Chapter 3: Current Forest Conditions

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3. CURRENT FOREST CONDITIONS

Chapter 3 of the Forest Management Plan describes the Current Forest Conditions within of Forest Management Licence #3. It is a description of the existing ecological-biophysical, socio-economic, and land use settings.

The current forest conditions are important. This chapter describes the baseline conditions at the beginning of the Forest Management Plan (the year 2020), before any forest management activities, such as harvesting and reforestation, have been proposed. Therefore, the baseline or current forest conditions will be compared to proposed forest management activities for the next 20 years (i.e. 2020 to 2040). For example, the forested area by cover type (hardwood, hardwood-mixedwood, softwood-mixedwood, and softwood) at the beginning of the plan can be compared to future projections of cover type, to see if changes occur due to forest management activities.

Furthermore, the current forest conditions also provide an opportunity for Information Sharing and Engagement, before any forest management decisions have been made. Maps, tables, and other information summaries can be brought to communities as a good start for discussion of what is important to the community. If information is provided to the planning team, a community's objectives can be incorporated into the plan and can help guide the forest management decisions for the next 20 years.

Ecological-Biophysical Conditions

Forest Management Licence #3 spans two Ecoregions, the majority being the Boreal Plain ecozone, but also contains the Prairie ecozone in the southern portion of FML #3. The Duck Mountain Provincial Forest is an 'island' forest, surrounded by farmland.

The current ecological-biophysical condition describes ecosystems and ecosystem components such as climate, geology, soils, vegetation, wildlife, species at risk, water, wetlands, carbon, *etc*. The current forest conditions are an important baseline that summarizes characteristics of the ecosystems before any proposed forest management activities are applied at either at the landscape or stand level.

Located within the Boreal Plains Ecoregion, in the west central Parklands portion of the province, Forest Management Licence 3 is bounded to the south by Riding Mountain National Park, to the west by the Saskatchewan/Manitoba provincial border, to the north by the Porcupine Mountain Provincial Forest, and to the east by Lake Winnipegosis and Lake Manitoba (Figure 3.1). The area is well-accessed with the existing road network, including Provincial highways #5, #10, and #83. A significant amount of the transportation infrastructure is located in agricultural areas as grid roads.

Socio-Economic Conditions

The social and economic environment is described in the middle of this chapter. Statistics Canada data from 2006, 2011, and 2016 census periods are used to describe the Parklands Economic Region, including current population, employment, and income. An economic profile of the Town of Swan River is also described.

The economic contribution of the Swan Valley siding mill is described. Recreational, cultural, and historic values that contribute to socio-economic conditions are also described. Communities' economic development policies are summarized.

Land Use Conditions
Land use is described in the third portion of this chapter. There is a wide diversity of overlapping land uses in Forest Management Licence # 3. Traditional land uses include trapping, hunting, and fishing. Currently, there are both commercial guiding by licenced outfitters, licenced hunting, and fishing. The Duck Mountain have Registered Trap Lines, and there is open trapping in the rest of FML # 3.

Tourism is significant, with trails being the common feature needed by various groups such as snowmobilers, All-Terrain Vehicle riders, mountain bikers, hikers, and cross-country ski enthusiasts. These trails are in both the Duck Mountain Provincial Forest and the Duck Mountain Provincial Park. Local (non-commercial) use of timber and non-timber products is also described.

