



## SFM Network Research Note Series No. 57

# Early stand-level assessment of forest harvesting in western boreal peatlands

### Highlights

- In Canada's boreal region, wooded peatlands comprised of bogs, fens, and conifer swamps make up a significant component of the forest land base and many have marketable-size trees.
- In parts of eastern Canada's boreal region logging of marketable trees in peatlands is common. Since the 1980s protocols have been developed to protect advance growth and minimize site disturbance. Logging of marketable trees in peatlands is uncommon in western Canada, and consequently there is comparatively little research on the effects to peatlands in the west.
- Results from an early (1-12 years) stand level assessment of timber harvest in Manitoba wooded fens have revealed impacts similar to those observed in northern Ontario nutrient-rich peatlands. These impacts include nutrient flushes, water table increases, loss of hummocks, and peat abrasion from wind and sun.
- Further research in Canada's western boreal peatlands is required to determine if early stand level impacts of forest harvesting are long-term, if impacts are comparable between nutrient-poor and nutrient rich peatland types, and between the western and eastern boreal regions.

### Boreal Peatlands

Approximately 20% of Canada's boreal region is covered by wetlands. Most of these are peatlands, which are defined as wetlands with at least 40 cm of moss and sedge-dominated organic soil. Commonly known as 'muskeg', boreal peatlands are comprised of bogs, fens, and conifer swamps (Figure 1).

### Peatlands and biodiversity

Recent studies in Canada's western boreal region have shown that the greatest overall species diversity and number of rare bryophytes (mosses, liverworts, and hornworts) and vascular plants occurs in wooded peatlands. This is particularly true for wooded moderate-rich fens and black spruce swamps. Most species of rare vascular plants in peatlands are orchids or sedges. Less is known of rare bryophytes.

Species diversity in peatlands may be lower than in uplands. However, peatlands have a higher proportion of characteristic species than upland ecosystems in the same region. Peatlands are important for biodiversity far beyond their borders. They maintain hydrological and microclimate features of adjacent areas and provide temporary habitats or refuges for upland species.

### Forest harvest in boreal peatlands: east vs. west

Timber harvesting on peatlands is relatively common in northeastern Ontario and in Quebec, primarily on bogs and black spruce swamps with peat 0.5 to 1.0 metres deep. Since the 1980s, these peatlands

## Peatland Types

**Bogs:** Receive water and nutrients primarily through precipitation and are acidic. Can be dominated by conifers, deciduous shrubs, or sedges. Expansive ground cover of primarily sphagnum and sometimes feather mosses.

**Fens:** Receive water and nutrients from surface or subsurface sources and range from slightly acidic to highly alkaline. Often classified by calciphile indicator species (plants tolerant of alkaline soil) which are generally correlated with surface water acidity: poor (slightly acidic); moderate-rich (moderately alkaline); extreme-rich (highly alkaline). Can be dominated by conifers, deciduous shrubs, or sedges/grasses. Expansive cover of mosses, with a mixture of brown and sphagnum mosses.

**Conifer Swamps:** Usually have dense forests of black spruce (sometimes tamarack or cedar) and are often transitional between uplands and peatlands or water bodies. Black spruce-dominated swamps commonly ring lakes in the western boreal region. Range from acidic and alkaline. Have the largest trees and densest forest of all of the peatland types. Expansive cover of various moss species.

have generally been clear-cut using Careful Logging Around Advanced Growth and other techniques. Specialized equipment has been developed, including tracked or low-pressure high-flotation wheeled equipment. Logging takes place primarily on frozen ground in the winter, but may also be carefully done in the summer under dry conditions. Under this regime, excellent advanced regeneration is realized with minimal damage to the living moss layer. However, snowfall may occasionally blanket the ground before complete freeze-up in the boreal region, delaying deep freezing of the soil and potentially creating conditions for disturbance of the peat.

Currently, peatland logging is limited in the western prairie provinces which may have comparatively more fens and black spruce swamps than bogs than in the wetter eastern boreal region. However, as pressure on timber resources in the southern portion of the western boreal region increases, wooded peatlands may be more commonly selected for forest harvest. As of 2003, less than 17% of the Boreal Plains Ecozone remained as intact contiguous forest. This high level of disturbance is attributed to logging, agriculture, and in Alberta, oil and gas activity. Some fens with peat depths greater than 1 metre have been recently harvested in Manitoba (Figure 2).



