ANTHROPOGENIC DISTURBANCE:

Resource Roads

Due to industry activities and public pressure, there has been a growing need to construct new roads to access remote areas. Across the boreal forest, there is approximately **600,000 km of linear disturbances, with roads and seismic exploration accounting for an estimated 80% of linear disturbances.**[1] Road construction typically avoids open-water wetlands (marshes and shallow open waters), but complete avoidance of all wetland types can be difficult and impractical in areas with high wetland abundance.

Compared to uplands, road construction through wetlands presents construction and management challenges due to the presence and flow of surface and subsurface water, saturated soils, and deep peat deposits in organic wetlands. Peat, the organic soil found in organic wetlands, can contain approximately **90-98% water,** making it an unsuitable foundation for roads and potentially leading to challenges with road integrity, safety, and environmental performance.[2,3] Wetland road design and construction practices have improved over time, but may be variably applied across industries, companies, and geographies. Roads can affect wetlands directly (e.g., loss of habitat) or indirectly (e.g., downstream or long-term effects of blocked surface or subsurface flow), as shown below. Though, road builing practices, the use of bridges, and culvert standards, design and layout can mitigate some of the impacts of roads on wetlands. Understanding how roads contribute to the cumulative disturbance footprint in wetlands, and practices that can be employed to mitigate these disturbances is needed to practice ecosystem based management. This factsheet specifically focuses on the impacts of roads to wetland fuctions, with resources on road and wetland best management practices listed in the ***Resources*** section at the end of the factsheet.

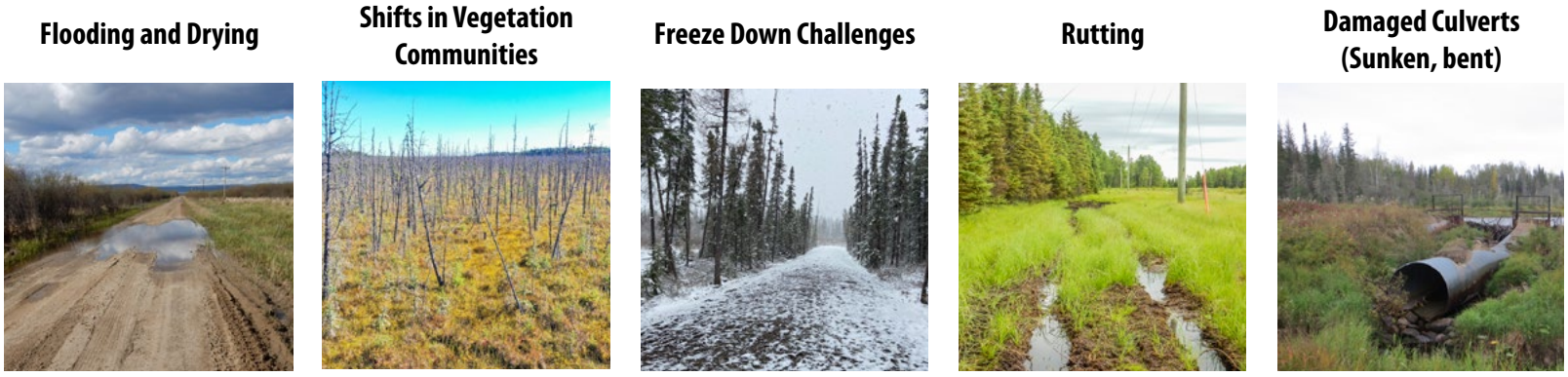


Figure 1. Examples of effects of road construction in organic wetlands.

Effects of Roads on Wetlands

Building roads through wetlands can cause challenges for road construction timing and costs, road performance (e.g., flooding, rutting, icing) and maintenance (e.g., maintaining or fixing culverts, and road safety. In return, roads can also affect wetland function and hydrology in various ways:

1. Roads can alter wetland soils, and therfore their hydrological function.

- Roads built though wetlands can result in **soil compaction**, reducing the soil pore space (by increasing the bulk density) needed for water transmission, often leading to redirection or blockage of subsurface flows.[1,4]
- By disturbing wetland soils for road construction, water movement (e.g., rainfall or run-off) or wind over disturbed, exposed and often dry soil, can reslt in **erosion**. Erosion can affect soil quality, structure, stability, and texture, making it more difficult for plants to establish due to the loss of nutrients and organic matter, and for the soil to retain moisture due to low surface permeability and textural changes affecting water-holding capacity.[5]

- Erosion results in the transport of sediment into nearby wetlands, lakes, and streams, or, **sedimentation**.[6] This results in impacts to water clarity and filling in of wetland habitats initiating changes in vegetation communities, and losses to aquatic invertebrate biodiversity.

2. Roads can affect quantity, timing and direction of overland and subsurface water flow.

- Road surfaces generate **overland flow** as they are impermeable to water, resulting in reduced infiltration rates and increased surface water flow.[4,6]
- Soils with coarse substrates, such as sand, experience greater rates of **subsurface water transmission** compared to easily compactable, organic soils such as those found in peatlands.[7] Roads built in peatlands can result in redirection or blockage of subsurface flows.[3,4]

3. Roads can affect vegetation communities.

- When roads block surface or subsurface flow, flooding on the upstream side of the crossing reduces available soil oxygen resulting in vegetation die off and a shift to water-tolerant vegetation. Drying on the downstream side leads to deeper root growth and increased canopy cover, resulting in vigorous vegetation growth and shifts in understory vegetation communities (see image below).[7,8,9]
- Changes in vegetation communities can reflect changes in wetland types and affect habitat use by species, wildfire susceptibility, traditional uses and other wetland values described in ***Factsheet #1.***

The impacts of roads often outlast the lifespan of the road itself.