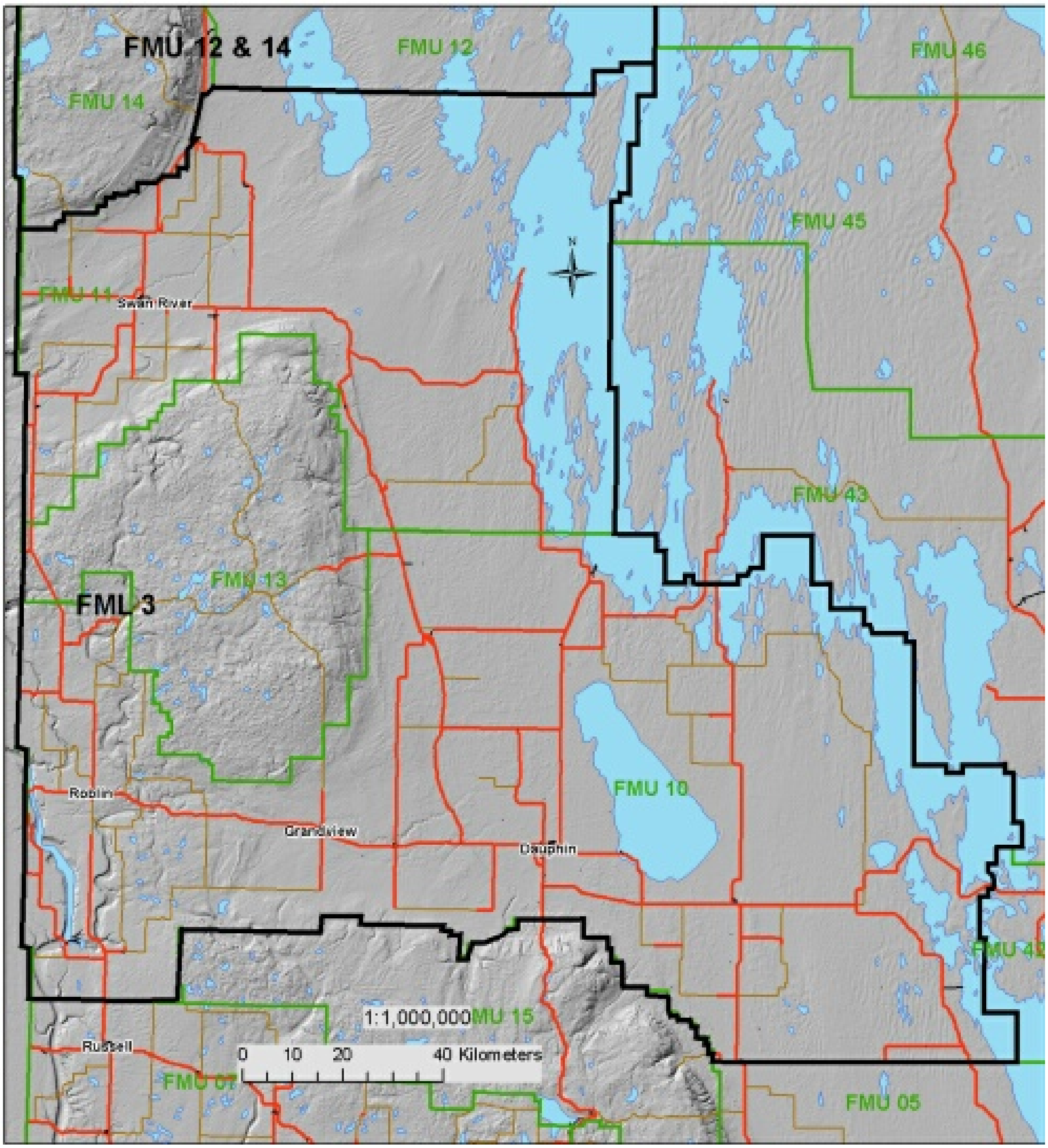


Figure 3.1 The geographic area of Forest Management Licence # 3.

3.1. ECOLOGICAL-BIOPHYSICAL ENVIRONMENT

The current ecological and biophysical environment of Forest Management Licence #3 is described in this section of Chapter 3. A physical description of the FML #3 area is required in the Forest Management Plan (Manitoba Conservation 2007a), and is required to include a description on climate, soils, geology, terrestrial and aquatic flora and fauna, water resources, physical infrastructure and protected areas.

Forest Management Licence #3 (FML #3) lies mostly within the Boreal Plain ecozone that is part of the Boreal Forest. A small portion of FML #3 contains Prairie ecozone in the Roblin and Dauphin areas.

An ecosystem-based approach is used to describe climate, surficial geology, soils, ecological land classification, wetlands (bogs, fens, swamps, marshes, and open water), and water (rivers, streams, and waterbodies). Vegetation (trees, shrubs, herbs, forbs *etc.*) are described at both the landscape and the ecosite-levels.

Common wildlife species are listed by lifeform (mammals, birds, fish, amphibians, reptiles, insects, and invertebrates) but details are focused on the socially important moose, elk, and marten. Endangered or threatened wildlife species are also listed and detailed. Song birds represent the full range of biodiversity (age, cover type, interspersion) in FML #3. Sufficient data exists from the LP Bird Project to link 17 song birds to probability of occupancy by habitat.

3.1.1. General Climate Conditions

The climate of the Parklands region is continental with large seasonal temperature variations. Winters are cold and long, with hot and short summers. A moderate amount of precipitation falls in the area, with the most precipitation in summer. Winter has the least precipitation, due to the cold air being unable to hold much moisture.

Weather data for Swan River, Manitoba (station ID 10188) was downloaded from Environment Canada website (accessed Jan. 25, 2018). A 12-year period of 2006 to 2017 calendar years were selected and summarized for temperature and precipitation:
http://climate.weather.gc.ca/climate_data/daily_data_e.html?StationID=10188

An overall climate summary (Table 3.1) of the recent past (1976 to 2005) for the Duck Mountain area was downloaded from the University of Winnipeg's Prairie Climate Centre's Climate Atlas interactive tool:
https://climateatlas.ca/

Table 3.1 Overall climate summary 1976 to 2005 (source: Climate Atlas Report).

