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A workshop on  
**SHORELINE MANAGEMENT  
AND STABILIZATION  
USING VEGETATION**



**COASTAL  
TRAINING  
PROGRAM**  
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# F OREST SOIL



**Soil pore space is the  
result of:**

## What is forest soil made of?

- Openings, called pore space, filled with air and water.
- Nutrients used by plants and animals.
- Clumps of soil called aggregates.
- Mineral particles.
- Plant and animal matter, both living and dead.



*Tiny cracks  
and crevices  
between soil  
aggregates*



*Small animal  
burrows*



*New and  
decaying root  
channels*



*Freeze-thaw  
wetting/drying  
cracks*

## Why is pore space so important?

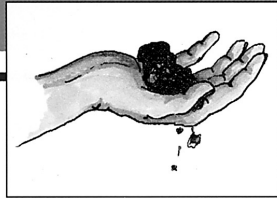
- Rain, snowmelt water and air enter the soil through pore space.
- Soil gases escape into the atmosphere.
- Tree roots grow through pore space, using water, oxygen and nutrients.

*Pick up a handful of undisturbed forest soil. Clear away the litter and decomposing layer and scoop up the mineral soil. Try not to squeeze it.*



## Take a look at forest soil . . .

- Look closely and you will notice that half or more is solid material, the rest is pore space.
- The pore space is filled with a combination of air and water depending on how moist the soil is.



Now squeeze that handful of soil. Because it's wet, it will form a lump in your hand. Dry soils do not form a lump.



Now try to pick up a handful of soil that has been carelessly rutted or compacted. You'll probably have a harder time prying loose a handful. Why?



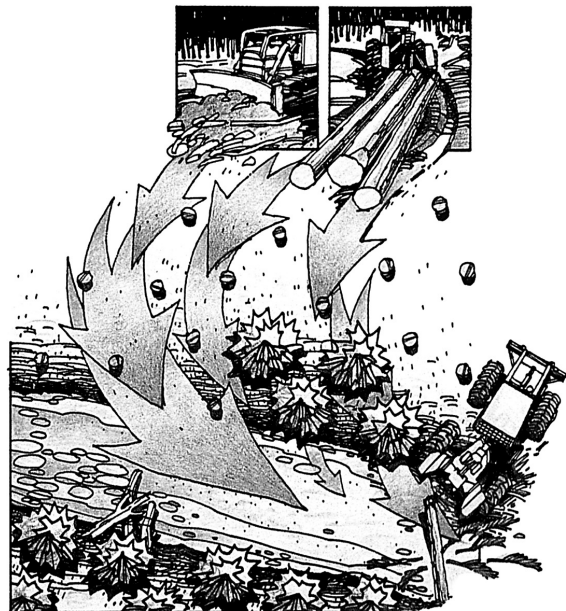
- The pore space is reduced.
- The solid particles of soil have been squeezed together.
- What was a handful of wet soil is now compacted. (see pgs. 32-35)
- The soil in the skidder track has also been compacted.

## Questions to think about . . .

1. How easy will it be for rain and snowmelt water to enter compacted soil?
2. How easy will it be for plant roots to grow into and through compacted soil?
3. How easy will it be for soil air to exchange with air in the atmosphere?

## Answers to the questions

- In undisturbed forest soils, rainfall and snowmelt easily move through the litter layer and decomposing humus layer, into soil pore space. Soil water moves slowly through the soil eventually draining into nearby streams and wetlands or ground water.
- But when forest soil is compacted or rutted by careless forest operations, longterm damage can result.
- Damage from compaction or soil rutting can prevent the natural infiltration of water into forest soils. (see pgs. 32-37)
- Often the protective forest litter layer is stripped away, exposing bare mineral soil to erosion by rainwater runoff and snowmelt.
- Eroding soil particles become sediment that can enter streams and cause problems for fish and the insects they feed on. (see pg. 40)
- Trees may not grow well in soil that has been compacted. (see pgs. 33-34)
- If careless forest management activities reduce the growing quality of a site, the effects can be longterm, and that's not forest stewardship.



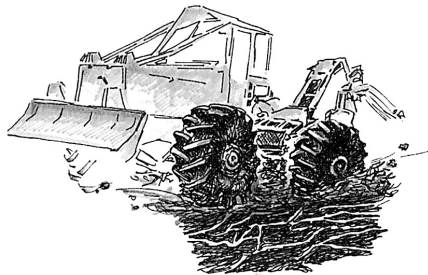
# S OIL COMPACTION



*Undisturbed forest soil*



*Soil compaction after 1 pass*



*Soil compaction after 3 passes*



*Soil compaction after 12 passes*

## What is it?

- The compression of soil to the point that pore space is reduced.

