Soil Quality in Working Forests

Healthy Forest Soils

- Lyn Townsend, Forest Ecologist (principal author and presenter)
- Terry Aho, Soils Specialist (co-author)

USDA-Natural Resources Conservation Service
West National Technology Support Center,
Portland, Oregon
Introduction to Ecological Sites … a platform for initiating planning and conducting “healthy” forest management which includes consideration of soil

Supporting this platform with 1) resource quality criteria requirements, 2) soil interpretations, 3) practice specifications; and 4) economic practicality for the landowner

Identifying key soil attributes (that are at risk) and developing sensible forest practices performance criteria to maintain soil and site health
An ecological site is ...

- A characteristic or distinctive kind of land with capacity to produce a distinctive kind and amount of vegetation.
- The kind of land consists of a specific and correlated set of named and mapped soil components.

Example
Representative soil series having components making up the example ecological site are Cinebar, Clackamas, Dollar, Hillsboro, Honeygrove, Katula, and Olympic.
1. Reference State (Site ID: F002XN__WA)

1.1 Douglas-fir-western redcedar-bigleaf maple/swordfern/vine maple
Overstory structure: Multi-story, mature-old-growth
Tree canopy: 50-60%
Tree age: 125+ years (with redcedar understory)

1.1a

1.1b

1.2 bigleaf maple-red alder/swordfern
Overstory structure: Even-aged
Tree canopy: 60-90%
Tree age: 15-50 yrs

1.2a

1.2b

1.3 bigleaf maple-red alder/swordfern
Overstory structure: Even-aged
Tree canopy: 60-90%
Tree age: 15-50 yrs

1.3a

1.3b

1.4 bigleaf maple-red alder-western redcedar/swordfern
Overstory structure: Multi-aged
Tree canopy: 60-90%
Tree age: 50-80 yrs

1.4a

1.4b

1.4c

1.5 Douglas-fir-bigleaf maple/brackenfern
Overstory structure: Even-aged
Tree canopy: up to 40%
Tree age: 1-15 yrs

1.5a

1.5b

1.6 Douglas-fir-bigleaf maple/swordfern
Overstory structure: Even-aged
Tree canopy: 40-90%
Tree age: 15-60 yrs

1.6a

1.6b

1.7 Douglas-fir-bigleaf maple-western redcedar/swordfern
Overstory structure: Even-aged
Tree canopy: 60-90%
Tree age: 60-125 yrs

1.7a

1.7b

1.7c

(Pseudotsuga menziesii-Thuja plicata-Acer macrophyllum/Polystichum munitum/Acer circinatum; Rev. 22May2007)

= Community phase pathway
1.X = Plant Community Phase
1.Xy = Pathways (ecological response to various natural and management disturbances)
The ecological site provides the platform for initiating forest management ... reducing the risk of unsubstantiated or unessential information being transferred to the landowner or land manager.
To support the platform on which to plan and implement forest and vegetation management, four elements related to forest soil quality must be integrated:

- Identifying key soil attributes that help define “health” of the local forest unit and the dynamic plant communities being managed
- Rating soil components on their susceptibility to degradation of identified soil attributes by various forest and vegetation management techniques (including equipment and timing of use)
- Developing sensible and understandable forest practices performance criteria that minimize degradation
- Assuring economic practicality for the forest landowner in carrying out prescribed forest practices
Status of integration …

http://www.fs.fed.us/cgi-bin/Directives/get_dirs/fsh?2509.18

- Northern Region (R1), Rocky Mountain Region (R2), Southwestern Region (R3), Intermountain Region (R4), Pacific Southwest Region (R5), Pacific Northwest Region (R6), and the Eastern Region (R9) of the USDA-Forest Service

- Soil Quality Elements: Displacement, Compaction, Rutting, Erosion, Soil Cover, Organic Matter, Burned Conditions

In 1979, the Pacific Northwest Region was the first Forest Service region to develop and implement soil quality standards … with a standardized protocol developed in 1983

From 1975 to 1979, NRCS in the Pacific Northwest assisted in the development of interagency criteria and making widespread ratings at the soil component level (in soil surveys) for displacement, compaction, rutting, and burned conditions.
Some background ...

- The Montreal Process criteria and indicators for the conservation and sustainable management of temperate and boreal forests were established following the endorsement, in 1995, of a statement of commitment to sustainable forest management known as the Santiago Declaration.

- Seven criteria and 67 indicators applicable to temperate and boreal forests were identified as important to sustainability.

- Member countries are: Argentina, Australia, Canada, Chile, China, Japan, Republic of Korea, Mexico, New Zealand, the Russian Federation, the United States of America and Uruguay.