Variable	Period	1976-2005 Mean
Precipitation (mm)	Annual	472
Precipitation (mm)	Spring	95
Precipitation (mm)	Summer	207
Precipitation (mm)	Fall	104
Precipitation (mm)	Winter	64
Mean Temperature (°C)	Annual	1.1
Mean Temperature (°C)	Spring	1.1
Mean Temperature (°C)	Summer	16.5
Mean Temperature (°C)	Fall	2.8
Mean Temperature (°C)	Winter	-16.4
Tropical Nights	Annual	0
Very hot days (+30°C)	Annual	6
Very cold days (-30°C)	Annual	17
Date of Last Spring Frost	Annual	May 27
Date of First Fall Frost	Annual	Sep. 15
Frost-Free Season (days)	Annual	111

3.1.1.1 Temperature

The air temperature in FML #3 is highly variable (Table 3.2). A 12-year average (2006 to present) of the daily mean temperature is 1.8 degrees Celsius. The hottest and coldest recorded temperatures have been +35.4 and -40.8 degrees Celsius, respectively. The range of temperature across an entire year has been as much as 75 degrees Celsius.

Table 3.2 Temperature summary in Swan River for the years 2006 to 2017 (Environment Canada).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Average
Average Temperature (°C) by month													
Daily Average (°C)	-15.0	-15.5	-8.0	2.6	10.0	15.6	18.5	17.3	12.4	4.5	-5.9	-15.0	**1.8**
Standard Deviation (+/-)	3.1	3.4	4.1	2.6	1.4	0.9	1.2	1.0	1.5	1.7	4.0	4.5	**2.4**
Daily Maximum (°C)	-4.5	-5.0	3.1	14.2	20.7	24.9	26.8	26.5	23.9	13.1	5.9	-3.8	**12.2**
Daily Minimum (°C)	-24.8	-26.6	-19.6	-8.3	0.0	7.4	9.4	9.1	3.7	-3.4	-15.4	-25.7	**-7.9**
Extreme Maximum (°C)	6.0	6.0	14.3	26.0	35.4	32.5	33.7	33.9	35.1	27.9	19.6	8.2	n/a
Extreme Minimum (°C)	-37.4	-40.8	-36.2	-23.1	-11.6	-3.0	3.6	1.5	-4.0	-11.5	-33.1	-38.2	n/a

The Climate Atlas of Canada interactive tool utilizes two climate change scenarios, and can display temperature metrics (mean, maximum, minimum temperature) and display them on a map for three time periods:

1. the recent past (1976 to 2005);
2. estimates for the future (2021-2050); and
3. estimates for further future (2051-2080).

The Climate Atlas of Canada also has hot and cold weather metrics. Hot weather metrics include:

- Tropical Night - occurs when the lowest temperature of the day does not go below 20 °C.
- Warmest Maximum Temperature - The highest temperature of the year.
- Summer Days - A Summer Day is a day when the temperature rises to at least 25 °C.
- Cooling Degree Days (CDD) are equal to the number of degrees Celsius a given day's mean temperature is above 18 °C. For example, if the daily mean temperature is 21 °C, the CDD value for that day is equal to 3 °C. If the daily mean temperature is below 18 °C, the CDD value for that day is set to zero.

Cold weather metrics include:

- Freeze-Thaw Cycles - This is a simple count of days when the air temperature fluctuates between freezing and non-freezing temperatures. Under these conditions, it is likely that some water at the surface was both liquid and ice at some point during the 24-hour period.
- Frost Days – coldest temp of the day is 0 or colder. Frost might form at ground level or on cold structures.
- Icing days – Air temp does not go above 0°C
- Coldest minimum temperature - coldest temperature of the year
- Heating Degree Days - Heating Degree Days (HDD) are equal to the number of degrees Celsius a given day's mean temperature is below 18 °C. For example, if the daily mean temperature is 12 °C, the HDD value for that day is equal to 6 °C. If the daily mean temperature is above 18 °C, the HDD value for that day is set to zero.
- Freezing Degree Days - Freezing degree days (FDD) begin to accumulate when the daily mean temperature drops below freezing: if a day's mean temperature is -21 °C, for example, it increases the annual FDD value by 21. Days when the mean temperature is 0 °C or warmer do not contribute to the annual sum.

3.1.1.2 Frost-Free Period

The frost-free period is the portion of the year when the temperature stays continuously above freezing or 0° C. The frost-free period is the potential growing season, during which there are no freezing temperatures to kill or damage plants. The last spring frost in FML #3 is usually the last week of May, but varies from mid-May to early June. The frost-free period averages 116 days (Table 3.3), and in the 2006 to 2018 period has varied from 104 days to as many as 135 frost-free days.

