Manitoba Peatlands

A Conservation Effort

Nicole Laurila & Andreanna Willems

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1.0 Wetlands and Peatland Biology

1.1 Introduction

Peat is a product of peat forming wetlands; peatland is the word used to describe a peat-covered landscape. Peatlands occur on all continents; most peatlands are found in the boreal regions of the world, although there are subtropical and tropical peatlands in the south.

1.2 Ecological Succession

Wetlands are vulnerable to man-induced and environmental changes because of their changeable nature. There are distinct zones of different vegetation that grown in rings in wetland areas. The fate of many wetlands that go through natural succession, is to become permanent or semi-permanent shallow lakes. Successive plant communities alter the ecosystem processes and functions, and therefore habitat suitability for different species, as well as ecological goods and services (Rydin et al 2006).

Submerged and floating leaved vegetation are the first to colonize a small pond area. The organic matter that accumulates because of these aquatic plants gradually deposits along the bottom of the pond (Rydin et al 2006). This can be a gradual process, which eventually fills the pond, making it shallow and advancing the shoreline into the lake area. When the substrate is composed of partially decomposed organics, this is when peat accumulates. As the water becomes shallower, emergent species will dominate the area, and they function to impede water movement, trap sediment and shade the under-water vegetation. Larger terrestrial plants, such as water-tolerable trees and shrubs, will begin to establish themselves along the edges of the basin in the areas that may flood on a seasonal basis. Domination of terrestrial trees changes the ecozone of the area from wetland to woodland ecosystem. There wetness of the area will change as the dominant vegetation changes. This succession process happens naturally to all wetland areas, but has been further described in the Van der Valk and Davis model of the wet-dry cycle of marshes.

1.3 Wet-Dry Cycle of Marshes

As described by the Van der Valk and Davis model, the wet-dry cycle of marshes is an integral part to wetland health. Marshes in nature typically go through wet and dry stages. With these wet and dry stages, there are continually changing seasonal water levels, which influence the amount and types of vegetation present, and in turn the amount and types of wildlife attracted to the ecosystem.

The dry-marsh stage occurs as a result of a drought or induced drawdown. With the absence of water, both terrestrial and emergent vegetation have an opportunity to reestablish by seed germination or rhizomal growth (Murkin et al 2000). Terrestrial vegetation may include those plants such as willows, grasses and sedges, and emergents include typical wetland vegetation such as phragmites, cattail and bulrush. During this stage, some species of aquatic invertebrates may leave the area and recolonize elsewhere; others may go into a dormant, drought-tolerant stage, whereas the rest without drought-resistant capabilities will expire (Murkin et al 2000).

As water refills the depression, the wetland regenerates out of the dry-marsh stage. Terrestrial vegetation is drowned out and emergent plant species begin to thrive (Murkin et al 2000). With standing water, submerged vegetation will begin to colonize, along with aquatic invertebrates. The marsh moves into a state of high productivity in both the algal and macrophyte communities, and more fauna are attracted to the wetland (Murkin et al 2000). Waterfowl are attracted to areas with an abundance of emergent vegetation as it blurs the sight lines between territorial nesting pairs, which allows for a higher density of birds in an area.

Standing water will eventually cause a reduction in the amount of emergent vegetation in the basin of the marsh and can be replaced by submerged vegetation

(Murkin et al 2000). With the lack of emergent vegetation, the amount of dissolved oxygen in the water will also decrease. There is an increase in benthic invertebrates, those that live in the sediment and are tolerant of poor water quality (Murkin et al 2000). At this point, waterfowl numbers are beginning to decrease because of the lack of diversity of invertebrate as food sources under water, and lack of cover above the water.

Prolonged periods of standing water will drive a wetland into a lake-marsh stage (Murkin et al 2000). At this point, there is a general decrease in plant matter; emergent vegetation is confined to the edges of the marsh area and submerged vegetation begins to disappear from the deeper parts of the basin (Murkin et al 2000). There can be an increase in phytoplankton depending on the nutrient availability and the most common invertebrates are those living in the benthos. Some types of waterfowl are still attracted to the area, mostly diving and piscivorous birds.

Somewhere in between the dry and lake-marsh stages, there is an ideal state which optimizes both vegetation and wildlife in a wetland. A hemi-marsh condition is where the wetland characteristically has a relatively even interspersion of open water and emergent vegetation. This hemi-marsh state is ideal for any plan wishing to manage for wetlands.

1.4 Wetlands

Wetlands can be characterized by low topography that causes unique hydrology in an area; the hydrology allows water to sit and accumulate in an area which leads to poorly aerated soil. Wetlands are:

"…areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres" (Rydin et al 2006).

Some sources define wetlands to a narrower scope, including the Canadian Wetland Classification, where a wetland is defined as

"…land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrophitic vegetation and various kinds of biological activity which are adapted to a wet environment" (Rydin et al 2000).

1.5 Types of Wetlands

There are four ecosystem classes of wetlands identified in Canada: marsh, swamp bog and fen. Each of these terms are used for different wetland ecosystems that provide similar ecological goods and services. They meet the characteristics of wetland areas, but each type is different in its own way.

Marshes are characterized by slowly moving or standing water and are dominated by emergent vegetation such as cattail, bulrush and reed grass; they can be seasonally or permanently flooded with a high fluctuation in water levels (Rydin et al 2006, Murkin et al 2000). Marsh ecosystems are sustained by sources of water other than just precipitation; they are also nourished by overland flooding and ground water systems. Marshes are not known as wetlands that accumulate large amounts of peat, and because of this they are not considered peatlands. Freshwater marshes account for a large percentage of the world's temperate wetlands; they are found at all latitudes where ground water, lakes or springs cause frequent flooding (Rydin et al 2006, Murkin et al 2000). Depressions in floodplains left behind by glaciations are referred to as pothole marshes. Saltmarshes are also common at estuaries and play an important part in the spawning, nursery and feeding requirements of some marine organisms (Murkin et al 2000).

Swamps are thicketed wetlands, often characterized by the presence of trees and tall shrubs; most swamps are often dominated by a single woody species and named as such. The soils of swamps and swamp forests are rich in organics, and can be considered peat forming wetlands, or a transition between forested area and peatland. Swamps are flooded for most of the growing season; this aids in the formation of peat because of the water saturated conditions (Rydin et al 2006, Murkin et al 2000).

Bogs are topographically high wetland areas, and are isolated from the ground and soil waters. Because bogs are ombrotrophic systems, there is less chemical variation than that of fens (Rydin et al 2006, Murkin et al 2000). Vegetation characteristic of bags are trees and shrubs with stunted growth, because of the extremely nutrient poor and highly acidic soils. The true meaning of 'bog' has been designated to mean ombrotrophic peatland, but is also a term used to describe *Sphagnum*-dominated peatlands. Blanket bogs are a peat covered landscape where the peat has expanded beyond the basin of the wetland. When peat forms upwards in a dome shape, the bog may grow to the point where it is no longer in a water-saturated state; this is known as a raised bog (Rydin et al 2006). Bogs can be classified by different types of tree cover. They may be treeless, treed only on the edges, or treed throughout.

Fens are considered peatlands because they accumulate a deep layer of peat. Fens are more open than swamps, in the sense that fens are not characterized by tall or many trees, instead mostly sedges, grasses and low shrubs (Rydin et al 2006, Murkin et al 2000). Fens accumulate peat, similar to bogs, but they have a higher nutrient content than bogs, and therefore more variation in vegetation (Rydin et al 2006, Murkin et al 2000). A mire is a term for wet terrain that is dominated by peat forming plants that are still living. A mixed mire is a type with bog and fen features (Rydin et al 2006).

Ombrotrophic wetlands are purely rain-fed water systems, and do not have contact with the ground water (Rydin et al 2006). Wetlands that receive mineral nourishment from the ground water are known as minerotrophic. Minerotrophic fens, swamps and marshes have a higher pH and usually more nutrients. The higher nutrient availability and variation in the pH allows for more biotic variation in the area as well. Ombrotrophic bogs are considered to be peatland areas that are nutrient poor and highly acidic. Northern temperate bogs tend to be more acidic due to the dominant vegetation, *Sphagnum sp*., and the low amounts of incoming rainwater (Rydin et al 2006).