**Figure 1.** Wooded peatlands from Canada's western boreal region. Photos courtesy of D. Locky.

## Effects of forest harvest activities in peatlands

Forest harvesting effects in peatlands are similar to many of those observed in harvested uplands. Eastern boreal peatland research indicates these include watering-up, modification of soil



microclimate, loss of nutrients with tree biomass, reduction of soil hydraulic conductivity, introduction of weedy species, formation of shrub communities, and loss of productivity due to paludification (peatland expansion). An early (1-12 years post-harvest) stand level study in west-central Manitoba on moderate-rich fens revealed post-harvest impacts similar to those observed in northeastern Ontario peatlands of various types under certain conditions. These impacts are described in further detail below.



**Figure 2.** Moderate-rich fens logged in Manitoba. Left, one year since harvest. Right, approximately 10 years since harvest. Photos courtesy of D. Locky.

### Nutrients

Significant flushes of nutrients, such as nitrogen and phosphorus, can be released after timber harvesting in peatlands. The increased levels of nutrients may be related to aeration or peat oxidation associated with summer water table drawdowns. Nutrient flushes may accelerate growth of weeds and shrubs in disturbed areas of the peatland. Recent research in Manitoba has shown that nutrient releases are significant but temporary, with nutrient levels moderating after five years.

### Water table

Water table increases are generally proportional to the amount of wood cut on peatlands and are often only observed under the most extreme harvest conditions. In peatlands with saturated soil profiles, water tables can drop due to increased net radiation from the soil and increased evaporation caused by wind exposure in the clear-cut area. In moderate-rich fens in Manitoba, water tables were significantly lower one to four years after harvest, but no difference was found in sites nine to 12 years after harvest.

### Reduced peat depths and peat abrasion

Compaction and oxidation of the peat due to late summer water table drawdown from reduced precipitation will reduce peat depth. Peat compaction can increase bulk density and the capacity to retain water. As well, peat may physically abrade and blow away due to long-term exposure. In moderate-rich fens in Manitoba, peat depths were significantly reduced in logged peatlands, with the effects observed as long as nine to 12 years after harvest. Peat exposed through mechanical disturbance is prone to increased surface temperatures and dryness, which inhibits plant establishment and growth. Patches of moss remaining after harvest may crack and the underlying peat may begin to degrade (Figure 3).

### Advance growth

Preservation of black spruce regeneration after harvest on peatlands is generally not a problem in the eastern boreal region. Current standards including Careful logging around advanced growth (CLAAG) and logging under frozen conditions in the winter have been employed.



**Figure 3.** A remaining patch of glow moss (*Aulacomnium palustre*) in a clear-cut wooded moderate-rich fen exhibits desiccation due to exposure to sun and wind and decreased water table. Photo courtesy of D. Locky.



The use of specialized equipment such as tracked clam-bunk skidders and other equipment with low-pressure high-flotation tires helps to preserve the surface of the moss layer, including hummocks. Hummocks can comprise 35% of the forest floor in some peatlands, but may contribute almost 50% of the conifer regeneration. Loss of hummocks due to heavy equipment use results in a loss of plant microhabitats. In an early stand-level assessment of logging in Manitoba moderate-rich fens, sites with intact hummocks (and more microhabitats) had comparatively higher bryophyte richness and rarity, and increased conifer regeneration. However, black spruce regeneration was suppressed in only the most significantly disturbed sites, which included vast areas of stable shrub communities or weed-filled (e.g., cattails) ruts.

### Native understory plants

In post-harvest peatland sites in the eastern Canadian boreal region (and Europe), site regeneration is generally dependent on portions of the remaining understory taxa (above-ground parts, below-ground parts, and seed bank), rather than a rain of seed from adjacent areas. The presence of understory plants (including bryophytes) is important and may affect the successional direction of the site following harvest. Most seedbeds in the boreal forest are dominated by bryophytes which may either facilitate or hinder seedling survival, depending on the community type and successional stage.

Of the peatland types logged, nutrient-rich sites (such as moderate-rich fens and black spruce swamps) exhibit the greatest changes in the plant community due to disturbance. Compared to bogs, nutrient-rich sites may be more susceptible to released nutrients that result from logging. This is due primarily to post-logging watering-up from reduced transpiration associated with tree removal. Logging may result in loss of diversity and ultimately the alteration of plant community composition in uplands and peatlands. In peatlands, communities of bryophytes, particularly liverworts, may show compositional changes in response to the severity of harvest impacts to the forest floor. Harvest intensity affects plant communities in different ways. Clear-cuts may potentially enact the most significant change to vascular plant communities, resulting in increased plant cover, changes in species composition, and potentially, difficulties in site renewal.

