

FIREMON and DDWoodyPC[®]: Results Derived From Brown's Transect Fuelbed Records

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ABSTRACT

Wildland fire exclusion policies have caused fire-adapted ecosystems to become loaded with excess fire fuels. Therefore, the need exists to discern and select candidate software applications that will calculate the average weight per acre of dead, down, and woody materials. The purpose of this study was to compare the results from FIREMON (\bar{X} = 4.64 tons per acre; n = 96) and DDWoodyPC[®] (\bar{X} = 2.84 tons per acre; n = 288) when respectively used to calculate Brown's Transect fuelbed records.

PROBLEM

Aggressive wildland fire exclusion policies have caused fire-adapted ecosystems to become underburned and, therefore, loaded with excess fire fuels. In the form of dead, down, and woody materials, these fuels can energize wildland fires capable of generating unusually large quantities of smoke and particulate matter. While prescribed fire can reduce fuels and their potential impacts, it cannot be employed without producing its own smoke. Therefore, a key factor in predicting the amount of smoke and particulate matter likely to be generated at any given prescribed burn site is an accurate assessment of the amount of wildland fire fuels on the forest floor (Acheson and Hardy, 1998; Thomas, 2002).

OBJECTIVE

To present the results from FIREMON (Fire Effects Monitoring and Inventory System; Lutes *et al.*, 2006) and DDWoodyPC[®] (Fuels Management Analyst Suite[®], FMAPlus[®]; Fire Program Solutions, L.L.C., 2005) when respectively used to calculate Brown's Transect (Brown, 1971 and 1974) fuelbed records.

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METHODS

Fuel records for down, dead, and woody (DDW) materials were collected using 288 Brown's Transects configured to the FIREMON FL streamlined sampling design (Lutes *et al.*, 2006; 96 single-point-centric groups of three Brown's Transects each = 288 transects) from Big Piney Ranger District (BPRD) fuelbeds by John Andre (Ecologist, BPRD, Ozark-St. Francis National Forests [OSF NFs]) and Mark Morales (Fire Management Officer, BPRD, OSF NFs). These data were entered into FIREMON and DDWoodyPC[®]. Results were obtained from each application, and respective sets of descriptive statistics were obtained using Minitab statistical software (Minitab, 1998).

RESULTS

FIREMON

Descriptive statistics were derived for: (1) DDW particles grouped into the following diameter-inch-classes: 0.00 - 0.25, 0.25 - 1.00, 1.00 - 3.00, 3.00 - 6.00, 6.00 - 9.00, 9.00 - 20.00, and >20.00 and (2) for duff- and litter-depths (Table 1). For all plots combined, mean DDW-loading was 4.64 tons per acre. The standard error of the mean for total DDW-loading was 31.2%. For all plots combined, mean duff- and litter-loading, respectively, were 7.14 and 5.89 tons per acre. Mean duff- and litter-depths, respectively, were 0.72 and 1.17 inches.

DDWoodyPC[®]

Descriptive statistics were derived for: (1) DDW particles grouped into the following diameter-inch-classes: 0.00 - 0.25, 0.25 - 1.00, 1.00 - 3.00, 3.00 - 6.00, 6.00 - 9.00, 9.00 - 20.00, and >20.00 and (2) for duff- and litter-depths (Table 2). For all plots combined, mean DDW-loading was 2.84 tons per acre. The standard error of the mean for total DDW-loading was 18.9%. Discrete figures for mean duff- and litter-loading were not reported. Mean duff- and litter-depths, respectively, were 0.72 and 1.16 inches.

DISCUSSION

The difference in the mean DDW-loading results from FIREMON ($\bar{X} = 4.64$ tons per acre; Table 1) and DDWoodyPC[®] ($\bar{X} = 2.84$ tons per acre; Table 2) could have resulted from several factors. FIREMON and DDWoodyPC[®] may use different algorithms to compute results. Additionally, DDW records by

species were not collected, which DDWoodyPC®, using species-specific gravities, requires to operate correctly. At BPRD's request, a default species of Ponderosa Pine (*Pinus ponderosa* Dougl. ex Laws.) was designated for all DDWoodyPC® DDW records, which introduced pseudomonocultural bias into those results.