1.6 Accumulation of Peat

Not all wetlands have the correct conditions to allow peat to accumulate in large amounts. All wetlands may produce peat, but areas will only be considered peatlands if the underlying peat layer is greater than forty centimetres in depth. Anoxic conditions, combined with seasonally low temperatures, allows peat to form and accumulate in layers in specific wetland areas (Rydin et al 2006). Low oxygen and acidic conditions are required for the formation of peat; as peat accumulates, it causes more acid and nutrient poor conditions, proving positive feedback.

Peatlands can have several metres of peat that accumulates over thousands of years. Peat is essentially incompletely decayed organic matter; it is the remains of plant and animal parts that do not fully decompose because of their placement in water saturated conditions. Much of the plant matter that makes up peat has a low ability to decompose, and this also helps to slow the process; most of the plant material is from parts below the ground, such as roots and rhizomes. In swamps, because of the high density of trees, woody materials are a large component of the peat matter.

1.7 Formation of Peat

All peat forming processes create drainage conditions that facilitate peat production; these are positive feedback mechanisms. Essentially, the more peat that is produced, the more peat that will be produced.

Infilling is a primary process, meaning it occurs in an area where there has been no prior formation of peat. It occurs when aquatic vegetation completely fills in a pond or water filled depression. This is a result of an anaerobic environment where temperature and microbial activity are low (Rydin et al 2006). During the infilling process, peat accumulates on the edges or shallows of ponds, lakes, or other slow flowing water bodies. The infilling may continue to fill the basin completely, or it may process into a bog ecosystem. The final succession stage after infilling will depend on the hydrologic situation. Some basins that have rising water and continuous accumulation of peat may maintain themselves as wet, slowly growing peatlands, where others will transform into marsh or fen communities (Rydin et al 2006).

In primary peat formation, layers in the soil will prevent downward penetration of water; this is the humus or clay layer (Rydin et al 2006). This creates persistently wet conditions that allow for the accumulation of organic matter that will form into peat. Primary peat formation occurs on freshly exposed, wet soil.

Paludification the term for secondary processes of peat production. This is when peat forms on previously less wet mineral ground (Rydin et al 2006).

1.8 Peat Composition

Although peat matter itself is not a living organism, there is a variety of microorganisms living within the peat that act to slowly decompose the organic remains (Rydin et al 2006). The texture and decomposition of the organics in the peat vary from very fibrous and poorly decomposed, to weak and very decomposed; this is because of the varying rates of diffusion of oxygen and water through the peat layer. The water saturated soil acts as an insulator to the peat layer underneath and allows more peat to accumulate in cool conditions (Rydin et al 2006).

The physical properties of peat that can be measured to determine quality include fibrosity and humification, density, porosity and water content. Botanical composition determines the fibrosity and humification of the peat. Fibrosity and humification are terms for how much of the original plant material is left at pre-decomposition state (Rydin et al 2006). Humification is the concept that determines how decomposed the peat is (Rydin et al 2006). A high-fibre content is associated with low humification (Rydin et al 2006). Bulk density is measured from dry peat matter, and water content is measured as a loss of mass from wet peat to dry peat.

2.0 Peatlands-Ecological Functions

"By clearing vegetation, draining bogs, and extracting peat, the Canadian peat industry has substantially altered the character of more than 100 km^2 of peatland." (Cleary et. al., 2005)

2.1 The Carbon Cycle and Additional Greenhouse Gases

Peatlands are a significant part of the boreal forest biome, considered to be one of Earth's biggest terrestrial carbon sinks as it can store nearly twice as much carbon as tropical forests. This is due to the annual net accumulation of biomass associated with boreal soils, permafrost deposits, wetlands and peatlands (Carlson et. al., 2009). Peatlands therefore characterize a major storage of carbon, playing an integral part in the global carbon cycle (Strack et. al., 2007). The main route in which carbon enters the peatland system is the through the process of plant photosynthesis, which use CO_2 as part of its respiration, where is stays in the plant material until the organism dies and begins to decay (Charman, 2009). The method in which peatlands prevent or delay the decomposition of biomass was previously discussed in this paper in terms of environmental factors facilitating organic matter accumulation over long periods of time.

In addition to acting a carbon sink, peatlands will release carbon as well. Some carbon is returned to the environment through the decay of the peat (Baird et. al., 2009 – From book). This decay can stem from both natural and anthropogenic changes to the peatlands water table, increasing decomposition through exposure to oxygen in the atmosphere (Strack et. al., 2007). During the decompositions process, the carbon can be transformed into a few different forms (Charman, 2009).

One such form is dissolved organic carbon (DOC), which can then leave peatlands through drainage waters. DOC can be viewed as an important aspect of peatland carbon budget and therefore for peatlands relationship with Earth's carbon cycle. (Charman, 2002). The DOC found in peatland drainage and runoff comes in the form of organic acids such as fulvic and humic acid. Such acids have implications on water quality as they raise the pH of these runoff waters (Charman, 2002). A study by Schiff et. al., 1998 found that the concentration of DOC can be higher after dry peat conditions as these acids had more time to form through breakdown of plant biomass.

Decay can also lead to gas production. The production of such gases can occur in different regions of the peat that are defined by the level as well as fluctuations of the water table (Charman, 2002). Depending on whether the decomposition aerobic or anaerobic will largely determine the types of gases being produced (Charman, 2002).

Not CO_2 but another significant greenhouse gas, CH_4, is also produced in peatland environments. Peatlands happen to be the biggest "natural terrestrial source" of CH_4 entering the atmosphere (Baird et. al., 2009 – From book). This atmospheric CH_4 is attributed to the anaerobic decay taking place in water saturated areas of the peatland (Baird et. al., 2009 – From book). The gas is produced by processes facilitated by methanogenic bacteria in this anaerobic zone. CH_4 production is largely dependent on environmental controls such as the water content, peat composition, temperature, nutrient and acidity (Charman, 2002). Peat composition will determine the type of the methanogenic bacteria present as well as the bulk density of the peat which can affect gas flow out to the atmosphere. Temperature displays a complicated relationship with the emission of CH_4 as higher temperature can increase production but can result in lower water tables and thus aerobic conditions. Low acidity has been linked to lower CH_4 emission (Charman 2002).

CO_2 in peatlands is produced not only through decomposition of organic matter, but through anaerobic decomposition as well. It is also emitted through plant respiration, especially in the root zone in the peat (Charman, 2002). The environmental controls on CO_2 gas emission from peat are similar to that of CH_4 including temperature, peat type and water content. However, the level of the water table will have the opposite effect on CO_2 emission as a higher water level will depress production (Charman, 2002).

Also significant in the peatland carbon cycle are the rates of plant respiration and photosynthesis, as these factors combine to determine the net ecosystem exchange (NEE) (Charman, 2002). This means that if the NEE is positive, the peatland is sequestering carbon. However, if the NEE is negative, it is acting as a source (Charman, 2002). It has been determined through experimentation that the balance between positive and negative NEE is very fine and can be influenced by environmental factors in either direction. The strongest of these factors appears to be moisture. Enough water is a very limiting factor for the growth of certain peatland species of plant and when this level is below optimal, photosynthesis can decrease rapidly leading to a negative NEE value (Charman, 2002).

One green house gas produced by peatlands that generally receives little attention is nitrous oxide (N_2O), a gas that is both consumed and produced by soil (Charman, 2002). It has been estimated from studied that significant amounts are not produced from natural peatlands, however estimates may vary. It has been determined production may be much higher in drained or otherwise damaged peatlands (Charman, 2002).

2.2 Catchment Hydrology and Water Quality

Water exchanges between peatlands and the adjoining areas is one way these wetlands can influence their environments. Peatlands can receive water from both precipitations as well as groundwater flow (Charman, 2002). Although at first it seems reasonable to assume that peatlands may act as sponges that can soak up excess water during wet periods and release water during dry periods, this is not the case. Peatlands can be up to 95% water but only a small quantity of this stored water is exchanged with outside landscapes (Charman, 2002). However certain types of peatlands may impact the hydrology of surround environments. Sloping and valley fens allow water drainage some their systems due to the slope gradient. Low-lying flood plain and basin fens will accumulate and store run-off simply because they are the lowest topographic features in the landscape (Charman, 2002).