Table 3.3 Frost-free period in Swan River for the years 2006 to 2019 (Environment Canada).

	Frost Free Days	Last Spring Frost		First Fall Frost	
2006	108	May	22	Sept	7
2007	107	May	27	Sept	11
2008	121	May	22	Sept	20
2009	123	June	7	Oct	7
2010	131	May	10	Sept	17
2011	109	May	27	Sept	12
2012	112	May	27	Sept	15
2013	104	June	3	Sept	15
2014	111	May	22	Sept	9
2015	119	June	1	Sept	27
2016	135	May	15	Sept	26
2017	121	May	20	Sept	17
2018	108	May	20	Sept	5
2019	122	May	26	Sept	27
Average	**116 days frost free**				

3.1.1.3 Precipitation

Yearly precipitation in FML #3 varies by year and also seasonally by month (Table 3.4). Extreme precipitation events by month are also shown. Unfortunately, some snow fall data are missing from the weather records, but snow depth was recorded. Warmer air temperatures all for greater rainfall in the summer months.

Table 3.4 Precipitation summary in Swan River for the years 2006 to 2017.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
Average Monthly Precipitation													
Total Precipitation (mm)	16.1	9.5	17.8	19.1	50.3	77.1	82.2	59.2	37.9	41.7	16.4	12.2	**36.6**
Extreme Monthly Total Precipitation (mm)	24.5	17.2	42.0	54.5	134.2	151.7	184.7	137.7	73.4	99.0	31.5	18.0	
Avg. Monthly Snow Depth (cm)	16.9	22.5	21.9	10.5	0.9	0.1				1.6	5.6	10.5	**10.0**
Extreme Snow Depth (cm)	49	53	65	49	8	4			1	7	32	31	

The Climate Atlas of Canada has annual and seasonal precipitation, in addition to heavy precipitation metrics:

- Heavy Precipitation Days (10 mm) - A Heavy Precipitation Day (HPD) is a day on which at least a total of 10 mm (or 20 mm) of rain or frozen precipitation falls. Frozen precipitation is measured according to its liquid equivalent: 10 cm of snow is usually about 10 mm of precipitation.
- Heavy Precipitation Days (20 mm) - A Heavy Precipitation Day (HPD) is a day on which at least a total of 10 mm (or 20 mm) of rain or frozen precipitation falls. Frozen precipitation is measured according to its liquid equivalent: 10 cm of snow is usually about 10 mm of precipitation.

3.1.1.4 Climate Moisture Index (CMI)

Climate Moisture Index (CMI) is a simple, climate-driven index of water balance (Hogg *et. al.* 2013), that is very important to plant growth. CMI is the difference between precipitation and potential evapotranspiration over an entire growing season. Long-term positive CMI values denote moist climates capable of supporting closed-canopy forests. Negative CMI values indicate drier climates with a moisture deficit, where forest cover is typically patchy (Parklands) or absent (prairie) (Hogg and Bernier, 2005).

Climate Moisture Index varies from year to year, depending on that years' annual precipitation compared to the temperature and wind (evapotranspiration). The 2015 and 2016 growing years for FML #3 are compared in Figure 3.2 showing the spatial variation of drier and wetter areas within FML #3.