## How does it happen?

- The force of weight by heavy equipment squeezes soil particles. Large pore channels are lost or reduced.
- The most damage is done after the first three passes.
- Six to 10 passes result in as much compaction as 20 passes.

## What's the effect of compaction on pore space?

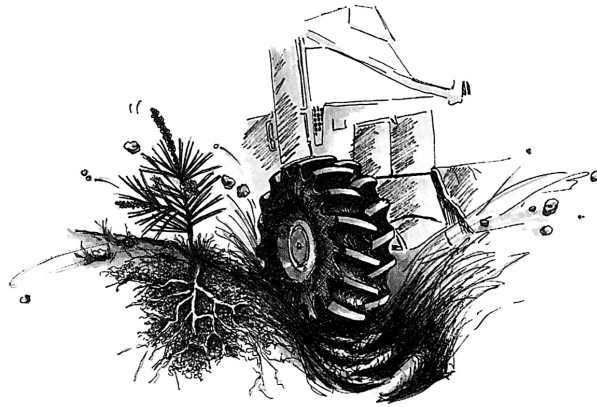
- Compaction decreases pore space and prevents water and nutrients from entering the soil. Both are essential to tree growth.
- When water cannot enter the soil, surface runoff and erosion can occur.
- Pores provide passageways for plant roots. Tree roots have trouble penetrating dense compacted soils.
- The supply of air to tree roots is reduced by the change in porosity and drainage.
- Tree seedling growth can be reduced by compaction.

## Does soil have to be wet for compaction to occur?

- Soil wetness determines compaction. It's more important than the number of passes across the soil surface.
- Compaction increases with increased soil wetness, but compaction occurs when soils are well below saturation. During summer months, soils are susceptible to compaction.



seedling



**Q**uestion: What about the seedlings that I've seen growing in compacted soil?

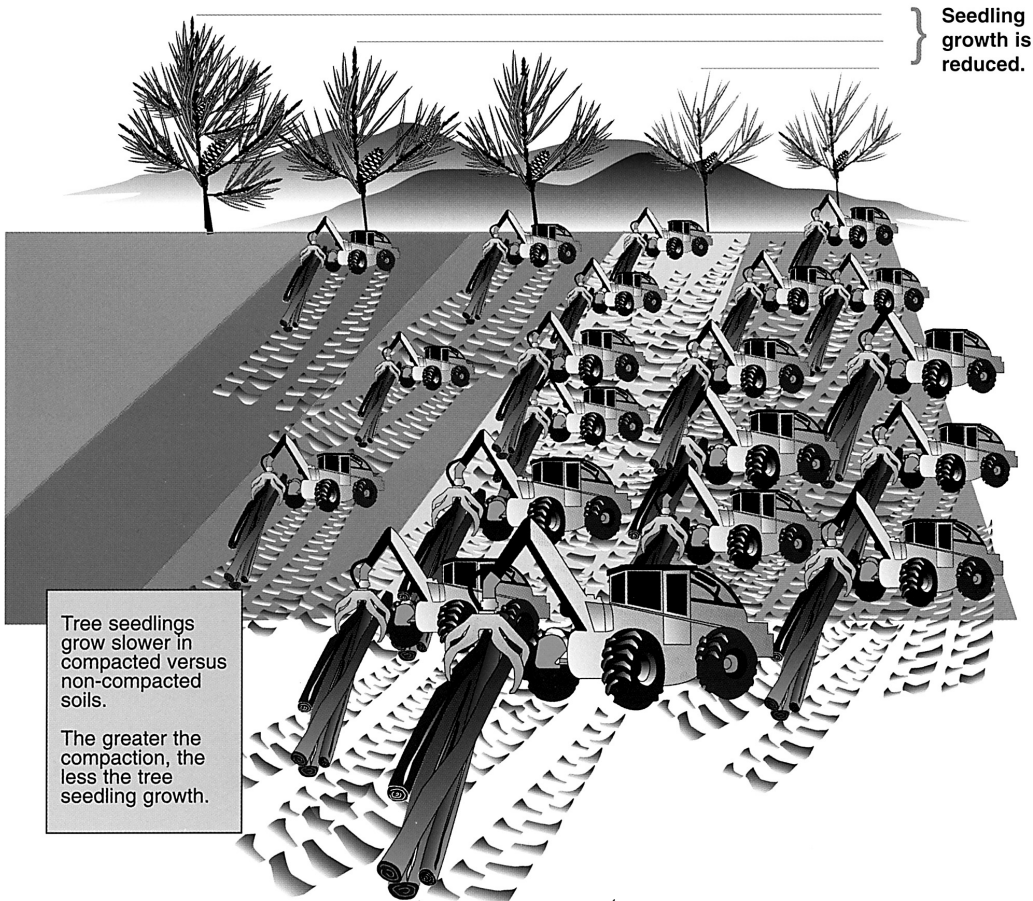
**A**nswer: Occasionally seedlings can get started in compacted soil but if they survive they grow poorly. (see graph below)