Through experimentation is was found that under moist conditions result in delayed run-off from the peatland for 3 to 6 hours compared to mineral soils. After the peatland had been under dry conditions, this delay was extended to 22 hours (Charman, 2002). This significant increase in run-off delay can be attributed to a lower water table increasing the water storage capacity prior to the precipitation event (Charman, 2002).

Peatlands, under normal conditions generally do not contribute a significant amount of suspended sediment to their run-off (Charman, 2002).

Peatlands can either become a net sink or source of nutrients to their catchment area. This will depend on if there is any damage to the peatland as well as the rate of peat accumulation (Charman, 2002). The accumulation of peat requires the growth of plants that require nutrients to develop. Studies in the Florida Everglades have also found uptakes of phosphorous that exceed predictions based on biotic activity (Charman, 2002). These systems can become a source of nutrients to adjacent waters when they are disturbed by natural events such as forest fires and dry periods, or damage through anthropogenic drainage.

2.3 Wildlife

The nature and distribution of peatlands mean they offer unique living conditions of values to many species of wildlife. Despite disturbances to these ecosystems, peatlands (especially in Northern regions), are regarded as some of the last truly natural landscapes in the world (Charman, 2002). This can be attributed to their general inhospitality when in a natural state (wet, cool, acidic soils…). This makes peatlands very valuable in terms wildlife conservation (Charman, 2002). We will now look at two virtues of these ecosystems in terms of their importance to wildlife.

The first virtue of peatlands for wildlife conservation is the fact they are home to many rare organisms that are specific to these regions. Even when peatlands are not exactly necessary for the survival of the species, they are needed to maintain substantial numbers (Charman, 2002). Additionally, peatlands themselves can be rare in certain parts of the world, with numbers shrinking especially from human activities, making conserving peatlands themselves a priority (Charman, 2002).

As previously mentioned, most intact peatlands are generally found in a natural or very near-natural state. This can be very significant as natural habitat is rare and at a premium for endangered and at risk species (Charman, 2002).

3.0 Peatlands- Economic Functions

Peatlands in Canada as well as the rest of the world as used/altered by humans for a variety of different reasons, in a variety of different ways. These exploitations and land-use alterations provide many economic functions which will be explained below.

3.1 Agricultural and Forestry Value

As previously mentioned, in Canada and most of North America the most significant caused of peatland destruction is for extraction, specifically for horticultural use. However, to a lesser extent, other peatland exploitations exist, even if they are more prominent in other countries. One of these other exploitations involves the conversion of peatlands to areas suitable for agricultural or forestry (Charman, 2002). Peatlands, like most wetlands, have been historically viewed as waste-lands that provide to value to humans and this conversion takes place to improve the economic potential of these areas (Charman, 2002).

3.2 Peat Extraction

The peat itself can be extracted through peat mining with the product being put to a few different uses.

In Canada and the United States, the most common use for peat is for horticultural reasons. This is due the specific physical and chemical properties of the peat that make it an excellent soil conditioner whether it is used on its own, or blended with other materials (Charman, 2002). The structure of the peat provides an optimum water holding capacity, while still allowing adequate aeration. A low bulk density means it is light and easy to handle process and transport to garden centres for sale (Charman, 2002). Its high acidity translates to a low pH that can be easily altered to any desirable amount. Similarity, it's low in nutrients so they may be added to attain any necessary amount or combination (Charman, 2002).

The horticultural peat industry took off in response to the explosion in popularity of amateur gardens that came in the post-war era (Charman, 2002).

Peat has also been extracted as a form of fuel for the last 2,000 years, beginning in mainland Europe. This practice was brought over to the New World with the early settlers, and thus peat exploitation for fuel has a long been established in both Europe and North America for many hundreds of years (Charman, 2012). The use of peat as a fuel has been declining over the last century; however it is still used in Northern Britain as well as Ireland. Despite this decline, peat is still used a fuel for the generation of energy in many European and Norwegian countries. This translates into 71 million m^3 of extracted peat being used for energy production. The table below illustrates the peat production for energy use by country as of the year 1996 (Charman, 2012).

Table 1: This table displays the country by country break down of the 71 million m^3 of extracted peat used for energy generation. Recreated from Charman, 2002.

Country	**Energy Peat Production (1000m)**
Finland	24 000
Ireland	15 000
Belarus	12 000
Russia	9 000
Ukraine	4 000
Sweden	3 200
Estonia	1 800
Latvia	1 040
Germany	600
Lithuania	214
Great Britain	100
Total	**71 000**

Peat mining combined with the burning of peat presents interesting consequences for peatlands role in the global carbon cycle in terms of both the damages peatlands, as well as the carbon emissions through combustion.

Peat is also extracted for other more minor industries. These include “peat baths” that used for therapeutic reasons. This is known as balneology (Charman, 2002). This practice involves a mixture of peat water that is then heated. The patient with then immerse themselves in the mixture for approximately 20 minutes to help heal aliments such as rheumatism, gynaecological disorders and other medical issues (Charman, 2002). Another minor use for extracted peat is the filtration of water. There has been some research into this use that can help treat waste water sewage, oil spills and heavy metal contamination (Charman, 2002). Finally, the *Sphagnum* moss presents another minor industry revolving around peatland extraction. The *Sphagnum* moss provides material to line plant containers and is sometimes used for decorative purposes (Charman, 2002).

3.3 Recreational Use

Peatlands are generally not overly popular areas for recreational activity when contrasted with other types of natural and semi natural areas, for example, mountains and beaches. It is sometimes said that the most frequent human peatland visitors are the scientists that study them (Charman, 2002). Peatlands can become a draw as they are sometimes the last areas seen as true wilderness in a landscape. Their wildlife can attract visitors through hunting and other activities (Charman, 2002). However, it appears that even moderate trampling from visitors can adversely affect the peatland ecosystem. Particularly in Manitoba, the placement of transmission lines has lead to impacts from the cutting of trees, vehicle traffic, and herbicide use (Charman, 2002). The impacts themselves were damage to vegetation in terms of cover. The amount of bare peat was increased from loss of moss and herbicide targeted plants (Charman, 2002).

4.0 Peat Extraction- A Detailed Look

4.1 A Brief History of Peat Extraction

Peat extraction in Canada can be traced back to origins in Quebec and Ontario starting in the 1860s. As of the 1930s, Canada became the small scale export of peat to the United States due to shortages of European exports due to the Second World War (Warner, 2000). World War II opened the doors for the Canadian peat mining industry, molding it into what it is today. Peat has been produced in every province in which it is present including British Columbia, Ontario, Quebec, New Brunswick, Manitoba and Alberta (Warner, 2000).

During the early years of Canadian peat extraction, most peat production was for fuel (Warner, 2000). The years post-World War I to the 1940s represent transitional years where producing peat for fuel was slowly shifted to producing peat for its other uses. Peat use expanded to animal bedding, horticulture, packing material and insulation (Warner, 2000). The 1950s mark the beginning of the modern peat industry by the shift largely horticultural peat (Warner, 2000).

Specifically in the province of Manitoba, 1941 marks the first commercial peat mine by Winnipeg Supply and Fuel Company in Julius Bog. In 1969, western Peat Moss Limited operated at Medika Bog in the Winnipeg region (Manitoba Conservation, 2012). In 1972, the Evergreen Peat and Fertilizer Limited company started peat moss production in Evergreen Bog. This bog was also located in the Winnipeg region (Manitoba Conservation, 2012). Premier West Peat Moss Limited started mining peat in a few areas in 1987. This included Giroux Bog, the Winnipeg Region and Caribou Bogs near the town of Hadashville (Manitoba Conservation, 2012). In the year 2002, Sunteera Horticuluture started peat production in Beaver Point. In 2008 Berger Moss Limited started production in a bog in Hadashville (Manitoba Conservation, 2012).

This brings us to June 2011 where the Save Lake Winnipeg Act was given royal assent on July 16, 2011 and passed into law. The new act puts into a motion a few different initiatives to improve the quality of Lake Winnipeg including a moratorium on giving permits or leases to peat extraction projects for two years (as of June 16, 2011) (Manitoba Wildlands, 2012). However, even with this moratorium, several peat mines project proposals have gotten the government ok to proceed. These newly granted licenses were grandfathered, meaning they were able to by-pass the new legislation due to pre-existing rights (Prystupa, 2012).

