A Soil Disturbance Classification System
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BACKGROUND
A classification system was developed for describing the types of soil disturbance that can potentially occur with ground-based harvesting. The classification system is based on type and degree of disturbance to topsoil and subsoil. This system was devised using the following criteria:

- Categories span the range of soil disturbance that potentially could occur with ground-based harvesting.
- Types and severity of disturbance are defined and effects on off-site soil movement, site productivity, or hydrology are under test or validated using a research-quality strategic database.
- Disturbance categories are visually discernible and readily recognized by equipment operators in the field.
- Disturbance category definitions can be understood and easily recognized by laypersons (i.e., categories are clear and unambiguous).

The soil disturbance classification provides a relatively simple method for identifying soil disturbance so that equipment operators, foresters, and harvest managers can monitor operations to ensure that soil disturbance guidelines aimed at maintaining long-term soil productivity are met. The range of soil disturbance types shown does not occur on every ground-based harvested setting. Standards and monitoring processes are in place to assist operations to minimize or eliminate disturbance types that are deemed detrimental to long-term soil productivity.

The amount of area in these disturbance types should also be considered when making decisions about disturbance standards and amelioration requirements. Landings may show larger contiguous areas of more severe soil disturbance where traffic pattern converge and are more concentrated and should be assessed separately from general traffic within the setting.

APPLICATION
The objective of this note is to provide a brief overview of the soil disturbance classification system in a format that can be laminated (pages 3-6) and taken to the field for reference. Soil disturbance from forest practices ranges from barely perceptible to very obvious, and its impacts on tree growth can be positive, of no consequence, or negative depending on the soil / climate conditions and degree of severity. Therefore, it is critical that the impacts of these disturbance types are assessed in controlled experiments for a given region before conclusions are drawn about their potential impacts on tree growth. Considerable research has been conducted on Weyerhaeuser Timberlands in the Pacific Northwest to confirm which classes of disturbance cause detrimental disturbance to soil properties and tree growth by soil and climatic zone (Miller et al. 1989, Miller et al. 1996, Heninger et al. 1997, Heninger et al. 2002, Ares et al. 2005). As with any tool, it is important that individuals receive training on how to recognize the different soil disturbance classes in the field so that monitoring and assessments are consistently applied, and soil disturbance standards are met.
## INDICATORS OF SCIENTIFIC CONFIDENCE

<table>
<thead>
<tr>
<th>Category</th>
<th>Lowest Rating</th>
<th>Rating</th>
<th>Current Rating Definition</th>
<th>Highest Rating Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literature review</td>
<td>None</td>
<td>X</td>
<td>Complete review for original project in 1979, and not included in this report. Updated for saturation issue only.</td>
<td>Complete review and benchmarking, summarized in report</td>
</tr>
<tr>
<td>Study approach</td>
<td>Methods development, preliminary experiment, initial observations</td>
<td>NA</td>
<td>A conceptual classification scheme is presented that can be used to classify types of soil disturbance that potentially could occur following ground-based harvesting.</td>
<td>Hypothesis testing with sufficient power for rejection</td>
</tr>
<tr>
<td>Experimental design</td>
<td>None – observations only</td>
<td>NA</td>
<td>Design replicated in both time and space</td>
<td></td>
</tr>
<tr>
<td>Data analysis</td>
<td>Summary of data (means, etc.), no analysis</td>
<td>NA</td>
<td>Complete results of either hypothesis testing or parameter estimation</td>
<td></td>
</tr>
<tr>
<td>Review process</td>
<td>Reviewed only by viewing presentation or by director</td>
<td>X</td>
<td>Reviewed by WTR Soil Team</td>
<td>External review with a referee</td>
</tr>
<tr>
<td>Overall confidence</td>
<td></td>
<td>X</td>
<td>Classification system has been successfully used for 20 years. Major advantages of system are: 1) easy to understand and use in the field with minimum training; 2) harvest managers, machine operators and foresters can easily recognize and control the amount of soil disturbance occurring as a result of any ground-based operation; 3) apply to a wide range of soil conditions; 4) apply to a wide range of machine types; and 5) is not dependent on measuring physical soil properties.</td>
<td>Highest confidence, can fully recommend operational implementation.</td>
</tr>
</tbody>
</table>
Definitions:

**Compacted:** soil bulk density is increased by significantly reducing macropore space. The connectivity of the macropore space is altered, thus reducing water and air movement in the soil.

**Churned:** soil is stirred and mixed with fine organic material; soil structure is altered; soil has massive or platey-like appearance; raw organic matter mixed into soil.

**Puddling:** The normal granular or blocky structure of the soil has been changed into a massive or platey structure. Air and water movement into and through the soil have been greatly reduced. Trafficking or tilling fine-textured soil when moisture levels are high can result in puddling.

**Displaced:** Soil is moved laterally from its usual place in the profile but it is not removed off-site. Soil can be bladed or pushed aside by machines or logs.

One or more of these disturbances can affect the topsoil, the subsoil, or both. **Topsoil** is the surface soil layer or horizon (A-horizon) characterized by its dark color or humified organic matter with the mineral fraction. It is more nutrient rich and generally more friable in structure than the subsoil. **Subsoil** is the subsurface layer or B-horizon located below the A-horizon, which is usually reddish, light brown, or yellowish in color. It generally has less organic matter (less nutrient rich), and has more blocky structure and less macropore space than the topsoil.
Class 1 Soil Disturbance

- **Non-disturbed surface**
- **Topsoil**
- **Subsoil**
- **Compacted**
- **Slightly or not compacted**

Soil is compacted but not churned. Original soil structure is evident. The fine roots are largely undisturbed and in place. Soil bulk density has been increased due to the reduction in macropore space.

Class 2 Soil Disturbance

- **Topsoil**
- **Subsoil**
- **Puddled**
- **Compacted**

Soil surface is churned and partly to completely puddled. The forest floor and some slash is stirred into the soil. Depth of churning and debris mixing is confined to the surface A horizon. The Subsoil is compacted, but is not churned.
Class 3 Soil Disturbance

Topsoil
Subsoil
Partly removed / Puddled
Mixed with topsoil / puddled

In this case the topsoil that is not displaced is mixed in with the subsoil and puddling can occur into the subsoil. This type of disturbance needs to be minimized, particularly on finer-textured soils. Water barring to prevent erosion and amelioration may be needed if area of disturbance is significant. Harvesting should be scheduled on sensitive soils when soil moisture conditions are relatively low.

Class 4 Soil Disturbance

Topsoil
Subsoil
Removed
Puddled

Prevent disturbance of this type by not pushing aside topsoil through blading or the gauging action of skidded logs. To ameliorate this type disturbance bring back displaced surface soil and till compacted layers.
This disturbance is difficult to correct so avoid blocking drains and disrupting hydrologic function creating saturated conditions.
REFERENCES


ACKNOWLEDGEMENTS

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