## How well do tree seedlings grow in compacted soil?

Scientists in the U.S. have planted tree seedlings in machine compacted soils. The graph below shows the results. Similar measurements are being done in Alberta.

### SEEDLING GROWTH AFTER FOUR YEARS IN COMPACTED SOIL

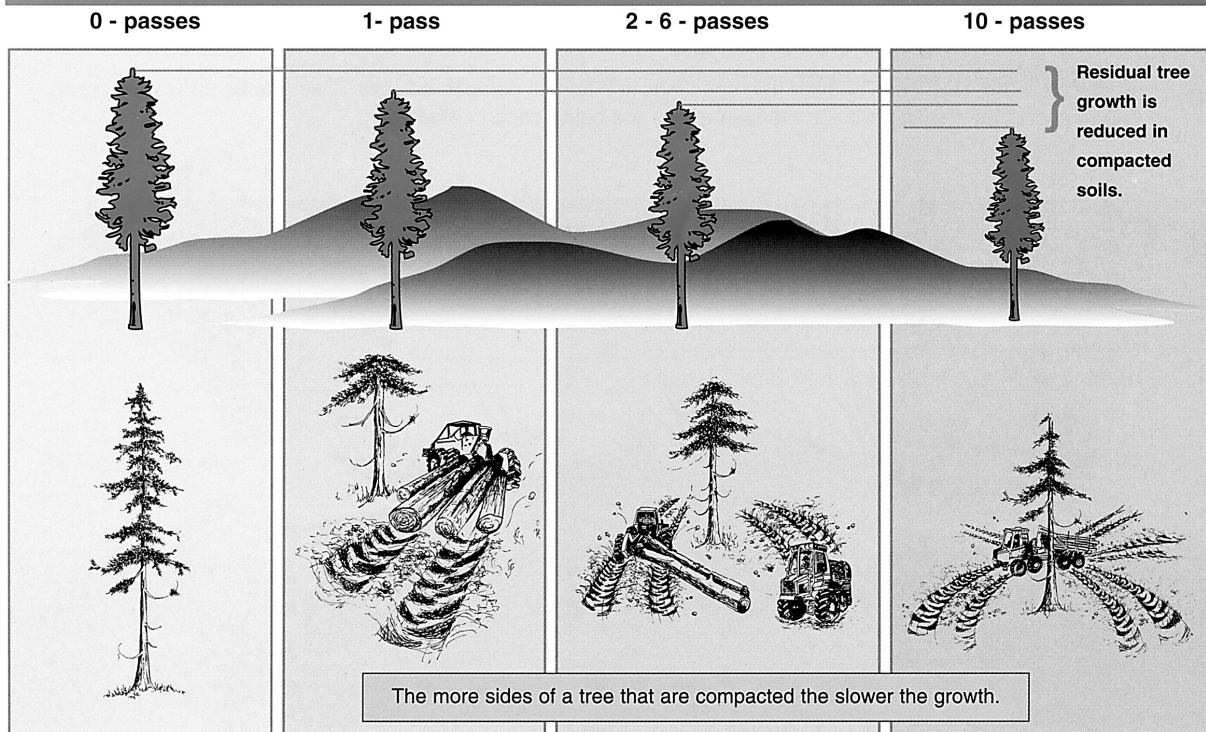
0 - passes      1 - pass      3 - passes      6 - passes      10 - passes



## How deep does compaction reach?

- The most severe compaction is found in the upper 15 cm of soil. Compaction below this level decreases with depth.
- Compaction generally doesn't reach below 35 cm.
- Most of the nutrient and water absorbing roots of trees are found in the top 10 cm.
- 

## EFFECT OF COMPACTION ON COMMERCIALLY THINNED TREES



## How much soil compaction occurs depends on:

- Soil moisture.
- The amount of force and vibration applied to soil.
- The number of passes made over the soil.
- Soil surface litter does not protect soil from compaction.

## How long does it last?

- Under favorable conditions compaction can be reduced within a few years.
- Trees growing in severely compacted soils will grow as smaller trees throughout the rotation.