A list retrieved from the Manitoba Wildlands website shows some of the peat mine projects which have received licences include:

- Berger Peat Moss Ltd's Deer Lake Harvesting Development (Granted July 20, 2011)
- Sun Gro Horticulture Canada Ltd's Ramsay Point Peat Mine Development (Granted June 29, 2011)
- Jiffy Canada Inc's Peat Mining Development at Poplar Creek Bog, Haute Bog and Boggy River Bog (Granted July 18th, 2011)

One other project is currently undergoing review. This is Sun Gro Horticulture Canada Ltd's Hay Point Peat Mine Development. Comments were due January 16th, 2012 but were extended until February 3rd, 2012 (Manitoba Wildlands, 2012). Additionally, this proposed development takes place in the Hecla/Grindstone Provincial Park and would involve an area of 531 ha. Many argue whether this type of development is appropriate to take place in a provincial park (Turene, 2012).

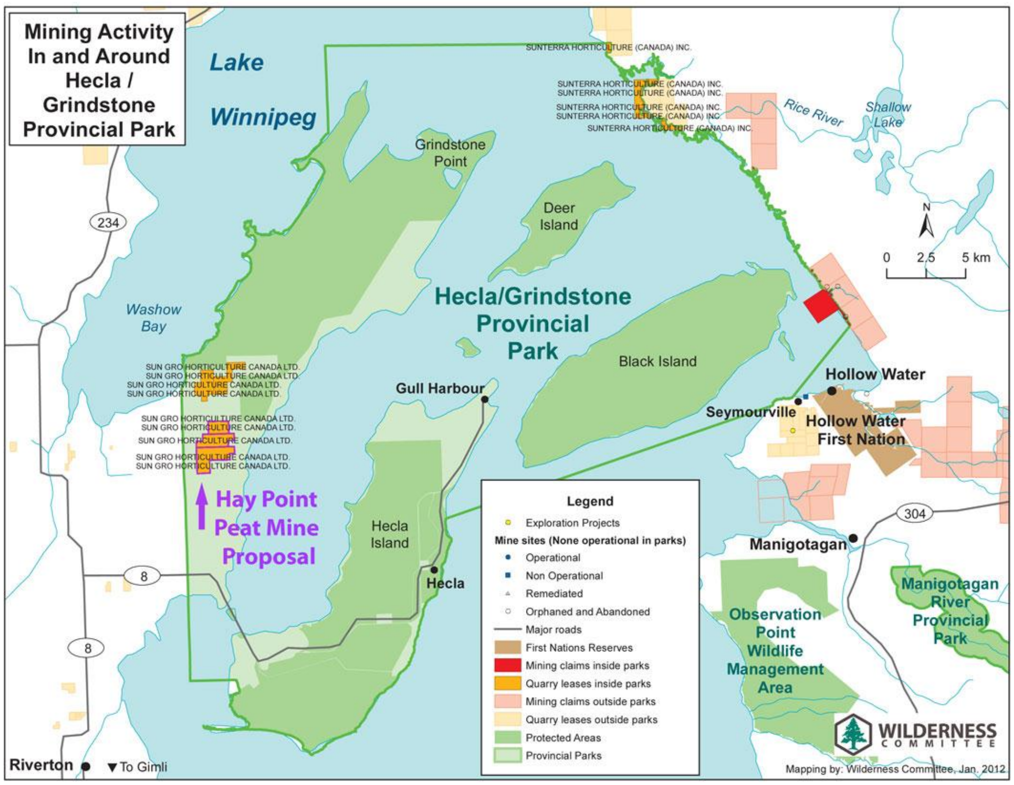

Figure 1: This picture displays the proposed Hay Point Mine location. It is very clearly situated inside the Hecla/Grindstone Provincial Park. This is an issue for some people as they believe such developments have no place inside a park area.

As the moratorium is for 2 years, this will expire on June 16th, 2013.

Presently in Canada there is approximately 17,000 ha of peatland that is being used for peat extraction, with 5,000 ha more being developed in the next 10 years (PERG, 2012). The industry creates around 3,000 jobs, both seasonal and permanent (PERG, 2012).

4.2 Methods of Peat Extraction

The extraction of peat, no matter what its ultimate use may be, involves a basic series of procedures. Drainage is almost always the essential first step in the mining process to dry the peat and make it more manageable to extract, process and transport (Charman, 2002). Controlling the hydrology of the peatland is necessary for its successful exploitation.

Drainage of a peatland can be accomplished in a few different using a few different methods. Direct drainage involves the excavation of ditches around the wetland to remove water from the area (Charman, 2002). Reduction in basal area requires the removal of peat that leads to increase in hydraulic gradients that further removes moisture from the wetland. This peat removal may also help to lower the resistance to the downward seepage of water. Another method involves dehydration through lowering of the groundwater table, adjacent waterways, or both (Charman, 2002). Additionally, either through man-made establishment or natural encroachment, invasive plant species may colonize peatlands, increasing their relative rates of evapotranspiration, drying them out (Charman, 2002).

After drainage of the area is achieved, it must then be removed. There are three major methods that can be used with the actual peat removal; these include cutting the peat in peat blocks with machine or by hand, peat milling, and “sausage cutting” (Charman, 2002).

Peat cutting is the most customary form of peat removal as it can be done by hand or by machine (Charman, 2002). When done my hand, it usually involves the removal of the peat to a depth of 1 -2m, while into the wetland. As explained above, the increased hydraulic gradient in the peat provides enough drainage necessary for extraction. The cut blocks are then placed in neat piles to dry out for a number of weeks before they may be transported (Charman, 2002). This is generally regarded as the least damage way to extract peat. This is because it is usually done on a small scale as well as the fact that surface layers of peat are not adequate for fuel burning and are therefore placed back on the cutover area (Charman, 2002). This provides a surface for vegetation re-growth important to peatland renewal. It has been suggested that recovery can happen around 3 years after cutover if this turf is replaced again properly. If this is not done, peat erosion and invasive vegetation may negatively impact the area (Charman, 2002). This hand cutting method is still present in some areas, but it is largely being substituted for extraction by tractor-towed extrusion machines, or "sausage cutting". This involves the removal of peat beneath the surface that is brought up through slits (Charman, 2002). This produces "sausages" of peat that can be cut to form convenient logs for fire places. This process could be arguably less detrimental to peatlands as the surface vegetation is mostly left intact, however more peatland area must be mined to produce the same amount of peat as block-cutting, mitigating any benefits (Charman, 2002).

Machine-based block-cutting extraction is much the same as when done by hand in that the blocks are cut, stacked and finally transported when they are light enough from drying. The difference is the scale between machines and manual work, machines covering much larger areas (Charman, 2002). Machines are also used to turn over the blocks to facilitate a faster rate of drying. This method leads to leaving a pattern of hollow areas in the peatland referred to as "baulks", then the area is abandoned (Charman, 2002).

Most recently, peat milling has become the main method in which peat is mined from an area. For this process, the surface of the peatland is drained and leveled by digging drain 15 m apart (Charman, 2002). The drain depth is gradually increased meaning this type of preparation takes approximately 3 years to complete. It is done to prevent the type of peat collapse that can occur with moist peat (Charman, 2002). The drainage process is sometimes also helped by cambering the peat, the arched surface lets water run-off more quickly. When draining and leveling of the area is complete, the "peat field" can now support the heavy extraction machines (Charman, 2002). The peat is extracted using a vacuum harvester and then move to an area off-site. As the peat depth decreases with every harvest, more and more drainage is needed, requiring drains to be dug deeper for the next harvest season (Charman, 2002).

Commercial peat extraction's ultimate outcome is the large area of exposed peatland it leaves behind. Usually at least a depth of 0.5 m is removed, and sometimes more depending on the peat accumulation in an area (Charman, 2002). After such removal, the peatland is decimated, providing not habitat for wildlife and can no longer of any recreational use to society for hunting or enjoyment of nature. Historically, these barren remnants were only seen suitable for agriculture or forestry (Charman, 2002). At present, this is slowly changing and efforts to restore peatlands after extraction activities are being made (Charman, 2002), a process that will be explored in more detail later in this report.

