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Boreal peatlands and plant diversity: what's there and why it matters

Highlights

- In the boreal region, knowledge of plant species diversity (richness and rarity) is low compared with other taxa such as birds and mammals. This is particularly true of peatlands, which have a higher proportion of characteristic species compared to upland ecosystems in the same region.
- Peatlands influence biodiversity far beyond their borders by maintaining hydrological and microclimate features of adjacent areas and providing temporary habitats or refuges for upland species.
- Although not yet commonly logged in western Canada, wooded moderate-rich fens and black spruce swamps may have stands of marketable timber. Research has shown that, compared to other peatland types, these types have significantly higher plant diversity.
- Knowledge of plant diversity in peatlands can improve the development of effective forest management plans. What is currently known about plant diversity in peatlands could be integrated into forest management plans at the ecosite and ecoelement scales.

Should plant conservation in western Canadian peatlands be an integral part of forest management activities? This research note introduces the concepts of plant diversity (richness and rarity) in a variety of peatland types from the perspective of forest management.

Forest management and conservation

Conservation in forest management areas is often focussed on mammals, birds, reptiles and amphibians. These taxa are easy to identify by a wide variety of observers and appeal to our higher senses. Consequently, rankings for rare animals are relatively well-known at federal, provincial, and local levels. This information helps foresters to develop and implement effective forest management plans.

Conservation of plants and plant communities in managed forest landscapes is hampered by a lack of information on plant distribution and diversity. One of the challenges in plant conservation is the cryptic nature of some species. This may be due to small size, time of season when emerging or flowering, and specialized habitats that may be difficult to survey. Some taxa, particularly bryophytes (e.g., mosses, Figure 1), are difficult to identify without experience and proper equipment.

Collectively, these factors elevate the cost of conducting plant community surveys, reducing the potential for detailed assessments, and hindering our knowledge of plant communities. This is unfortunate, as plants contribute significantly to overall biodiversity and ecosystem function. Tied to their substrates, they are particularly sensitive to disturbance, thus increasing their potential as indicators of forest management impacts, direct or indirect. Additionally, some plant communities may have high potential for rare species.

Lack of information on plant communities can hinder the development of holistic forest management plans. This is particularly true of ecosystem types that, while appearing to have comparatively less economic value than other types, may be ecologically important on the landscape – including peatlands.

Figure 1. Bryophytes commonly found in peatlands, including Magellan's sphagnum, *Sphagnum magellanicum* (in red) and one of the three common feather mosses, big red stem moss, *Pleurozium schreberi* (in green). Photo courtesy of D. Locky.

Peatlands

Peatlands are wetlands with organic soil at least 40 cm deep. These are the most common wetlands in the boreal region and are comprised of bogs, fens, and black spruce swamps:

- **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.
- **Black spruce 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 to alkaline. Have the largest trees and densest forest of all of the peatland types. Expansive cover of various mosses.

Peatlands and biodiversity

Peatlands are important for biodiversity far beyond their borders. They maintain hydrological and microclimate features of

Rare plant rankings

The federal Species At Risk Act lists rare plants in Canada. However, the rare plant tracking system used by provincial Conservation Data Centres and Natural Heritage Programs is more useful for peatlands. This system tracks plant rarity provincially and globally. Alberta and B.C. rank vascular plants and bryophytes, whereas Manitoba and Saskatchewan rank only vascular plants. For details see Alberta Native Plant Council (2009) in 'Further reading'.

adjacent areas and provide temporary habitats or refuges for upland animals and plants. Plant species diversity may be lower in peatlands than in some uplands, but there is a higher proportion of species characteristic only to peatlands compared to upland ecosystems in the same biogeographic zone. Many plant species only exist in peatlands, and they are adapted to low nutrient availability and water-saturated soils. Peatlands are often the last remaining natural areas in degraded landscapes and thus mitigate fragmentation. They may also support adaptation by providing habitats for endangered species or those displaced by climate change.