When roads are decommissioned and restored, their effects may persist on the landscape, making it difficult to restore a wetland back to its original form and function. Older roads often have greater impacts on wetland flow than new roads, they have not been build to the same standards. New wetland restoration techniques can improve restoration outcomes, but may not reverse long-term changes in wetland ecosystems.[6]

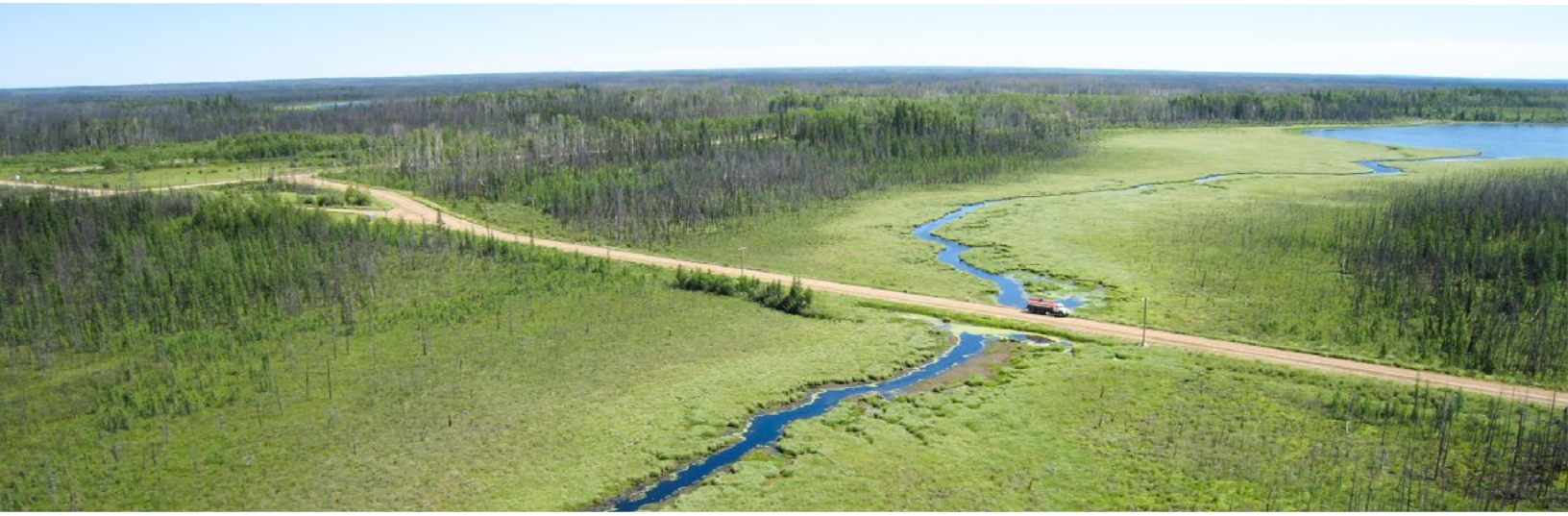
Figure 2. Example of tree mortality and vigorous vegetation growth due to subsurface flow blockage from road construction in a boreal treed fen.

WINTER ROADS

Winter roads are widely recommended to mitigate the impact of wetland road crossings on wetland soil and hydrology.[10] However, research suggests that changes in tree canopy cover and soil compression by heavy equipment may alter local thermal, hydrological, and ecological conditions. Roads constructed in winter conditions can have higher bulk density, shallower water tables, higher graminoid cover, and have been observed to thaw earlier than the adjacent, undisturbed wetland.

Resources:

- Boreal Wetlands Conservation Codes of Practice - Manitoba
- Alberta Watercourse Crossing Collaborative Guide
- Resource Roads and Wetlands: A Guide for Planning, Construction, and Maintenance
- Forest Road Wetland Crossings Operational Guide
- Bocking, E., Cooper, D. J. & Price, J. (2017). Using tree ring analysis to determine impacts of a road on a boreal peatland. Forest Ecology and Management, 24-30, 404.
- Millier, C. A., Benscoter, B. W. & Turetsky, M. R. (2015). The effect of long-term drying associated with experimental drainage and road construction on vegetation composition and productivity in boreal fens. Wetlands Ecology and Management, 845-854, 23(5).
- Sarawati, S., Petrone, R., McDermid, G. J., Xu, B. & Strack, M. (2020). Hydrological effects of resource-access road crossings on boreal forested peatlands. Journal of Hydrology, 584.



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7. Willier, C. N. (2017). Changes in peatland plant community composition and stand structure due to road induced flooding and desiccation. Department of Renewable Resources, University of Alberta.
8. Bocking, E., Cooper, D. J. & Price, J. (2017). Using tree ring analysis to determine impacts of a road on a boreal peatland. Forest Ecology and Management, 24-30, 404.
9. Millier, C. A., Benscoter, B. W. & Turetsky, M. R. (2015). The effect of long-term drying associated with experimental drainage and road construction on vegetation composition and productivity in boreal fens. Wetlands Ecology and Management, 845-854, 23(5).
10. Lauren A, Lepilin D, Uusitalo J, Fritze H, Laiho R, Kimur B, Tuittila ES. 2021. Response of Vegetation and Soil Biological Properties to Deformation in Logging Trails in Drained Boreal Peatlands. Canadian Journal of Forest Research. in press.