In addition to the demolition of the natural peatland ecosystem, an assortment of other environmental issues can arise after extraction. This includes the release of particulate carbon, DOC and heavy metals to run-off and subsequently waterways, as well as the emission of carbon dioxide through combustion and decomposition peat during and after production (Charman, 2002). These potential environment affects will be explored in the coming section of this report.

4.3 Effects of Extraction on Carbon Emissions: A Climate Change Connection?

Peat extraction is a concern from a changing climate perspective because the industry generates GHG emissions in every facet of its operation. From the land use changes involved with extraction, to the fossil fuel combustion of mining equipment. Then, once the peat has been extracted and processed, it is shipped to stores for sale where it is then driven home by consumers and left to decompose in their private gardens. This entire process, from extraction to garden, contributes to Canada's net atmospheric burden and thus contributing to climate change (Cleary et. al., 2005).

Firstly, the significant land use change from undisturbed to mine revolves around the draining of the peatland. Removing the moisture from the area greatly increases the rate of decomposition in the bog (Cleary et. al., 2005). This increase can be attributed to increasing the depth of the oxic zone (Waddington et. al, 2002). This increase carbon dioxide emission (CO_2), but decreases methane emission (CH_4) (Cleary et. al., 2005). It has been found that the total CO_2 emissions from a cutover peatland are approximately 3 times greater than that of an undisturbed site (Waddington et. al, 2002).

Following the drainage, the extraction of the living biomass from the peatland effectively causes the gross production of the wetland ecosystem to fall to zero (Cleary et. al., 2005). This prevents any new biomass from developing and therefore successfully ends the carbon storage potential of the peatland through the accumulation of biomass (Waddington et. al, 2002).

The GHG emissions do not end there for the Canadian peat mining industry as their vehicles and extraction equipment are powered by fossil fuels. The horticultural product is then shipped to sellers via fossil fuel powered automobiles, and taken home by the consumer and incorporated into their garden care. Additionally, although the decomposition of extracted peat depends on many factors such as temperature, soil pH and water availability, the rates of decomposition are meaningfully higher in well aerated gardens than in natural peatlands (Cleary et. al., 2005).

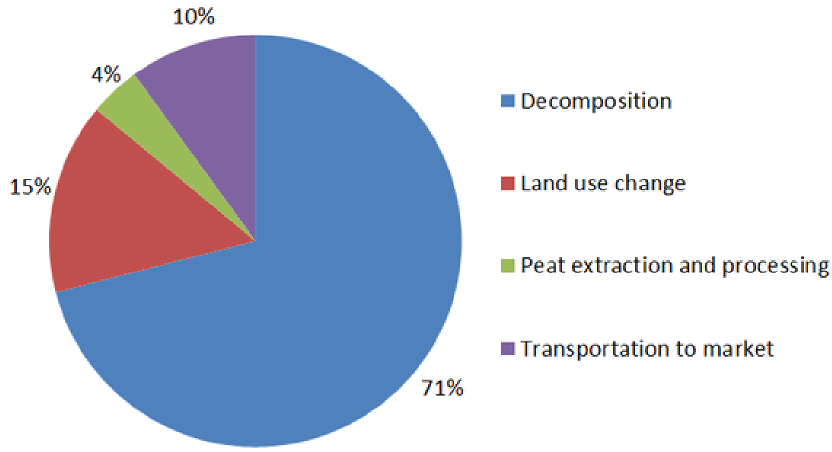

Figure 2: This graph displays the percent contribution to carbon emission from the various activities revolving peat extraction in Canada. Re-created from Cleary et. al., 2005.

From the above Figure 2 we see that by nearly two thirds in-garden decomposition of extracted peat is the largest GHG emitter in the Canadian peat industry (Cleary et. al., 2005). From this information we make take that to make a significant impact on reducing GHG emissions from peat extraction an appeal must be made to the consumer to make changes in their consumption habits. Increasing awareness, for example through the project website is a start, however to create real change, the consumer must be provided with simple and cost-effective alternatives to horticultural peat.

As of 2005, the only part of the Canadian peat industry being accounted for in Canada's official GHG inventory is the fossil fuel combustion by extraction, processing and shipping machinery (Cleary et. al., 2005). In the year 2000 these particular emissions accounted for around 62 X 10^3 t CO_2 equivalents. This was 0.008% of Canada's total emissions of 726 X 10^6 t CO_2 equivalents. Although this is a very small percentage, the Canadian peat industry carbon emission grew 83% from the year 1990 to 2000 (Cleary et. al., 2005), displaying rapid growth. It has been calculated in the paper by Cleary et. al., 2005 that in 2000 the true emissions from the Canadian peat industry was 893.3 X 10^3 t CO_2 equivalents. This brings the percentage of total Canadian emissions from 0.008% to 0.12%. The Canadian peat industry's contribution to Canada's GHG emission is comparatively very small but is a growing component (Cleary et. al., 2005).

With only approximately 16,000 ha of peatlands being used for the peat extraction industry, this translates to only 0.01% of Canada's peatlands being used for horticultural peat (Waddington et. al, 2002). Under present natural to impacted peatland ratios, draining and extraction operations fail to result in a significant deficit to net carbon storage (Waddington et. al, 2002). However, it has been calculated that only 5% of peatlands in Canada (or a specific region) must be drained and/or harvested to result in net carbon source over a net carbon sink (Waddington et. al, 2002). In many parts of the world, this ratio has already been exceeded, and it is expected the global loss will only increase into the future (Waddington et. al, 2002).

Peatlands and climate change is an intensely complicated issue due to the many natural and anthropogenic forces that drive both phenomenons. For example, some peatlands across the world have been drained to facilitate forestry operations, resulting in carbon sequestration (Waddington et. al, 2002). To further complicate the issue is the fact that the methane produced by the anaerobic decomposition in peatlands has a greater radiative forcing potential than carbon dioxide (Waddington et. al, 2002). This means that methane is 21 times more efficient at trapping infrared radiation, which then warms the atmosphere (Frolking and Roulet, 2007). It has been found that CH_4 emission drops 12-50% over impacted peatlands compared with natural sites, however it is important to note that CO_2 emissions were 235-255% greater at the cutover sites compared with the natural site (Waddington et. al, 2002). This is very significant and facilitates the argument that any reduction in CH_4 by mining peatlands could be mitigated by the highly significant increases in CO_2 emissions. Additionally, CH_4 has a much shorter life in the atmosphere compared with CO_2.

Damage to peatlands may put into effect a positive feedback loop of worsening climate change (Carlson et. al., 2009). A positive feedback loop can be thought of as a system that keeps reinforcing itself. In contrast, a negative feedback loop is a self controlling feedback. For example, a wolf eats all the deer in a region and the deer population crashes meaning no more food for the wolves. This then causes the world population to crash, allowing the deer population to recover once again. This system controls itself. Instead, this positive feedback loop of worsening climate change, the disturbed peatlands emit more carbon into the atmosphere which then warms the planet. This warmer planet destroys more peatlands, emitting more carbon and etc. You can see how this system keeps reinforcing itself and worsening the problem. To clarify, an illustration can be seen below. However, this is a largely simplified version of how the degradation of peatlands can make climate change worse. It is important to realize a multitude of factors are taking place under the umbrella of “climate change”.

Peatlands are a main feature of the boreal forests of Canada, regions storing more carbon than any other terrestrial ecosystem on the planet (Carlson et. al., 2009). As such, the conservations of these areas will be key in both mitigating climate change as well as adapting to it. Boreal forests are the best equipped to withstand the effects of rapid climate change due to their intactness (Carlson et. al., 2009). Some of these climate change fueled changes include northward expansion of habitat, increased fire risk, increases in incidences of pest outbreaks and degraded water resources (Carlson et. al., 2009).

4.4 Effects of Extraction on Water Quality

As previously discussed, the main step in peat extraction is the drainage of the wetland. The subsequent drying can then cause changes to the chemistry of the surface layers of peat (Charman, 2002). In an undamaged peatland, the mineralization of nutrients is kept in balance by both plant up-take and microbial immobilization. This means there can be minimal leeching of these nutrients, as well as little erosion (Klove, 2001). The fact there is little erosion means the concentration of suspended sediments in peatland run-off is low.