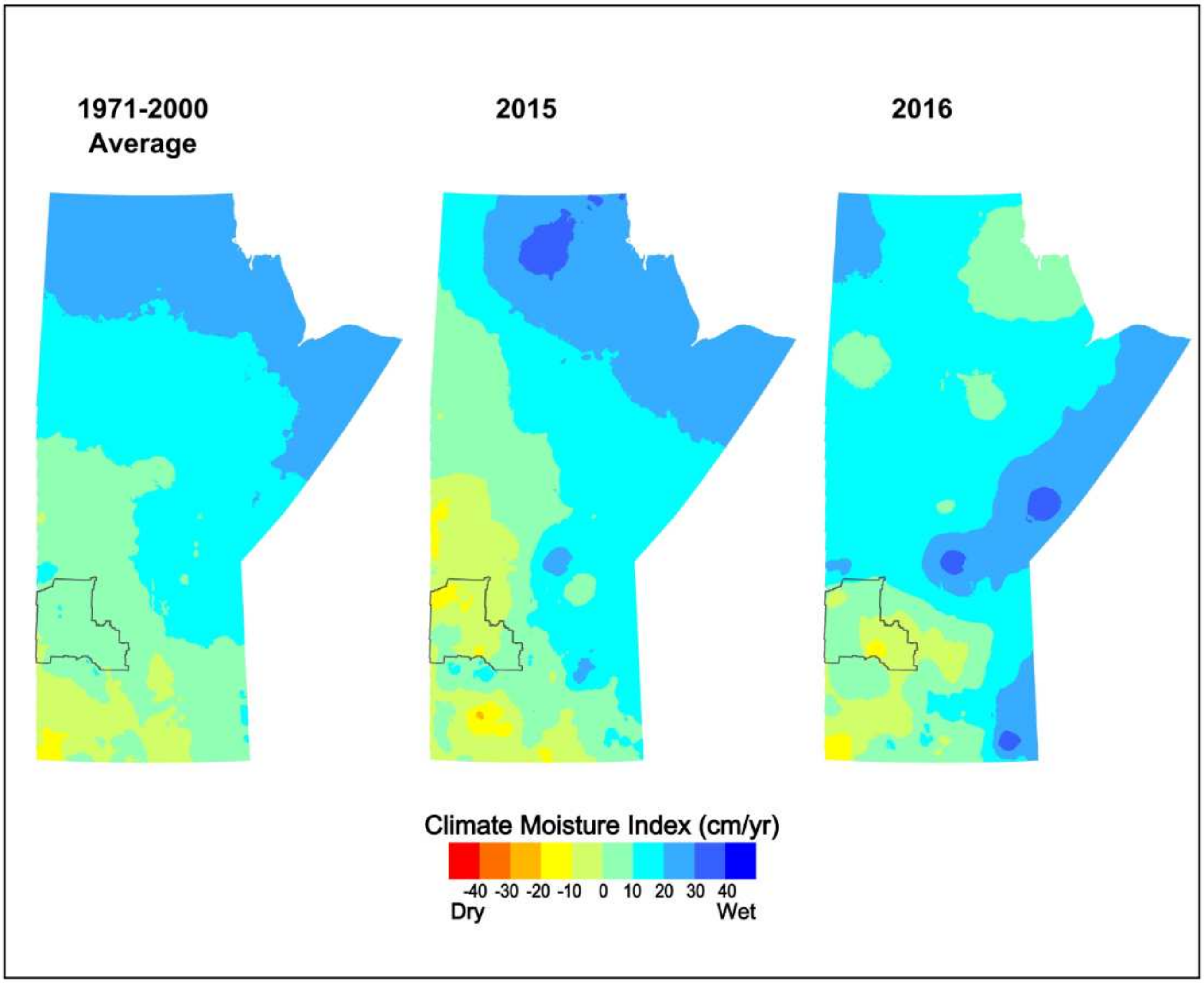


Figure 3.2 Climate moisture index compared for 2015 to 2016, as well as the 1971-2000 average (Natural Resources Canada).

3.1.2. Air and Atmosphere

The composition of the earth's atmosphere is mostly (78%) nitrogen, 21% oxygen, 1% argon, 0.4% carbon dioxide or 400 parts per million (CO_2), and trace elements, including neon, helium, methane, water vapour, krypton, hydrogen, xenon, and ozone. The composition by percentage is represented in Figure 3.3. Note that argon is a chemically inert gas, and not significant to ecosystems, and is therefore not discussed further.

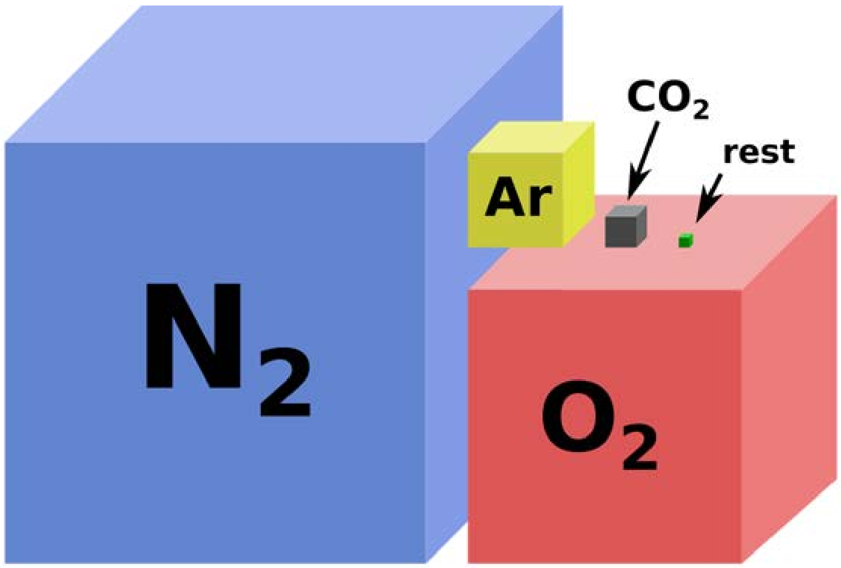


Figure 3.3 Composition of the earth's atmosphere

3.1.2.1 Nitrogen

Nitrogen is the most prevalent gas in the earth's atmosphere. Previously science has indicated that 100% of the nitrogen on Earth available to plants comes from the atmosphere. However, a recent study from the University of California, Davis, indicates that up to 26% comes from Earth's bedrock, with the remaining fraction from the atmosphere (Houlton *et al.* 2018). Nitrogen weathering, physical or chemical, is a globally significant source of nutrition for soils and ecosystems worldwide. Nitrogen may allow forests and grasslands to sequester more CO_2 emissions than previously thought.