- These countries on five continents represent 90 percent of the world’s temperate and boreal forests and 60 percent of all forests. (The countries account for about 45 percent of world trade in wood and wood products and 35 percent of the world’s population.)

http://www.mpci.org/home_e.html
Montreal Process …

<table>
<thead>
<tr>
<th>Montréal Process Working Group Meetings:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>July 24-28, 2006</strong></td>
</tr>
<tr>
<td><strong>October 18-23, 2004</strong></td>
</tr>
<tr>
<td><strong>September 2003</strong></td>
</tr>
<tr>
<td><strong>April 2003</strong></td>
</tr>
<tr>
<td><strong>November 2001</strong></td>
</tr>
<tr>
<td><strong>November 2000</strong></td>
</tr>
<tr>
<td><strong>November 1999</strong></td>
</tr>
<tr>
<td><strong>October 1998</strong></td>
</tr>
<tr>
<td><strong>July 1997</strong></td>
</tr>
<tr>
<td><strong>June 1996</strong></td>
</tr>
<tr>
<td><strong>November 1995</strong></td>
</tr>
<tr>
<td><strong>February 1995</strong></td>
</tr>
<tr>
<td><strong>November 1994</strong></td>
</tr>
<tr>
<td><strong>October 1994</strong></td>
</tr>
<tr>
<td><strong>September 1994</strong></td>
</tr>
<tr>
<td><strong>July 1994</strong></td>
</tr>
<tr>
<td><strong>June 1994</strong></td>
</tr>
</tbody>
</table>
Welcome to the MCPFE

Ministerial Conference on the Protection of Forests in Europe

The MCPFE is a high-level political initiative towards the protection and sustainable management of forests throughout the region.

This political commitments involves 46 European Countries, the European Commission and cooperates with a range of world countries and international organizations.

ALBANIA, ANDORRA, AUSTRIA, BELARUS, BELGIUM, BOSNIA and HERZEGOVINA, BULGARIA, CROATIA, CYPRUS, CZECH REPUBLIC, DENMARK, ESTONIA, FINLAND, FRANCE, GEORGIA, GERMANY, GREECE, HUNGARY, ICELAND, IRELAND, ITALY, LATVIA, LIECHTENSTEIN, LITHUANIA, LUXEMBOURG, MALTA, MOLDOVA, MONACO, MONTENEGRO, NETHERLANDS, NORWAY, POLAND, PORTUGAL, ROMANIA, RUSSIAN FEDERATION, SERBIA, SLOVAK REPUBLIC, SLOVENIA, SPAIN, SWEDEN, SWITZERLAND, THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA, TURKEY, UKRAINE, UNITED KINGDOM
Back to “status of integration” ...
<table>
<thead>
<tr>
<th>Disturbance variable</th>
<th>USFS region</th>
<th>Thresholds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil displacement</td>
<td>1</td>
<td>Loss of 2.5 cm of any surface horizon, usually the A horizon</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Loss of either 5 cm or 0.5 of the humus-enriched topsoil, whichever is less</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Loss of 50% of the A horizon</td>
</tr>
<tr>
<td>Compaction</td>
<td>1</td>
<td>Bulk density increase of 15%, usually in the A horizon</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Reduction of &gt;10% soil porosity or a doubling of soil strength</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>15% bulk density increase (Volcanic soils: 20%)</td>
</tr>
<tr>
<td>Rutting and puddling</td>
<td>1</td>
<td>Wheel ruts at least 5 cm deep</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Ruts or hoof prints in mineral soil or Oa horizon</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Ruts to at least 15 cm depth</td>
</tr>
<tr>
<td>Erosion (surface)</td>
<td>1</td>
<td>Visual evidence of detrimental soil loss and maintenance of minimum ground cover based on local conditions (soil loss should be &lt;2-4 t/ha/year)</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Establish local minimum ground cover guidelines to limit erosion (not to exceed the natural rate of soil formation)</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Visual evidence of detrimental soil loss and maintenance of minimum ground cover based on erosion hazard class (not to exceed the soil formation rate)</td>
</tr>
<tr>
<td>Soil cover</td>
<td>1</td>
<td>Enough cover to prevent erosion from exceeding natural rates of formation</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Too little to prevent erosion from exceeding natural rates of formation</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Less than 20% cover on sites with low erosion hazard ratings, 30% for moderate, 45% for high, and 60% for very high (for year 1 after disturbance)</td>
</tr>
<tr>
<td>Organic matter</td>
<td>1</td>
<td>Local guidelines developed based on ecological type</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Local guidelines developed based on ecological type</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Local guidelines developed based on ecological type</td>
</tr>
<tr>
<td>Burned conditions</td>
<td>1</td>
<td>Forest floor lost and A horizon has intense heating</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Loss of either 5 cm or 0.5 of litter layer, whichever is less</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Mineral soil oxidised and next 1.5 cm blackened due to charring of organic matter</td>
</tr>
</tbody>
</table>
Detrimental Soil Conditions (Collectively < 15%*)

- Compaction
- Displacement
- Puddling/Rutting
- Burned
- Eroded

*not included are permanent roads and trails and other administrative facilities within the activity area
How do these standards translate on the ground?