Drainage facilitated decomposition leads to the leaching of previously immobilized nutrients in the once only partly decomposed plants (Klove, 2001). Peat mining can lead to significantly higher concentrations of nutrients and suspended solids in waters down-stream. Such consequences of peat mining can lead to environmental changes in the nearby waterways, in local eutrophication and in biodiversity (Klove, 2001).

Through study it has been determined that the transport of nitrogen, suspended solid and dissolved solid loads is much higher in mine disturbed peatlands than from natural peatlands. This illustrates that peat extraction activities lead to elevated loads compared with other peatland utilisations (Klove, 2001).

However these observed effects will often be strongly dependent on the surrounding climate (Charman, 2002).

As drainage is the key first step in the extraction process, the hydrology of peatlands are therefore extremely altered by the process. As expected, this drainage affects the peatlands themselves by drying out. Depending on the type of peatland, this drying can cause shrinkage, cracking and a permanent structural change in the peat (Charman, 2002). This may stunt any natural restoration of the area, which will perhaps instead change to a different landscape, allowing now trees and woody shrubs to grow (Charman, 2002).

The hydrologic change may have consequences on the adjacent environmental as well, as any change to a catchment will lead to effects on other parts of the system. As discussed earlier, since peatlands are described as a “wet sponge” and wet sponges are not efficient at up-taking more water, it is arguable that mined areas may have a larger water storage capacity (Charman, 2002). However, studies have found this not to be the case, as cutover areas have increased storm flow. This may be attributed to a high number drainage ditches place to initially facilitate the draining of the peatland (Charman, 2002).

4.5 Effects of Extraction on Forest Fires

Peatlands are generally some of the wettest landscapes, however when dry becomes a very effective combustible material susceptible to fires that can then spread to surrounding vegetation. Peatlands may become dry due to environmental causes such as droughts, or anthropogenic causes such as drainage (Charman, 2002). Increased instances of fire can lead to effects on the peatland, as well as have negative implication for any human populations living in the area.

Fire can destroy living biomass in the peatland. Depending of the type of plant, it may or may not regenerate quickly after the fire has passed. Fire may also kill any soil organisms through heating, reducing their populations (Charman, 2002). Fire can also destroy any plant litter and surface peat. This loss of peat layers can lead to considerable impacts on the rate of peat accumulation, as well as the carbon cycle of the system (Charman, 2002). Fire also has the ability to release nutrients as the burnt plant material makes formally immobilized nutrients more available. This can lead to a net loss of nutrients from the peatland through gaseous loss or water run-off (Charman, 2002). Finally, fire can lead to a hydrological change in the peatland. Since fire reduces plant coverage, transpiration rate may be suppressed leading to more surface water (Charman, 2002). Additionally, due to the removable of the low bulk density peat material, what is left of the peatland as a low hydraulic conductivity meaning it now has less of a capacity to retain and store water (Charman, 2002).

In terms of implications on human populations in surrounding areas, peatland drainage has been blamed for forest fires affecting regions such as Russia and Indonesia (Pearce, 2011). During the summer 2011 heat wave, wild fires spread across

Russia resulting in wild fires that killed thousands of people. A similar occurrence took place in Indonesia in 1998, where peatland fires covered the country as well as neighbouring areas (Pearce, 2011).

4.6 Effects of Extraction on Wildlife

Finally, by the very nature of peatland creation, peatlands are very fragile ecosystems that do not bounce back quickly from disturbance or damage. Currently restoration efforts are being explored; however anything done may not result in a full return to the peatlands previous functional capacity (Charman, 2002). Besides peat extraction's obvious damage to wildlife through the removal habitat, it can also have negative impacts through the fragmentation of intact habitat.

The various land-use changes of peatland has resulted in the large scale fragmentation of remaining peatland habitats. These still undisturbed peatlands are "islands" among human activity (Charman, 2002). This is an issue in Europe, and so a smaller extent North America including Canada. It is possible these fragmented habitats are not sustainable over the long run as these ecosystems require maintenance through larger hydrological regimes (Charman, 2002). The hydrology of the peatland and the region can be severely impacted by the anthropogenic activities surrounding and taking place within it. Drainage around the peatland may eventually overcome the entire remnant (Charman, 2002).

Fragmentation also poses issues to the wildlife themselves, as it can affect the chances of specialist plants and viable populations from surviving. It has been well documented in England that fragmentation as been linked to with declines in peatland plant species (Charman, 2002). Certain specialist animal species restricted to peatland habitat will see their numbers decline through shear loss of liveable area, as well as separation from other populations decreasing the amount of breeding taking place (Charman, 2002).

Peat extraction requires landscapes and ecosystems to be altered. Many areas that are harvested for peat matter or under consideration for harvest are in remote locations with no road access. The boreal regions of Canada have peat deposits in layers ranging a few metres thick. If these areas are to be mined, more roads would need to be constructed for ease of transportation to and from the extraction site.

Species may be sensitive to these changes in the landscape, especially with increased access. In order to assess populations that are at risk or potentially at risk, the following information must be collected:

- Information on the population
  - Population numbers and demographic data
  - Population trends: stable, increasing, declining
- Information on habitat
  - Habitat quality and availability
- Information on interrelated species
  - Predators
  - Competitors
  - Hunters: human harvest

When monitoring populations for wildlife management planning, certain social values need to be considered such as the subsistence needs of aboriginal people, cultural roles of wildlife in communities, opportunities for licensed hunting, wildlife viewing opportunities (Leavesley 2011). There are a diversity of perspectives when managing for species, viewpoints and opinions are influenced by background, knowledge base, experience and personal connection (Leavesley 2011). Factors that influence populations that require monitoring include predation, hunting, disease, habitat, climate and access.

Access is the biggest threat to native populations. Roads in remote areas increase transmission of disease, parasites, and invasive species, as well as increase access to and from the areas of hunters and poachers (Leavesley 2011). Roads create predator corridors and fragment habitat, as well as increase edge ratio to create more islands.

Looking at the example of moose in Manitoba, access is the biggest threat to moose populations on the east side of the province. Moose are specifically vulnerable around trails. Access roads have allowed increased movement of predators, such as wolves and bears, in the area for hunting corridors. Access roads also allow white-tailed deer into moose habitat, and white-tail deer carry parasites and disease that are fatal to moose, such as brain worm (Leavesley 2011). Roads also highly fragment moose habitat, which is sparse as it is, and create habitat islands (Leavesley 2011). Poaching may also increase as a result of access roads, however it is hard to monitor the effect of poaching efforts on any population (Leavesley 2011).

5.0 Alternatives to Peat Use

After an extensive look at the uses for peat as well as the negative consequences of its extraction, we will now explore some alternatives to peat. We shall explore alternatives for many of its uses, ranging from energy to horticulture.

Alternatives to using peat as fuel include solar power, wind power, hydroelectric power and even nuclear power. There are also other alternative biofuels such as the new cattail biofuel project currently under research by the IISD.

Peat is spread or mixed with soil for planting, but peat pots are also made. A number of alternatives have emerged, however, as we've become clearer about where peat is needed. Instead of using peat as mulch, tree bark, cocoa shells, shredded prunings, straw, and mushroom compost serve the same purpose, without drying out and blowing away, which peat often does. In terms of soil improvement, animal manure, leaf mold, and compost are just as effective, if not better, since peat has little nutrient value. Vermicompost and compost are good, natural replacements for use of peat in horticultural practices. Perlite and vermiculite are other alternatives for tree and garden planting.

Peat pots are decomposable plant pots that are used inside green houses or for indoor planting. There are peat-free alternatives that are made from coir, which comprises fibers derived from the husk and outer shell of coconuts, as well as cow manure. Cow-pots are decomposable seed starter pots that can be planter right into the ground. Seed starter pots can also be made out of newspaper at home.

6.0 Restoration

The following section discusses the possibilities, goals and methods of restoring peatlands after they have been disturbed by human activities.

6.1 Introduction to Restoration

The depth of cutting, duration of operations, and methods of extraction have a long-lasting effect on the quality of the substrate, and in some cases the hydrology of the local landscape (Rydin et al 2006). Combined with appropriate water management after extraction, some original peatland functions can be recreated, however, many of the changes are irreversible, such as changes to the soil structure.