Peatlands and plant diversity

Of the peatland types observed in the western boreal region, species diversity (richness and rarity) of vascular plants and bryophytes is highest in wooded moderate-rich fens and black spruce swamps and lowest in bogs and extreme-rich fens (Figure 2). Rare vascular plants observed in these peatlands are commonly orchids (Figure 3) and sedges. (Our knowledge of bryophyte rarity is comparatively poor in western Canada). High species diversity in wooded moderate-rich fens and black spruce swamps is attributable to a variety of factors, but it is primarily governed by the level of pH/alkalinity in the surface water and soil and degree of habitat heterogeneity.

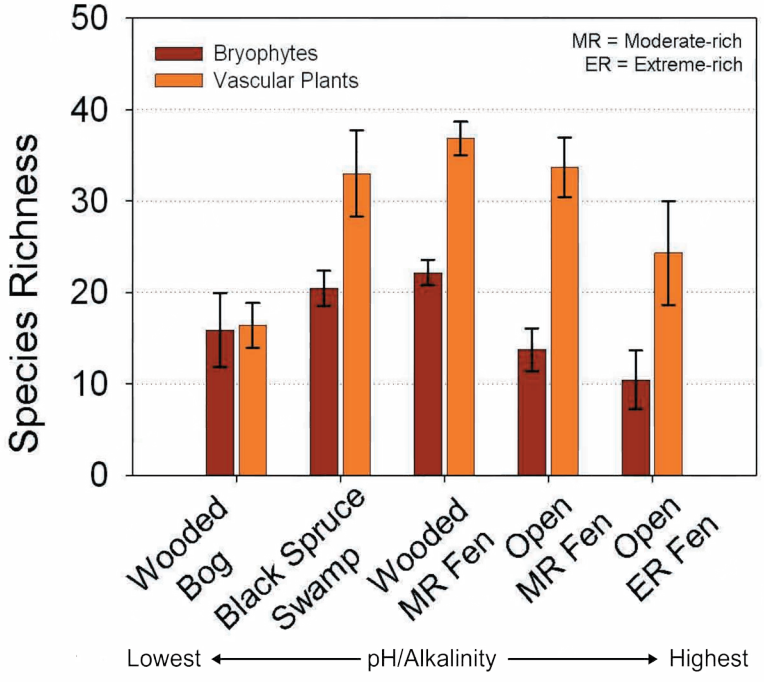
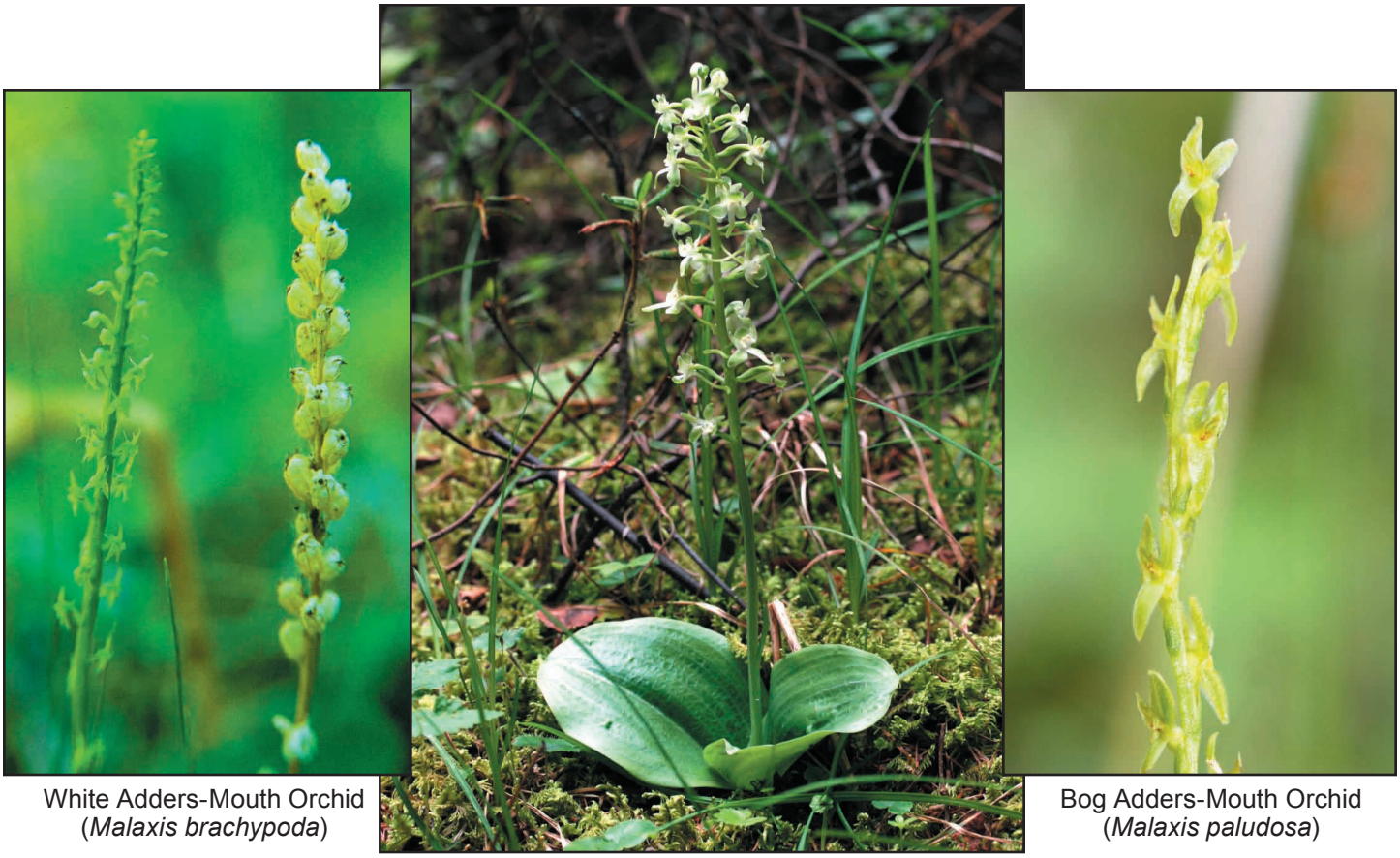