The nitrogen cycle (Figure 3.4) describes movement of the element from the air into the biosphere and organic compounds, and then back into the atmosphere. The nitrogen cycle is a biogeochemical cycle in which by that nitrogen is converted into multiple chemical forms as it circulates throughout the atmosphere, and terrestrial and marine ecosystems. The conversion of nitrogen is carried out through both biological and physical processes. Important processes in the nitrogen cycle include fixation, ammonification, nitrification, and denitrification. Atmospheric nitrogen (N_2) has limited availability for biological use and leads to a scarcity of usable nitrogen in many types of ecosystems.

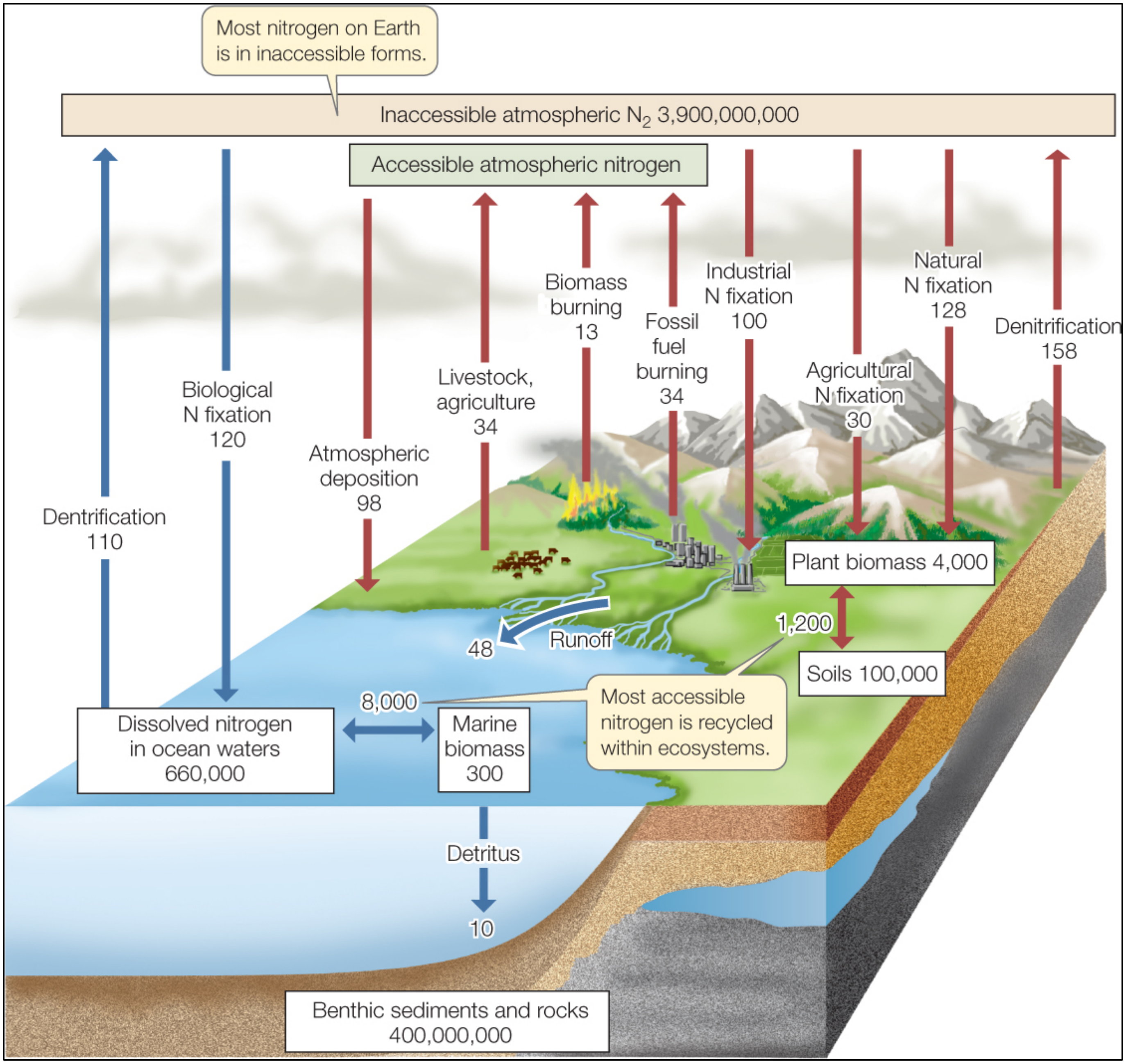


Figure 3.4 Nitrogen pools and fluxes (www.macmillanlearning.com).