Peatland restoration is a relatively new field of study. The European and North American approaches to peatland restoration differ mostly because of different land uses of peatlands, peat mining methods, and goals for restoring biodiversity and ecological functions.

Little natural regeneration of *Sphagnum sp.* occurs on harvested bogs in Quebec and New Brunswick that have been extracted by vacuum methods; active management is essential for recovery. In Canada, some peatlands are not recolonised by *Sphagnum* even after many years of natural succession (Rochefort et al 2003, Rydin et al 2006)

This is because extraction methods impede plant reestablishment. Bare peat surfaces are home to harsh conditions including poor water availability, exposure to desiccation, erosion and lack of seeds or other plant material that has the ability to generate new growth (Rydin et al 2006).

6.2 Goals of Restoration

Peatlands in the boreal region of Canada are where most human activities on peatlands takes place, the long term objective after peat harvest is often to return a functional peat accumulating ecosystem, as in a self-sustaining peat accumulating ecosystem. The return to a functioning peatland within 20 to 30 years may not be realistic; short term restoration is not considered in the realm of possible because of the need to regenerate plant growth and accumulate organics that will become the peat matter (Quinty et al 2003). Short term objectives of a peatland restoration project are to establish plant cover composed of mire species and to recreate hydrological conditions similar to natural bogs and fens. There are two main components to peatland restoration: reestablishing plant cover by species that dominate peatlands, and re wetting harvested sites by raising the water table (Quinty et al 2003).

Peatlands can be classified into different levels of disturbance from the harvesting process. This is characterized from natural disturbance that is no human influence, to minor, moderate and major disturbances, to artificial (Rydin et al 2003). Natural disturbance requires no initiation or development by human processes; all natural processes of hydrology are unaffected by human activity (Rydin et al 2006). The characterization of artificial disturbance means that the damage to the area has almost completely destroyed the original peatland, and all existing peat land is a result of human managed efforts.

6.3 Restoration Process

Peatland restoration is essentially assisting in the recovery of damaged ecosystems. The Canadian peatland restoration method consists of the following steps:

1) surface preparation, 2) plant collection, 3) plant spreading, 4) straw spreading, 5) fertilization, and 6) blocking drainage (Quinty et al 2003). Diaspores are any part of a plant that can regenerate a new individual; such as seeds, rhizomes, shoots or branches (Quinty et al 2003). The first step, field preparation aims at providing suitable hydrologic conditions for diaspore survival.

6.4 Surface Preparation

Surface preparation usually includes identifying the site conditions, goals and objectives of the restoration project, as well as the planning of the restoration project. Information about the site conditions include site characteristics prior to extraction, hydrology and topography of the area, peat characteristics, source of plant material, surrounding landscape, and then setting attainable goals and objectives, combined with continued monitoring (Quinty et al 2003). Knowing the site characteristics prior to harvest will ultimately help to measure success of the restoration project that occurs after extraction is complete. It is essentially to keep as much water in the site as possible because bog plants require water, but at the same time, flooding must be avoided for extensive periods to not drown out new growth (Quinty et al 2003).

6.5 Plant Collection

Plant collection after extraction is another important aspect to consider during restoration projects. The plant collection must contain species that dominate in peatlands, as well as pioneer and colonizing species (Quinty et al 2003). The collection of plants essentially includes gathering vegetation from an established site and shredding it to spread it over a post-extraction site (Quinty et al 2003). Plant composition at a collection site, as well as the size of the site, need to be taken into consideration when attempting a collection (Quinty et al 2003). If the plant collection is done properly, little damage can be done to the collection site, and it may have a fast recovery. If the collection site is of poor quality, then the quality of the restoration may also be poor after transplanting (Quinty et al 2003).

6.6 Plant Spreading

Plant spreading is technically considered an easier step of the restoration process. When spreading, fragments of the plant collection need to be in contact with the peat surface at the site in order to have good access to water. The area must fully be covered in order to maintain a full regeneration of plant growth because lateral spreading cannot be relied on (Quinty et al 2003). When spreading the vegetation, it is important not to make the spread layer too thick; vegetation at the top of a thick layer will not receive enough water for growth and will just dry out; vegetation at the bottom of a thick layer will not receive enough sunlight in order to produce substantial growth (Quinty et al 2003). A good estimate for a thin layer of plant spreading is in between 1 to 5 cm (Quinty et al 2003).

6.7 Straw Spreading

The use of mulch, or straw spreading, has been shown to significantly improve the chances of re-colonization of plants in a restoration area. Harsh conditions after spreading may not allow plants to re-establish an acceptable amount of growth when they are exposed to the elements (Quinty et al 2003). The straw spreading step is similar to the plant spreading step in that too thick of a layer will impede plant growth underneath, and too thin of a layer will not provide enough protection for the vegetation layer to establish growth (Quinty et al 2003). The spreading of straw mulch must be done as soon as possible after the spreading of the vegetation collection to protect plants from conditions that can prevent or impede growth.

6.8 Fertilization

Fertilization helps to facilitate plant growth, and therefore establishment after extraction of a harvest site. Fertilizers with a higher phosphorous content are recommended for fertilizing areas for recolonization after peat extraction (Quinty et al 2003). Fertilizers with nitrogen may be unnecessary because the bare peat surface contains enough nitrogen for plant growth (Quinty et al 2003). Fertilizers with a high calcium content are not beneficial to restore plant growth in a peat land because calcium has a negative effect to *Sphagnum* species (Quinty et al 2003). The fertilization step in a restoration project is applied after the straw mulch is applied after the plant spreading. Special conditions to consider when applying fertilizers include avoiding contamination into waterways and applying the correct amount.

6.9 Water Retention

Blocking drainage ditches is not just as easy as putting in a soil plug. The change in the water storage properties of peat, along with the drainage ditch network, affect the amount and ability of water storage on the site (Quinty et al 2003). Blocking the ditches or constructing berms can restore the summer water budget of a drained cutover peatland or wetland. Usually it is necessary to provide additional water during the growing season, by retaining more rainfall or snowmelt water (Quinty et al 2003). The blockages may be impervious to water, or they may sink and not retain water.

6. 10 Planning and Monitoring

Planning of a restoration project is an important aspect in the extraction process. If a restoration project is planned for a harvested area, restoration processes may be able to be put in place during the peat harvesting operations. For example, if the restoration of one project is occurring simultaneously with a new extraction project, some of the plant materials may be transferred from one site to the other (Quinty et al 2003).

After the harvesting of peat material at an extraction site, peat mining cannot be considered sustainable and peat cannot be considered a renewable resource within the time frame of resource extraction and use. Even though the volume of peat mined annually is less than the annual global production of natural systems, local impacts are substantial (Quinty et al 2003). Hydrological properties and processes of the ecosystem are impacted and may never be restored to a pre-extraction state. Continual monitoring is required for every project that manipulates land use areas. The failure or success of a restoration will only be determined by continual monitoring after many years, based on the speed of the reestablishment of the plant community and accumulation of debris to create peat. Soil conditions may never be restored to a pre-extraction state, until after many years of regeneration of peat (Quinty et al 2003, Rochefort et al 2003).

7.0 Recommendations and Conclusions

Based on the research presented in this report, a few recommendations can be made.

7.1 Increase Awareness of Peatlands (Especially in Manitoba)

A website has been created from the information presented in this report that hopes to raise general awareness of Manitobans, Canadians and people around the world to peatlands. Through our presentation of information about their ecological functions as well as the consequences of their destruction we aspire to help the peatland conservation effort. We hope to make real change in a few different ways:

- Promoting this site through the Oak Hammock Marsh website
- Providing an small lesson plan and experiment that teachers may do with their students to illustrate how peat accumulates in a peatland
- Promoting alternatives to horticultural peat

The letter to Oak Hammock Marsh is as follows:

Dear Nathalie Bays,

This letter is a proposal to the Oak Hammock Marsh Interpretive Centre from two students of Environmental Science at the University of Manitoba. This Winter 2012 term, we enrolled in a course entitled Sustainable Water Management as instructed by

Rick Baydack. This course required students to look at current issues associated with water and water systems and develop a project to create a change.