## What kind of soils recover the fastest from compaction?

- Recovery occurs quickest in the upper 10-15cm of coarse textured soils that freeze one or more times per year.
- Recovery is slowest in clayey soils below 15 cm.
- Soils with very active plant roots and soil organisms recover sooner.
- Soils with repeated freeze-thaw cycles in the same year recover sooner.

*Soils are generally not frozen under heavy snow. However, packing the snow will cause soils to freeze.*



## Measures to reduce compaction

- Minimize the number of passes over the same location.
- Use high flotation tires or low ground pressure track machines.

*Try to skid trees immediately after cutting. Standing trees take up soil water and dry the soil. Once trees are cut, soils will become wet and remain wet if rain occurs.*

*Wide tires cause lower stresses than conventional tires.*



# S OIL RUTTING



*Rutting looks bad.*



*Rutting leaves the impression forest workers don't care about soil.*



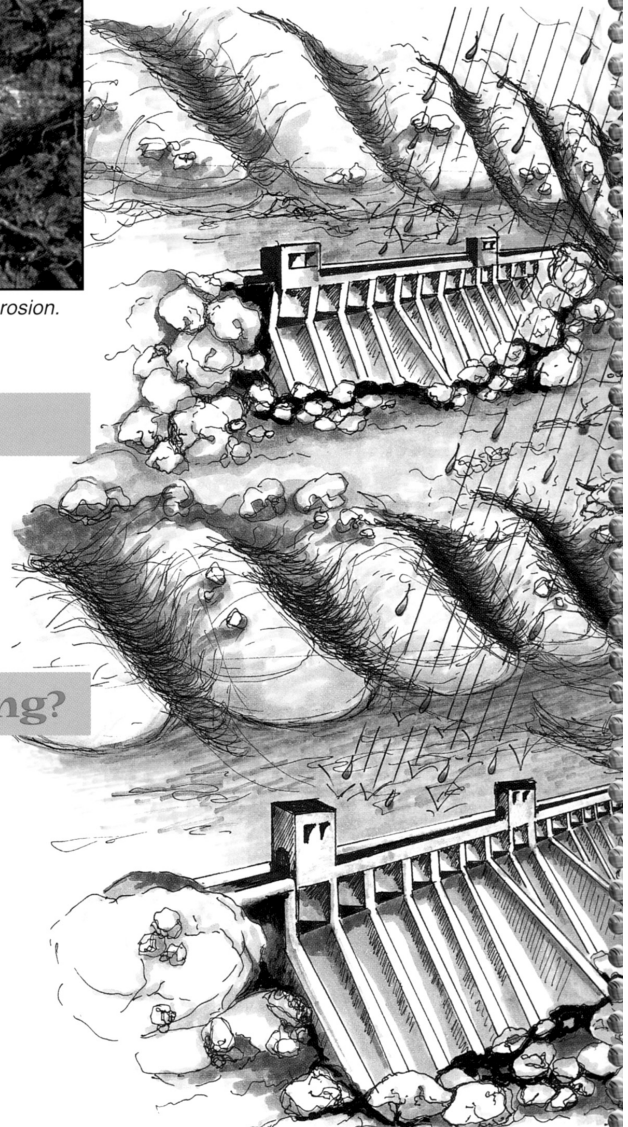
*Ruts become pathways for erosion.*

## What is a rut?

- Ruts are depressions left in the soil by wheels and tracks.
- Wet soils have no strength. Soil flows under the wheels, up and around the sides.

## What's wrong with soil rutting?

- Rutting builds mini-dams on the site and raises the water table.
- Rutting can change the drainage network of a site, making it wetter.
- Trees grow poorly on saturated sites and long-term productivity is reduced.
- Tree root systems are restricted by rutting.
- Rutting around large trees may make them more susceptible to windthrow.
- Rutting can increase erosion and sedimentation.





Avoid springs, soft spots or depressions.



Avoid areas with cow parsnip, fern and sedges. They indicate wet spots.

## How to avoid soil rutting?

- If you're rutting. . .STOP!
- Use good judgement in determining when, where and how to operate in wet soil conditions.
- Use low ground-pressure equipment and flotation tires.
- Consider reducing the weight of transported log loads.
- Avoid potentially wet areas, ephemeral areas or intermittent streams. When disturbed by harvesting or site preparation activities, these areas send sediment to streams. *(see pgs.38-39)*



Ruts interrupt the normal water flow and drainage patterns.



Rutting around trees reduces future growth. *(see pgs.33-34)*



### NOTICE

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