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RESEARCH NOTE NC-27

NORTH CENTRAL FOREST EXPERIMENT STATION, FOREST SERVICE—U.S. DEPARTMENT OF AGRICULTURE

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Wetland Road Crossings: Drainage Problems and Timber Damage

ABSTRACT. — More than half the 70 wetland road crossings observed in a northeastern Minnesota survey showed timber killed or weakened by a rise in the water table caused by the damming effect of the road.

A common sight in the Lake States and parts of Eastern Canada is dead or dying timber in patches or strips along one side of a wetland forest road (fig. 1). Cause is failure to provide adequate cross drainage. Such damage is especially prevalent on peatland.

The Study and Its Purpose

As a followup of a previous article on this subject citing European experience and practice, defining the hydrological problems, and describing solutions[1], a survey was made of 70 wetland crossings in seven contiguous counties (Cook, Lake, St. Louis, Carlton, Aitkin, Itasca, and Koochiching) in northeastern

[1] *Stoeckeler, Joseph H. Drainage along swamp forest roads—lessons from Northern Europe. J. Forest. 63: 772-776, 1965.*

Figure 1.—Trees at the right on the "uphill" side of this road crossing a black spruce swamp show depressed growth and poor vigor compared with the normal trees at left on the "downhill" side. Because no culvert was used here the water table was raised about 10 inches. Cattails predominate on the flooded side of the crossing showing site retrogression. Alder, fern, and willow make up the ground cover on the other side.

Minnesota. The purpose was to evaluate tree damage and drainage problems caused by the damming effect of the roads. A starting point was selected at random and the first 10 forest wetland crossings found in each county were taken as they came. The forest types involved were largely pure black spruce, tamarack, and mixtures of the two or with northern white-cedar; the swamp hardwood type was also involved, which included black ash, red maple, and associated species. On the better sites many of these wetland tree species are used for pulpwood.

All but one of the 70 wetland crossings examined in this study were built by township or county road agencies, by forestry agencies, or by forest industry. These roads can be generally classified as low-standard truck trails or timberland roads in terms of width, surface quality, foundation, and drainage. Most were graveled, a few were blacktopped, and one had a dirt surface.

Eighty percent of the crossings were on peat; the rest on mineral soil. The gradient on the swamps ranged from nearly level to 4.7 percent. Two-thirds of the sites had 1 percent or less gradient.

Tree Damage

The tree damage observed was classified into three categories: none, trees killed or weakened within 50 feet of road, and trees killed or weakened beyond 50 feet (table 1).

Occurrence of damage was affected by the direction of the road in relation to the contours of the land. All of the 39 crossings that showed damage were within 45 degrees of being parallel to the contour; in other words, they ran across the drainage flow. Nearly two-thirds of the crossings over peatland showed damage compared with about one-fifth of those over mineral soil. A higher percentage of peatland crossings suffered damage than mineral-soil crossings apparently because there was more of a tendency for the water that flowed in the latter to cut a natural channel into which a culvert had to be set. Hence there was less tendency to have a damming action at such sites.

The apparent rise in water table level (in the zone of most serious tree damage) on the 39 crossings showing tree damage averaged about 11 inches, with a maximum of 30 inches.

The damage in acres of adversely affected tree growth per mile of wetland road crossing varies somewhat with average length of crossing: there is more damage where the swamp crossings are short than where they are long (table 2). The reason for this is that the short crossings are more commonly located at the narrowest point in the wetlands, quite sensibly sought out by the road surveyor. In planimetric view they appear in hour-glass shape. The swamps may be three to seven times wider a short distance "upstream" than at the crossing itself, and poor cross drainage has a pronounced damming effect at these places. Also, it was more common to have no culverts at all on short crossings than on long ones, tending to increase the distance back from the road where timber was killed or growth was depressed.

Based on a general average of 14 acres adversely affected per mile of wetland crossing and a count of the total number of crossings on 46,080 acres of land in Minnesota, it was roughly estimated that there may be about 30 thousand acres of wetland in northern Minnesota where trees are actually killed, where crown vigor is markedly affected, or where natural regeneration is inhibited because of periodic or permanent flooding adjacent to road crossings. Not only is valuable timber destroyed but also the esthetic quality of the roadside landscape is degraded.

Drainage Problems

The chief problems were absence of culverts or other cross drainage, culverts set too high, no collector ditch, no discharge ditch, inadequate collector or discharge ditches, and low culvert capacity (table 3, fig. 2). Many sites had a combination of two or three of these deficiencies.

One of the crucial cross-drainage problems is the shallow placement of culverts. When small-diameter culverts are only a few inches below the surface of the road, they invariably fail to adequately drain the area on the higher side of the road; hence, pools of water form and timber may be flooded for prolonged periods and killed. The "high" culverts are

Table 1. — *Frequency of tree damage observed on the wetland sites*

(In percent)

Trees killed or weakened	On 56 peat-soil crossings	On 14 mineral-soil crossings	On all 70 crossings
None	36	79	45
Within 50 feet of road	30	14	24
Beyond 50 feet of road	34	7	31

Table 2. — *Area of forest land adversely affected per mile of wetland crossing*

Length of crossing (feet)	Sites showing damage	Average length of crossing	Area adversely affected per mile of crossing
	Percent	Feet	Acres
0 - 500	63	305	59.1
500 - 1,000	18	740	33.3
1,000 - 2,000	8	1,530	9.8
2,000 - 4,000	5	2,650	6.4
4,000 - 6,000	3	4,800	6.0
6,000 - 8,000	3	6,600	7.2

Table 3. — *Types of wetland road-crossing problems observed on 70 study sites*

(In percent of sites)

Type of problem	Prevalence[1/]	Sites where this factor was most important cause of timber killing
No culvert or bridge	21	21
Culvert set too high	24	17
Poor culvert capacity owing to siltation	7	4
No collector ditch	23	7
Inadequate collector ditch	10	3
No discharge ditch	16	0
Inadequate discharge ditch	11	3
Beaver (dams or plugged culverts)	1	0
No problem that resulted in timber killing	44	--

[1/] Many of the study areas had two or three of these problems present on the same site, hence totals exceed 100 percent.

sometimes damaged by road-grader blades or snowplows. Capacity of such culverts is reduced and potential life span shortened.

Other problems are lack of stability of ditch slopes or road shoulder, sloughing of soil, and subsequent siltation of culverts. Sometimes dry sticks or other debris may plug up the inlet or outlet of culverts. Vegetation such as willow and tall grass or weeds may also reduce culvert capacity.

The remedy for the culvert problem is to set the bottoms of the culverts in most Lake States wetlands about 1½ to 3 feet below the general level of the swamp surface (depending on swamp gradient, drainage area, and culvert size). Also, there should be provided an adequate collector ditch parallel to the road on its "upstream" side, and beyond any zone of spoil deposit or compaction. An adequate discharge ditch, where necessary, should be carried out at about right angles to the road for several hundred feet or more on the "downstream" side of the road, or a sufficient distance to cross two 1-foot contours and thus avoid any backwater effect. If a naturally incised stream channel is already present, the dis-

Figure 2.—A, culvert set too high, damaged by road grader; B, culvert intake capacity reduced probably by snowplow damage; C, culvert outlet half filled with gravel that sloughed off the road shoulder; D, grass, willow, and chunks of sod constrict culvert entrance; E, a culvert with about half its intake plugged with dry sticks; F, discharge end of a culvert partially plugged with sticks by beavers.

charge ditch may not be required; and, if the "valley" slopes on both sides toward the stream or drainageway at about a right angle, the collector ditch is probably not necessary.

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