Figure 2. Mean species richness of bryophytes and vascular plants in peatlands arranged along the bog – extreme-rich fen gradient at Duck Mountain, Manitoba. Bars denote 95% confidence intervals which indicate significant differences among groups where there is no overlap (by bryophytes and by vascular plants). See Locky and Bayley (2006) in 'Further reading'.

Moderate-rich fens and many black spruce swamps are in the middle of the pH/alkalinity range (Figure 2). Moderate acidity values tend to improve nutrient availability to plants, increasing the potential for a wider variety of species to be present. At either ends of the range, with highly acidic or highly alkaline water chemistry, diversity is lowest, as observed in bogs and extreme-rich fens. Nutrient availability is low at the extremes of pH/alkalinity and is exemplified by the presence of pitcher plants in both bogs (low pH) and extreme-rich fens (high pH); pitcher plants derive nutrients in nutrient-poor environments from insects.

Moderate-rich fens and many black spruce swamps have comparatively high habitat heterogeneity. This can be described as the rich tapestry of habitats created from the varying layers of canopy and a variety of hummocks and hollows with dry and wet areas (Figure 4). Open peatland types have fewer habitats due to a lack of trees, shrubs, and associated hummocks. Extremes in depth to water table can also reduce plant species richness and rarity; bogs generally have low water tables, whereas extreme-rich fens often have high water tables.

To summarize, wooded peatlands with high habitat heterogeneity, moderate pH/alkalinity, and moderate water table fluctuations are most likely to have the highest plant diversity. These include wooded moderate-rich fens and nutrient-rich black spruce swamps.