Source:
http://www.macmillanhighered.com/BrainHoney/Resource/6716/digital_first_content/trunk/test/hillis2e/asset/img_ch45/c45_fig07.html

The nitrogen cycle is of particular interest since nitrogen availability can affect the rate of key ecosystem processes, including primary production and decomposition. Productivity affects all aspects of ecosystems, including the soils, herbs, shrubs, trees, and the insects, birds, mammals and other animals that utilize ecosystems as part of their life cycle.

3.1.2.2 Global Oxygen Budget

Oxygen is the second most common gas in the atmosphere, and is essential for life (*e.g.* respiration, decomposition, oxidization, and stratospheric ozone). The photosynthesis process converts carbon dioxide (CO_2) from the atmosphere into sugars, which are used for energy. Oxygen (O_2) is emitted, and carbon (C) is sequestered in plant tissues. Oxygen is consumed by living organisms are also used for combustion.

Most of the Earth's oxygen (99.5%) is in mineral oxides in the crust or lithosphere (Figure 3.5). A small fraction (0.5%) resides in the atmosphere and an even smaller fraction (0.01%) resides in the biosphere. The biosphere is crucial to understanding the atmospheric oxygen budget, as it controls short-term exchanges between sediments and the atmosphere.

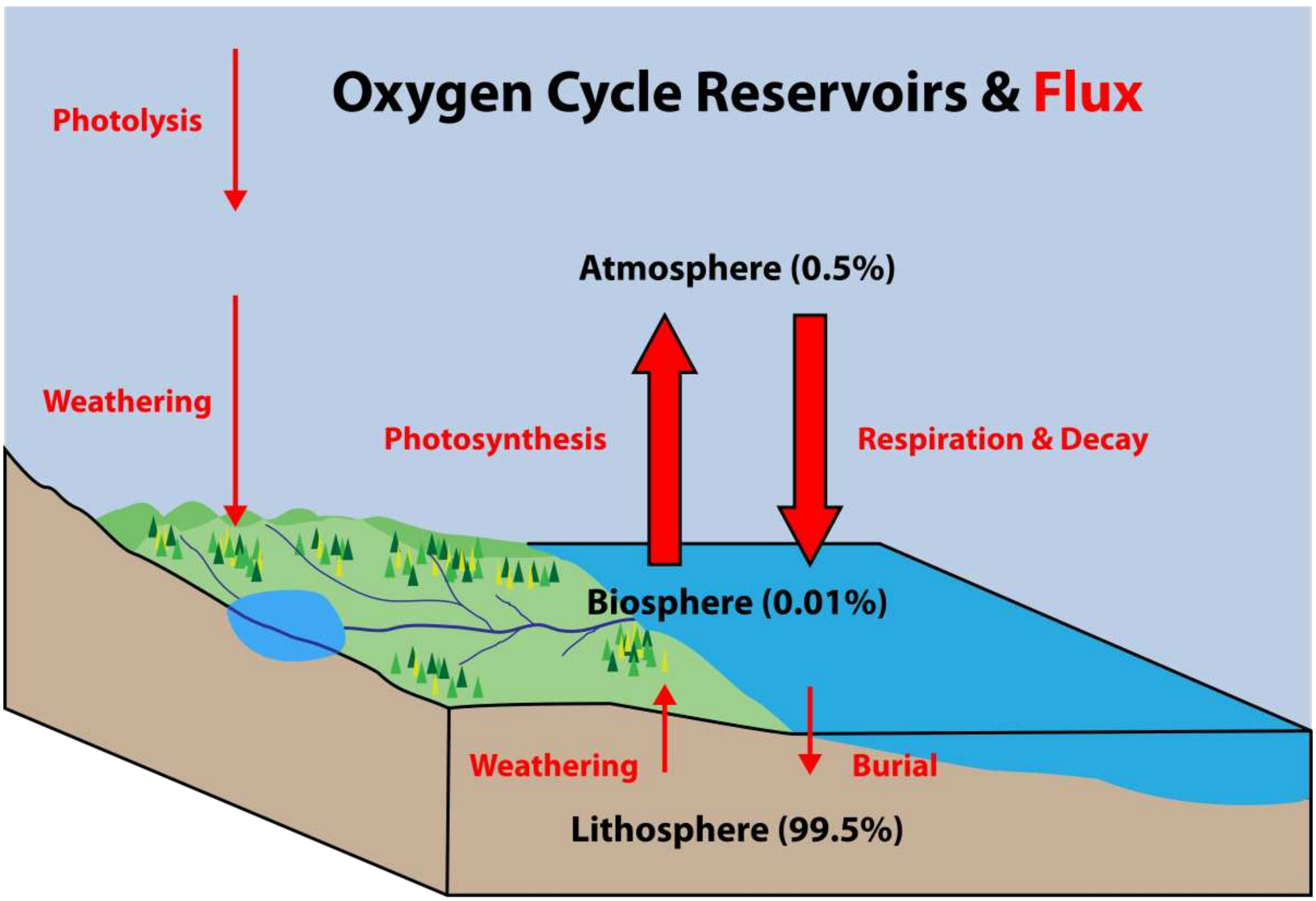


Figure 3.5 Oxygen cycle reservoirs and flux (exchanges)