Table 1. Descriptive statistics derived from data obtained from FIREMON for sampling (FIREMON FL streamlined sampling design; 96 single-point-centric groups of three Brown's Transects each = 288 transects) locations in the Big Piney Ranger District (USDA, FS, Ozark-St. Francis National Forests). Sampling dates: 15-17 and 19 July 2003; 20, 23, and 27 August 2005; 5 and 7-9 November 2005.

| Variable | N | Mean | Median | TrMean | StDev | SE Mean |
|---------------------------|----------|-------------|---------------|---------------|--------------|----------------|
| 0-.25"-Dia 1-Hr Fuels | 96 | 0.09833 | 0.10000 | 0.09698 | 0.04827 | 0.00493 |
| .25-1"-Dia 10-Hr Fuels | 96 | 0.8314 | 0.7000 | 0.7676 | 0.6075 | 0.0620 |
| 1-3"-Dia 100-Hr Fuels | 96 | 1.2000 | 1.0000 | 1.1360 | 0.9407 | 0.0960 |
| Total 1-100-Hr Fuels | 96 | 2.135 | 1.900 | 2.037 | 1.287 | 0.131 |
| ≥9"-Dia 1000-Hr Sound | 96 | 1.250 | 0.400 | 0.940 | 2.098 | 0.214 |
| ≥9"-Dia 1000-Hr Rotten | 96 | 1.252 | 0.550 | 1.074 | 1.563 | 0.160 |
| Total 1-1000-Hr Fuels | 96 | 4.639 | 4.050 | 4.379 | 3.060 | 0.312 |
| Duff | 96 | 7.140 | 6.600 | 6.983 | 4.024 | 0.411 |
| Litter | 96 | 5.888 | 5.000 | 5.155 | 5.340 | 0.545 |
| Total 1-1000-Hr + Duf&Lit | 96 | 17.663 | 16.800 | 17.050 | 8.304 | 0.848 |
| Duff (Depth) | 96 | 0.7167 | 0.7000 | 0.7012 | 0.3978 | 0.0406 |
| Litter (Depth) | 96 | 1.173 | 1.000 | 1.026 | 1.066 | 0.109 |
| Total Duf&Lit (Depth) | 96 | 1.898 | 1.850 | 1.749 | 1.289 | 0.132 |

| Variable | N | Minimum | Maximum | Q1 | Q3 |
|---------------------------|----------|----------------|----------------|-----------|-----------|
| 1-Hr Fuels | 96 | 0.00000 | 0.30000 | 0.10000 | 0.10000 |
| 10-Hr Fuels | 96 | 0.0000 | 3.0000 | 0.4000 | 0.9000 |
| 100-Hr Fuels | 96 | 0.0000 | 4.9000 | 0.6000 | 1.7000 |
| Total 1-100-Hr Fuels | 96 | 0.300 | 8.100 | 1.300 | 2.775 |
| 1000-Hr Sound | 96 | 0.000 | 12.700 | 0.000 | 1.700 |
| 1000-Hr Rotten | 96 | 0.000 | 6.700 | 0.000 | 1.975 |
| Total 1-1000-Hr Fuels | 96 | 0.600 | 19.100 | 2.200 | 5.975 |
| Duff | 96 | 0.500 | 19.500 | 4.100 | 10.275 |
| Litter | 96 | 0.000 | 32.500 | 2.825 | 7.175 |
| Total 1-1000-Hr + Duf&Lit | 96 | 3.800 | 49.800 | 11.925 | 21.775 |
| Duff (Depth) | 96 | 0.0000 | 1.9000 | 0.4000 | 1.0000 |
| Litter (Depth) | 96 | 0.000 | 6.500 | 0.600 | 1.400 |
| Total Duf&Lit (Depth) | 96 | 0.100 | 8.000 | 1.100 | 2.200 |

Table 2. Descriptive statistics derived from data obtained from DDWoodyPC® for sampling locations (FIREMON FL streamlined sampling design; 96 groups of three Brown's Transects each = 288 transects) in the Big Piney Ranger District (USDA, FS, Ozark-St. Francis National Forests). Sampling dates: 15-17 and 19 July 2003; 20, 23, and 27 August 2005; 5 and 7-9 November 2005.