White Adders-Mouth Orchid (*Malaxis brachypoda*)

Round-Leaved Bog-Orchid (*Platanthera orbiculata*)

Bog Adders-Mouth Orchid (*Malaxis paludosa*)

Figure 3. Rare orchids found in western Canadian boreal moderate-rich fens. Rarity rankings (S) are from Manitoba. See Alberta Native Plant Council document under Further reading. Outside photos courtesy of D. Locky. Centre photo courtesy of B. Rostron.

Figure 4. Various layers of canopy and drier hummocks with wetter hollows form diverse microhabitats in a wooded moderate-rich fen. Photo courtesy of D. Locky.

Peatlands within the managed forest land base

Peatlands are often considered to be non-harvestable areas and are often excluded from timber harvest activities in a managed forest land base. Thus, plant community conservation may be indirectly occurring through coarse filter approaches designed to protect wildlife habitat or riparian area management. However, peatlands with marketable-size black spruce and tamarack can be logged in winter when the peat is sufficiently frozen to hold heavy forest operations equipment. Although logging is not yet common in western boreal peatlands, these ecosystems may become increasingly important as wood volume decreases in the southern parts of the region.

Forest management planning in Alberta (and other provinces) can include various parameters around modelling conservation efforts during forest development. The approach models various indicators and targets which the company and stakeholders identify as important for sustainable management of the landscape. If information on plant diversity is known (e.g., which plants occur on which sites), it can be included as a variable in the forest development model. Future logging operations can be guided in these critical areas if supported by stakeholder needs and sentiments.

Logging and plant diversity in peatlands

When peatlands are logged, in addition to the loss of overstory cover, changes may occur to the depth to surface water, surface water chemistry, and the peat. Collectively, these changes may impact plant species richness and rarity. Plant species richness in logged peatlands may actually increase by 30% post-harvest for up to five years. However, the colonizing plants are often undesirable invasive species, including many upland species. Loss of hummocks and other microhabitats can significantly reduce bryophyte species richness. Exposed bare peat may dry and abrade, making it difficult for peatland species to re-colonize the surface. Ruts may fill with water during post-harvest watering-up, facilitating fast-growing monocultures of weeds. Extensive shrub communities may develop in disturbed and wet peat, excluding re-growth of peatland plants for decades, further diminishing diversity. Additionally, the nature of peatland plant communities may be changed with the damming or drying of peatlands following road-building. All logging activities have the potential to negatively impact rare species. Hence, the potential for significant changes to the plant community through logging activities is high in peatlands.

Forest managers value development of conservation guidelines for animals, particularly rare ones. The same rationale can be applied to plants, which are a basic component in ecosystems. The suite of species in an ecosystem not only defines the

Management Implications

- Classification of peatland types at the highest possible resolution (e.g., ecosite or ecoelement level) in managed forest landscapes will help to identify sites with potential for high plant species diversity based on known research.
- While our knowledge of plant diversity in peatlands needs improvement, wooded moderate-rich fens and black spruce swamps have been identified as having high plant diversity compared to other peatland types. Elevated conservation values should be considered for these types and subsequently integrated into forest management plans at the ecosite and ecoelement scales.
- Where feasible, support plant community surveys in key ecosystems by qualified botanists utilizing proven methods. These data can help refine conservation planning in forest management areas and, when shared with government agencies, will augment databases on species distributions and refine plant species and plant community rarity rankings.
- When logging and working in peatlands, minimize site disturbance by choosing proper equipment and timing activities when peatlands are frozen.

system, but is part of the structure and functioning of the system. Currently, our knowledge of plant diversity in peatlands is still developing. However, what we currently know could be integrated into forest management planning at the ecosite and ecoelement levels.

Further reading

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Written by: David A. Locky
Athabasca University, Edmonton, Canada

For more information on the SFM Network Research Note series and other publications, visit our website at http://sfmnetwork.ca or contact the Sustainable Forest Management Network
University of Alberta, Edmonton, AB. Tel.: 780-492-6659. Email: info@sfmnetwork.ca

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