Possibilities to reduce rut formation in logging operations on unfrozen peatland

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Introduction

The low bearing capacity of unfrozen peatland forms difficulties for logging operations. Better information on bearing capacity of logging sites would facilitate improved scheduling of operations. The aims of this work were, to study factors affecting bearing capacity, to form a model on rut formation for peat soil logging operations and to study possibilities to reduce rut formation with high flotation logging machinery and wider logging trails.

Materials and Methods

Field studies were conducted on six drained peatland stands located in Central Finland. The amount of 8 m by 16 m study plots was 30 per site. Logging trails on the plots were either 4.5 m or 6 m wide. Stand properties, vegetation, thickness of peat, moisture content of peat, groundwater level, shear strength of decomposed peat and shear modulus of peatland surface layer were measured before logging.

Harvesting and test drives were carried out from June to November in 2013. Stands 1, 3 and 5 were harvested with an excavator type tracked Prosilva 910 harvester and forest haulage were carried out with an excavator type tracked Prosilva 15-4ST forwarder. Stands 2, 4 and 6 were harvested with an 8-wheeled Ponsse Fox harvester equipped with tracks on both front and rear bogies and forest haulage were carried out with a 10-wheeled Ponsse Buffalo 10w forwarder equipped with tracks on both front and rear bogies. Study plots were thinned with harvester following typical thinning procedures. Timber was hauled to landing with one or two forwarder runs after cutting. After that, study plots were further loaded with two to five passes with a fully loaded forwarder. Ruts were measured after every machine run. The total over-driven mass for each pass is calculated by summing up the mass of the harvester and the estimate of mass of the forwarder (mass of the machine + mass of load) for each time it passes the sample plot.

Results and Discussion

Average rut depths after the fourth passes by site and trail width are presented in table 1. These four passes, including a harvester pass, a driving-while-loading forwarder pass and 2 fully loaded forwarder passes, mimics typical stress to trail in logging. Volume of trees, shear modulus of peatland surface layer and moisture content of peat have significant effect on rut formation. Widening logging trails from 4.5 m to 6 m seems to have significant but relatively small effect on rut formation. Excavator type tracked Prosilva machines produced slightly smaller ruts than wheeled Ponsse machines.

Table 1. Average rut depths after the 4. pass by site and trail width.

	Average rut depth after the 4. pass 4.5 m wide trails	Average rut depth after the 4. pass 6 m wide trails	Average rut depth after the 4. pass, All trails
Site	cm	cm	cm
1	13.47	9.67	11.57
2	11.90	12.55	12.22
3	9.42	10.11	9.76
4	17.20	11.56	14.38
5	7.37	5.41	6.39
6	11.76	11.66	11.71
Total	11.85	10.16	11.01

Study proves that it is possible to execute logging operations successfully on unfrozen peatland with similar machinery utilized in this study. Success of operations requires good planning, well equipped machinery and skilful operators. Successful planning of logging operation includes understanding where landings and main logging trials should be placed. Logging machinery has to meet the requirements that the conditions of a stand at the time of logging necessitates. In these circumstances, tree processing has to be carried out above

the trail, since logging residue has crucial effect on the bearing capacity of terrain. Forwarder operator may reduce rutting by minimizing traffic along the weakest trails and steer machine to go along the trails with highest volumes of standing trees around.

Keywords: peatland, harvesting, bearing capacity, rut formation, wide logging trails, high flotation logging machinery, logging machinery running gear type