- Sullivan* compiled one of the most complete soil disturbance data sets on the impacts of ground-based harvesting systems (1981-1985) in NE Oregon ...

How do these standards translate on the ground?

- A classic case study (1995-1997) from the La Grande Ranger District in NE Oregon …
- “It demonstrated that operators at Limber Jim were able to meet Regional soil quality standards by keeping detrimental soil disturbance under 10 percent using cut-to-length timber harvest technology.”

Figure 10.2—Installing contour-felled logs for erosion control after a wildfire. (Photo by Peter Robichaud).
Some Closing Comments

- The Montreal and Ministerial Conference Processes have been involved with conceptual development of soil quality indicators and how to measure extent of impacts within member countries. With formulation of technical notes on each indicator (now underway), the processes will eventually progress to how indicators might work on-the-ground.

- The costs of soil quality degradation, meeting soil quality standards at field sites, and soil quality monitoring have to be linked to forest productivity and other environmental benefits … to explain and justify expenditures. Because benefit-cost validations have not reached a ‘critical mass,’ some agencies and private forest organizations have yet to establish national soil quality standards.
Some Closing Comments

- Can’t divorce soil quality from vegetation -- ecological sites give the reference plant communities, altered states, and pathways of ecological response and transition ... i.e., the scope of sensitivity expressed by vegetation to changes in soil attributes. NRCS is leading a pilot effort on “Dynamic Soil Properties” to link soil quality with changes in vegetation and forest productivity using ecological sites as a basis.

- NRCS and state forestry agencies as lead agencies working “on-the-ground” with private forest lands need to seriously consider adopting soil quality standards and incorporate the technology into ecological site descriptions, soil surveys, forestry plans, and forest practices performance requirements.
Thanks!

- **Principal author:**
  - Lyn Townsend, Forest Ecologist
  - USDA-NRCS-WNTSC
  - 1201 NE Lloyd Blvd, Suite 1000
  - Portland, OR 97232
  - (503) 273-2419
  - Lyn.townsend@por.usda.gov

- **Co-author:**
  - Terry Aho, Soil Scientist
  - USDA-NRCS-WNTSC
  - 1201 NE Lloyd Blvd, Suite 1000
  - Portland, OR 97232
  - (503) 273-2422
  - Terry.aho@por.usda.gov
**Forwarder**

A Forwarder is a tracked or rubber tired machine consisting of a power plant, operator enclosure, dozer blade, articulating grapple, and a bunk to the rear. This machine usually follows the processor and picks up the cut-to-length logs, places them in the bunk and then takes the logs out of the woods and piles them at the landing. It then moves back into the woods to repeat the process. A forwarder may also be used to pick up bunched trees and forward them to the landing where a machine called a delimber is used to remove the limbs, cut off the tops, and pile the logs.
Program Features

Forest Health Indicators

<table>
<thead>
<tr>
<th>Ozone</th>
<th>Crown Condition</th>
<th>Soil Quality</th>
<th>Lichen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Down Woody Materials</td>
<td>Vegetation</td>
<td>Tree Mortality</td>
<td>Tree Growth</td>
</tr>
</tbody>
</table>

Soil Quality Indicator

Soils represent the basic support system for terrestrial ecosystems because of their role in providing nutrients, water, oxygen, heat, and mechanical support to vegetation. Any environmental stressor that alters the natural function of the soil has the potential to influence the productivity, species composition, and hydrology of forest systems. In the Forest Inventory and Analysis (FIA) Program, we collect data to evaluate soil physical and chemical properties and the extent of erosion and compaction.

Why Is the Soil Quality Indicator Important?

Soil quality refers to the capacity of a soil to function within ecosystem and land use boundaries, to sustain biological productivity, maintain environmental quality, and promote plant and animal health (Doran and Parkin, 1994).

Information about soil chemical and physical properties can be used to answer the following types of questions about soil quality and forest health:
The Environmental Monitoring and Assessment Program (EMAP) is a research program to develop the tools necessary to monitor and assess the status and trends of national ecological resources. EMAP's goal is to develop the scientific understanding for translating environmental monitoring data from multiple spatial and temporal scales into assessments of current ecological condition and forecasts of future risks to our natural resources.

EMAP aims to advance the science of ecological monitoring and ecological risk assessment, guide national monitoring with improved scientific understanding of ecosystem integrity and dynamics, and demonstrate multi-agency monitoring through large regional projects. EMAP develops indicators to monitor the condition of ecological resources. EMAP also investigates designs that address the acquisition, aggregation, and analysis of multiscale and multitier data.

Web Site Statistics