### Weeds

Rutting and other disturbance in peatlands, particularly in more nutrient-rich types such as moderate-rich fens, can result in the introduction of upland, non-native, and invasive plants. As in the eastern boreal region, logging practices in moderate-rich fens in Manitoba that cause disturbance to the peat can create conditions for the introduction of native and non-native weedy wetland species. These include cattails, grasses like bluejoint, and liverworts, some of which exclude most other plants for up to nine to 12 years after harvest (Figure 4).

### Stable shrub communities

Peatlands with organic soils disturbed by logging may be susceptible to the long-term continuity of shrubs. In northeastern Ontario, patches of persistent shrubs may remain on sites for decades and stall succession, and are often referred to as stable shrub communities. The expansion of these dense thickets of alders, willows, and raspberry species on logged peatlands has been associated with the most nutrient-rich sites, such as fens or



**Figure 4.** Profuse growth of green tongue liverwort (*Marchantia polymorpha*) within a log skidder tire rut in a logged peatland (approximately 10 years since harvest). Green tongue liverwort is common in peatlands in small localized patches. However, post-harvest monocultures can establish due to high nutrient and water availability, excluding other plants.

Photo courtesy of D. Locky.

black spruce swamps. Early results from logging moderate-rich fens in Manitoba confirm this (Figure 5). In peatlands, the establishment of stable shrub communities is generally related to disturbance of the peat in association with high water yields from loss of transpiration from trees, which allows wetland shrubs already present to dominate.

## Future research needs

Increased pressure to harvest merchantable timber in peatlands in Canada's western boreal region will increase the requirement for further research. This is particularly important given that recent studies on peatlands in the west have demonstrated that those with the greatest plant diversity and rarity include wooded moderate-rich fens and black spruce swamps. Most research on the impacts of forest harvest in peatlands has been conducted in Canada's eastern boreal region and northern Europe. Impacts revealed in those studies on nutrient-rich peatland types have been mirrored in part in the results of early stand-level research in Manitoba. However, longer-term studies are necessary to determine if some impacts may be similarly enduring. These studies would then be comparable with the longer term body of work conducted on eastern boreal peatlands.

Clear-cutting is the dominant harvest regime currently being used on peatlands in northeastern Ontario. However, alternate methods have been developed and are gaining favour. A comparison of impacts from different cutting regimes in western boreal peatlands would be useful. Also further research is required on the comparative differences of impacts from logging on nutrient-poor bogs compared with more nutrient-rich peatlands, such as rich fens and black spruce swamps.

## Further reading

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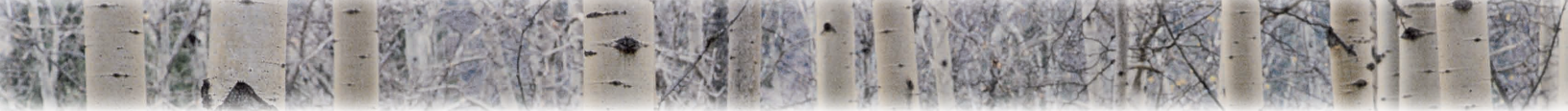


**Figure 5.** Lush growth of alder, birch, and willows in a wooded moderate-rich fen that was logged approximately 10 years ago. These stable shrub communities can remain for decades once established. Photo courtesy of D. Locky.

## Management Implications

- Ensure accurate classification of peatlands when developing forest management plans.
- Apply protocols which protect advanced regeneration such as Careful logging around advanced regeneration and maintenance of hummocks to provide microhabitats for site renewal. Sites which undergo minimal disturbance have a high probability of successful tree recruitment without replanting.
- Use specialized equipment conducive to minimizing site disturbance such as rutting, including skidders and other vehicles with wide tracks or low-pressure, high flotation tires.
- Use specialized equipment in the winter on frozen soils to prevent rutting and ponding of water, thus encouraging tree regeneration and discouraging formation of expanses of weeds and stable shrub communities.





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The views, conclusions and recommendations contained in this publication are those of the authors and should not be construed as endorsement by the Sustainable Forest Management Network.

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