The goal of our project is to increase awareness about the importance of peatlands and the status of peatlands in Manitoba. For our project, we developed a website about the importance of peat and peatlands in the province of Manitoba. The website includes:

- *A background on wetlands, peatlands and peat and their importance*
- *The processes of harvesting peat and implications of extraction*
- *The possibility of peatland restoration after extraction*
- *The uses of peat and alternatives to these uses*
- *Local peatland news and current legislation surrounding peat mining*

What we are asking is to have our project website promoted on the Oak Hammock Marsh Interpretive Centre website, or within the interpretive centre itself. This would be a wonderful opportunity for our work to be presented to the public, those who visit the interpretive centre and are already interested in wetland restoration and conservation.

Sincerely, Andreanna Willems and Nicole Laurila

The Lesson Plan is as follows:

The Lesson Plan is designed for teaching students anaerobic vs. aerobic decomposition in wetlands, and it useful looking at larger topics such as climate change. This is because it explains one type of natural method of carbon sequestration, the very slow decomposition involved with low oxygen and water-logged conditions. Lesson plans such as this are designed to increase awareness through education, both public and in the school system, is an effective tool that can be used to create change. Such an experiment would also be ideal for an outdoor classroom, a resource becoming increasingly popular in public schools.

An easy example of a project that teachers can use in the classroom is to compare decomposition rates under anaerobic (low oxygen) and aerobic (high oxygen) conditions. This can help to illustrate to students how the low oxygen levels present in peatlands leads to the buildup of peat.

Materials required include:

-Soil

-2 two cups of the same size (one with a tight fitting lid)

-Water

-Organic material (fruit peels, green kitchen waste or fresh leaves)

To perform this experiment, fill the two cups 1/4 full of soil. Place the organics on top of the soil, and put more soil in the cup until it is ½ full. Fill the cups with water to just before ¾ full. On one of the cups, place the tight fitting lid. This experiment should be kept outside, just for the sake of possible odour and mess. If these cups are outside, it will also expose the experiment to the 'natural elements of the outside world'. The cups can be monitored once a week to see the rate of decomposition. Students can examine the contents of the cups with their fingers in the open cup and by shaking the closed cup and also compare smells of the two. This is an especially good idea for outdoor classrooms because you can keep the mess outside!

The contents in the cup with the tight fitting lid should decompose much slower than the contents in the cup without the lid. The lid is to help simulate low-oxygen conditions and also to prevent the water from evaporating to represent water-saturated conditions. The cup without the lid will let the water evaporate and decomposition should happen faster than in the cup with the lid.

7.2 Extend Moratorium on Peat Mining to At Least 5 Years

It is our hope that with extending the freeze on granting licences to companies wishing to develop peat production, it will give more time to pass more concrete legislation banning the practice altogether. To put this idea into action we have come up with a petition asking for an extension on the peat mining moratorium, with an eventual ban. This petition will have an online component available on our website, as well as a physical copy to gather as many signatures as possible. In addition to this petition, we have also drafted a general letter for people to copy and email to the Gord Mackintosh, Manitoba's current minister of Conservation and Water Stewardship. This letter expresses concern for the Health of Lake Manitoba and peatlands all over the province. It asks for an extension on the 2 year moratorium to 5 years, as well as consideration of a total ban on extraction activities.

The letter is as follows:

Dear Gord Mackintosh,
My name is (name), and I am a concerned citizen of the province of Manitoba. I am writing your office today in regards to the review of the proposed peat mining operation by Sun-Gro Horticulture in the Hecla-Grindstone Provincial Park.

I understand that their rights to a peat mining license pre-dates the amendment in the Save Lake Winnipeg Act, however I feel that allowing such a development undermines the spirit of the act, as well as that of a provincial park.

I am concerned about the potential environmental effects of such a development in Manitoba, such as the continued pollution of Lake Winnipeg, as well as exasperating climate change through the removal of this valuable carbon sink.

I ask that you do not approve or allow approval for this development and hope you consider banning the extraction of peat material in Manitoba altogether.
Thank you for taking the time to acknowledge my concerns.
Sincerely,
(name and address)

7.3 Closing Remarks

After the completion of this project, we have found that when taking into consideration the environmental consequences of peat extraction combined with the knowledge that many alternatives to resource exist, we have found extraction activities should be ended in this province and all over the world. Due to its value in sequestering carbon and providing valuable wildlife habitat, as well as the negative effects on people and surrounding landscapes when these areas are disturbed such as increased forest fire risks and impacting surface water quality, disturbing peatlands should be kept to a minimum. We feel our efforts at increasing awareness of these natural areas can help the public to pressure our governments into creating more protective laws, with the first step being increasing the moratorium on peat extraction licenses to 5 years. Upon speaking with people, they are always amazed to learn about the ecological functions of the often overlooked peatland and wish to know more. It is our hope that encouraging the public will bring to light the importance of preserving peatlands for many years to come.

References

Carlson Matt, Wells Jeff, and Dina Roberts. *The Carbon the World Forgot*. Seattle and Ottawa: Boreal Songbird Initiative, 2009.

Charman, D. J.. *Peatlands and environmental change*. Chichester, West Sussex, England: J. Wiley, 2002. Print.

Cleary, Julian, Nigel T. Roulet, and Tim M. Moore. "Greenhouse Gas Emissions from Canadian Peat Extraction, 1990-2000: A Life Cycle Analysis." *Ambino* 34.6 (2005): 456-461.

"Environmental Consultations and Legislation - Manitoba." *Manitoba Wildlands - Current News and Home page*. N.p., n.d. Web. 14 Mar. 2012. <http://manitobawildlands.org/consult.htm>.

Frolking, S., and N. Roulet. "Holocene radiative forcing impact of northern peatland carbon accumulation and methane emissions." *Global Change Biology* 13 (2007): 1079-1088.

Klove, Bjorn. "Characteristics of Nitrogen and Phosphorous Loads in Peat Mining Wastewater." *Pergamon* 35.10 (2001): 2353-2362. 7

Leavesley K. “Moose Management in GHA 26” (presentation and personal contact). Wildlife and Ecosystem Protection Branch, Manitoba Conservation. 2011.

"Manitoba Mining thru the Centuries | Mineral Education | Mineral Resources Division | Manitoba Innovation, Energy and Mines | Province of Manitoba." *Province of Manitoba* . N.p., n.d. Web. 15 Mar. 2012. <http://www.manitoba.ca/iem/mrd/min-ed/minfacts/mbhistory/timeline.html>.

Murkin H, Van der Valk D and Clark W (eds). *Prairie Wetland Ecology, The contribution of the Marsh Ecology Research Program*. Iowa State University. 2000.

Pearce, Fred. "The Big Payback from Bringing Back Peat Bogs." *Yale Environment 360: Opinion, Analysis, Reporting & Debate*. N.p., 26 Sept. 2011. Web. 20 Feb. 2012. <http://e360.yale.edu/feature/the_big_payback_from_bringing_back_peat_bogs/2445/>.

Peatland Ecology Research Group (PERG). "Peat Industry: Groupe de recherche en écologie des tourbières (GRET)." *Home: Groupe de recherche en écologie des tourbières (GRET)*. N.p., 12 Jan. 2012. Web. 20 Mar. 2012. <http://www.gret-perg.ulaval.ca/industrie-gret.html>.

Prystupa, Mychaylo. "Peat mines ok'd despite expert ojections." CBC News Manitoba. CBC, 2 Feb. 2012. Web. 5 Feb. 2012. <www.cbc.ca/news/canada/manitoba/story/2012/02/01/mb-peat-mines-manitoba.html>.

Quinty F and Rochefort L. *Peatland Restoration Guide (Second Edition)*. University Laval. 2003.

Rochefort L, Quinty F, Campeau S, Johnson K and Malterer T. “North American approach to the restoration of Sphagnum dominated Peatlands”. Wetlands Ecology and Management 11:3-20. 2003.

Rydin H and Jeglum J. *The Biology of Peatlands*. Oxford University Press. 2006.

Waddington, J.M., K.D. Warner, and G.W. Kennedy. "Cutover peatlands: A persistant source of atmospheric CO2." Global Biogeochemical Cycles 16.1 (2001): 2-7.

Warner B and Buteau P. "The Early Peat Industry in Canada, 1864-1945." Geoscience Canada 27.2 (2000): 57-66. Geoscience Canada. Web. 19 Mar. 2012.