| Variable | N | Mean | Median | TrMean | StDev | SE Mean |
|-------------------------------|-----|---------|---------|---------|---------|---------|
| 0-.25"-Dia 1-Hr Fuels | 288 | 0.2514 | 0.2100 | 0.2378 | 0.1717 | 0.0101 |
| .25-1"-Dia 10-Hr Fuels | 288 | 0.3045 | 0.2200 | 0.2726 | 0.2990 | 0.0176 |
| 1-3"-Dia 100-Hr Fuels | 288 | 0.4210 | 0.3400 | 0.3643 | 0.5058 | 0.0298 |
| Total 1-100-Hr Fuels | 288 | 0.9760 | 0.8600 | 0.9155 | 0.7289 | 0.0430 |
| 3-6"-Dia 1000-Hr Fuels | 288 | 0.4902 | 0.0000 | 0.3923 | 0.8144 | 0.0480 |
| 6-9"-Dia 1000-Hr Fuels | 288 | 0.5990 | 0.0000 | 0.3791 | 1.4569 | 0.0859 |
| 9-20"-Dia 1000-Hr Fuels | 288 | 0.771 | 0.000 | 0.306 | 2.579 | 0.152 |
| ≥20"-Dia 1000-Hr Fuels | 288 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| Total ≥3"-Dia 1-1000-Hr Fuels | 288 | 1.860 | 0.000 | 1.412 | 3.163 | 0.186 |
| Total 1-1000-Hr Fuels | 288 | 2.836 | 1.610 | 2.434 | 3.216 | 0.189 |
| Duff (Depth) | 288 | 0.7188 | 0.6500 | 0.6906 | 0.4636 | 0.0273 |
| Litter (Depth) | 288 | 1.1561 | 1.0000 | 1.0408 | 1.0734 | 0.0633 |
| Total Duf&Lit (Depth) | 288 | 1.8749 | * | * | * | * |

| Variable | N | Minimum | Maximum | Q1 | Q3 |
|-------------------------------|-----|---------|---------|---------|---------|
| 0-.25"-Dia 1-Hr Fuels | 288 | .0000 | 1.3800 | 0.1300 | 0.3400 |
| .25-1"-Dia 10-Hr Fuels | 288 | 0.0000 | 2.4400 | 0.1100 | 0.3400 |
| 1-3"-Dia 100-Hr Fuels | 288 | 0.0000 | 3.7000 | 0.0000 | 0.6700 |
| Total 1-100-Hr Fuels | 288 | 0.0000 | 6.5200 | 0.5025 | 1.2625 |
| 3-6"-Dia 1000-Hr Fuels | 288 | 0.0000 | 3.6700 | 0.0000 | 1.1500 |
| 6-9"-Dia 1000-Hr Fuels | 288 | 0.0000 | 8.1800 | 0.0000 | 0.0000 |
| 9-20"-Dia 1000-Hr Fuels | 288 | 0.000 | 17.520 | 0.000 | 0.000 |
| ≥20"-Dia 1000-Hr Fuels | 288 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| Total ≥3"-Dia 1-1000-Hr Fuels | 288 | 0.000 | 20.100 | 0.000 | 2.293 |
| Total 1-1000-Hr Fuels | 288 | 0.000 | 20.830 | 0.853 | 3.775 |
| Duff (Depth) | 288 | 0.0000 | 3.1500 | 0.4000 | 1.0000 |
| Litter (Depth) | 288 | 0.0000 | 10.0000 | 0.6700 | 1.3300 |
| Total Duf&Lit (Depth) | 288 | * | * | * | * |

Also, FIREMON grouped the 288 total transects by their original FIREMON FL streamlined sampling design, which, accordingly, produced 96 grouped mean outputs. DDWoodyPC® treated all 288 transects individually, and, therefore, derived 288 raw mean outputs. The respective difference in total numbers of mean outputs may have biased each program's standard error of the mean. By convention, a standard error of the mean >20% is usually unacceptable.

For DDW material with ≥3-inch diameters (coarse woody debris or CWD), the transect-length needs to be extended sufficiently to provide ≥1 CWD-intersection per ≥75% of sampled transects. If too many zeros are recorded for CWD-intersection sampling points, then a large sampling variance will result. Therefore, in areas where CWD is uncommon, to yield adequate precision, transects may need to be extended up to several hundred feet to produce adequate precision. Additionally, recording the length and diameter of all DDW may become necessary (FIRE PROGRAM SOLUTIONS L.L.C., 2005). As a final note, Lutes (2002) could not completely verify the accuracy of the line-transect method due to inconsistent results when testing for random and orientational distribution of DDW.

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