth on 4-28-14











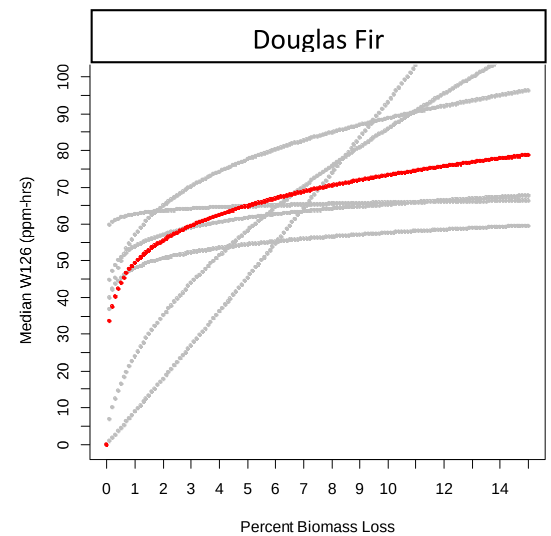


Figure 1. W126 Levels given alternate percent biomass loss.