Soil Compaction at Bonnaroo Music and Arts Festival, Manchester, TN

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BACKGROUND

This study aims to determine whether detrimental soil compaction occurred at an outdoor music festival hosting approximately 80,000 patrons.

Excessive compaction by heavy machinery and foot traffic has the potential to reduce soil moisture and fertility, decrease vegetation, and ultimately increase erosion within event grounds (Hakansson et al. 1988; Horrigan et al. 2002).

MATERIALS & METHODS

Samples taken using a hand-penetrometer.

- 270 samples taken
- before and after the festival
- among seven areas (6 stages, 1 control)
- measuring maximum *depth of penetration*
- at area-density thresholds of 70, 140, and 210 kg/m^2

Model 1: Variation in *depth of penetration* by *soil area-density*, *location* and *sample period* was examined using a full-factorial ordinary least squares model (ANOVA).

Model 2: Variation in *depth of penetration* by *soil area-density* and *sample period* was examined *individually* for each *location* using a two-factor ANOVA.

Model 3: Variation in *depth of penetration* by *sample period* was examined *individually* for *soil area-density* threshold using a single-factor ANOVA.

RESULTS

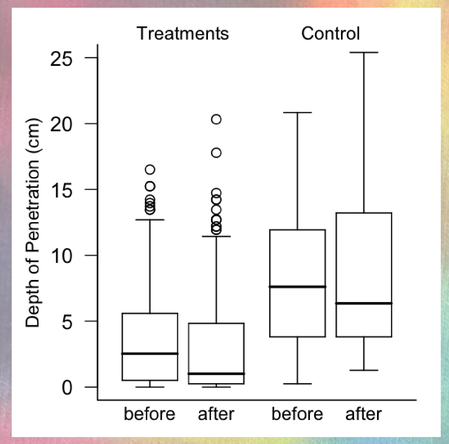

Figure 1:

Comprehensive distribution of the data (*depth of penetration*) by *sample period* (June 6, 2012 vs. June 15, 2012) for both *treatments* (areas 1-6) and *control* (area 7).

Areas 1-6 demonstrated a significant effect on *depth of penetraton* by all individual factors – *location* ($F_{5,504}$ = 19.1624, P < 0.0001), *soil area-density* ($F_{2,504}$ = 344.8898, P < 0.0001), and *sample period* ($F_{1,504}$ = 21.8651, P < 0.0001) – as well as a significant interaction between *location* and *soil area-density* ($F_{10,504}$ = 4.0461, P < 0.0001).

The control model demonstrated a significant effect by *soil area-density* on *depth of penetration* ($F_{2,89}$ = 54.4234, P < 0.0001), but no effect by *sample period* ($F_{1,89}$ = 0.2413, P < 0.6245).

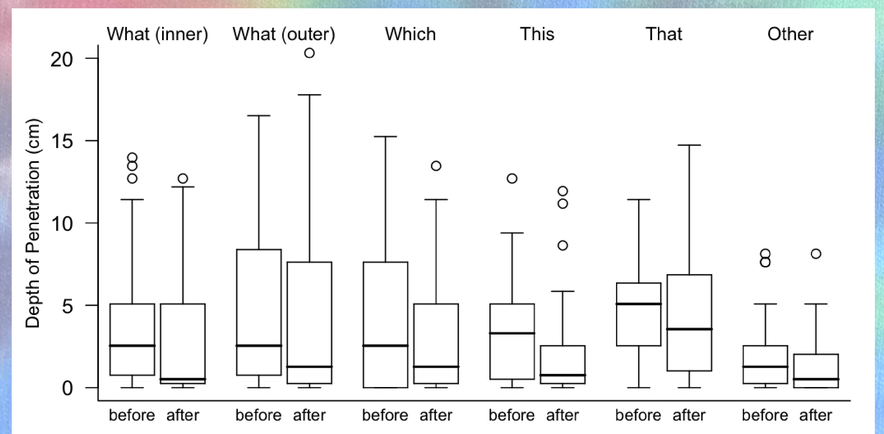

Figure 2:

Distribution of the data (*depth of penetration*) by *sample period* and *location*.

For each sample area, *soil area-density* had a significant effect on *depth of penetration* (for all areas, P < 0.001), but only two sample areas, *What (inner)* and *This*, detected a significant interaction (at α = 0.05) between *depth of penetration* and *sample period*.

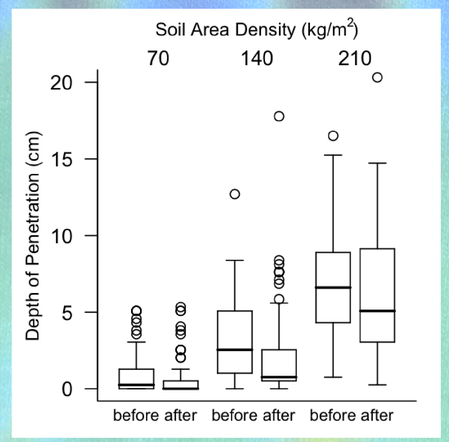

Figure 3:
Distribution of the data (*depth of penetration*) by *sample period* and *soil area-density*.

This model showed that while significant changes in *depth of penetration* occurred at thresholds of 70 kg/m^2 ($F_{1,179}$ = 4.5291, P = 0.0348) and 140 kg/m^2 ($F_{1,179}$ = 16.3243, P < 0.0001), only a marginally significant change occurred at the most critical threshold, 210 kg/m^2 ($F_{1,179}$ = 3.3855, P = 0.0675).

While the general trend in *depth of penetration* at 210 kg/m^2 still decreased, the overall impact is considerably less in a single year than at lower soil area densities.

CONCLUSIONS

The results of the comprehensive model suggest that:

- Across all treatment areas, compaction increased as a result of the event.
- Maximum *depth of penetration* varies by *location* and *soil area-density*.
- *Soil area-density* also varies by *location*.
- There was no change in the control.

Other considerations:

- The relationships demonstrated by the first model are highly variable from stage-to-stage.
- Analyses of *depth of penetration* by *sample period* for individual stages would be best supplemented by increasing sample size.
- Analyses of spatial variability in *soil area-density* would be best supplemented by gathering soil profiles of each stage area.
- The control model would be best supplemented by additional sample plots nearer each stage.

Limitations:

- Event had taken place on the same land for 10 years prior to sampling.
- Late arrival to the event.
- Limited access to some stage areas.
- Confounded results due to yearly sodding of some stage areas.
- No data for soil moisture content.
- No data related to runoff of erosion.
- Bonnaroo is massive.

REFERENCES

- Hakansson, I., W.B. Voorhees, and H. Riley. 1988. Vehicle and wheel factors influencing soil compaction and crop response in different traffic regimes. *Soil and Tillage Research*, *11*(3-4), 239–282.

- Horrigan, L., R.S. Lawrence, and P. Walker. 2002. How sustainable agriculture can address the environmental and human health harms of industrial agriculture. *Environmental Health Perspectives*, *110*(5), 445-456.

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