source: https://en.wikipedia.org/wiki/Oxygen_cycle

3.1.2.3 Global Carbon Dioxide Budget

Carbon dioxide (CO_2) is one form of carbon in the atmosphere. Estimated CO_2 exchanges are depicted by red arrows. Estimated CO_2 pools are shown in blue text (Figure 3.6).

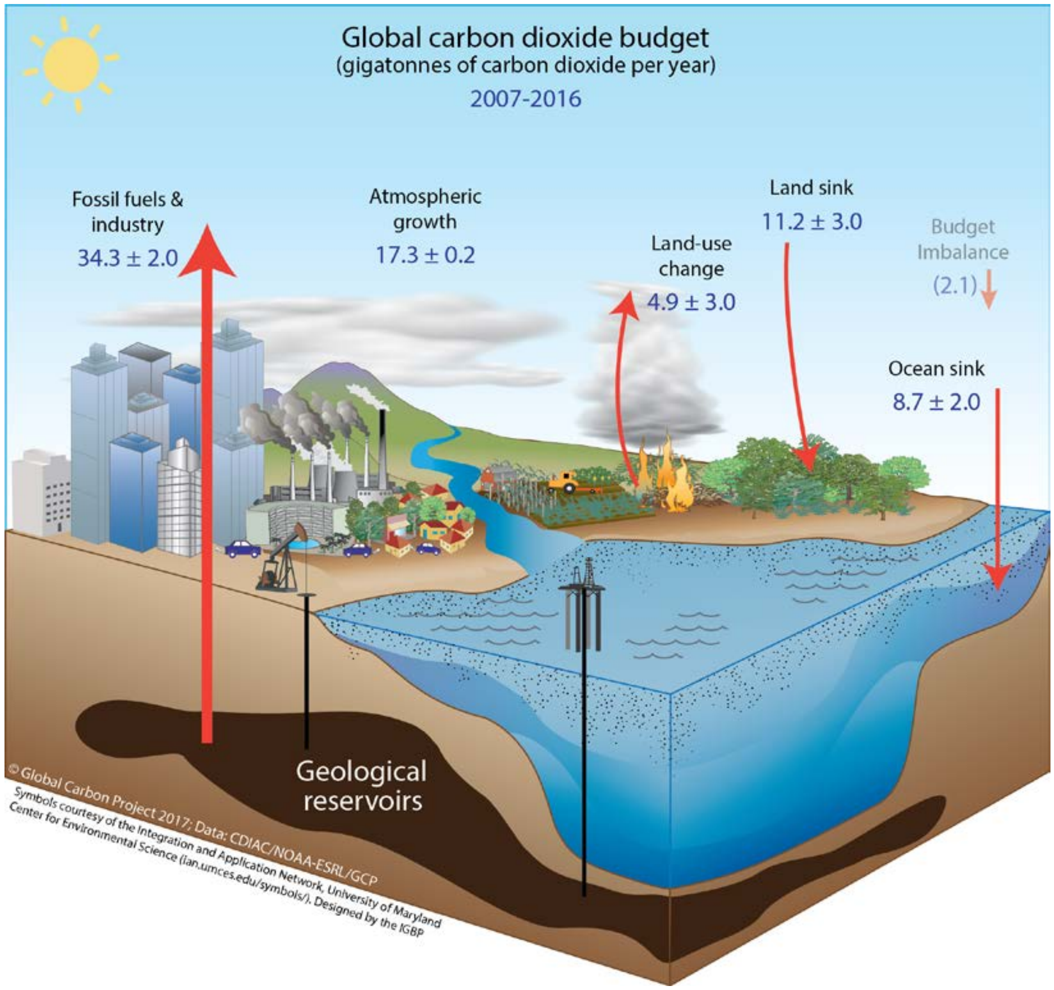


Figure 3.6 Global carbon dioxide cycle averaged globally for the decade 2007–2016 (Global Carbon Project 2017).

The flux, or change, in CO_2 levels from 1990 to 2016 are depicted in Figure 3.7 (Global Carbon project). CO_2 from fossil fuels is absorbed by the ocean, land (vegetation and soil), as well as the atmosphere.

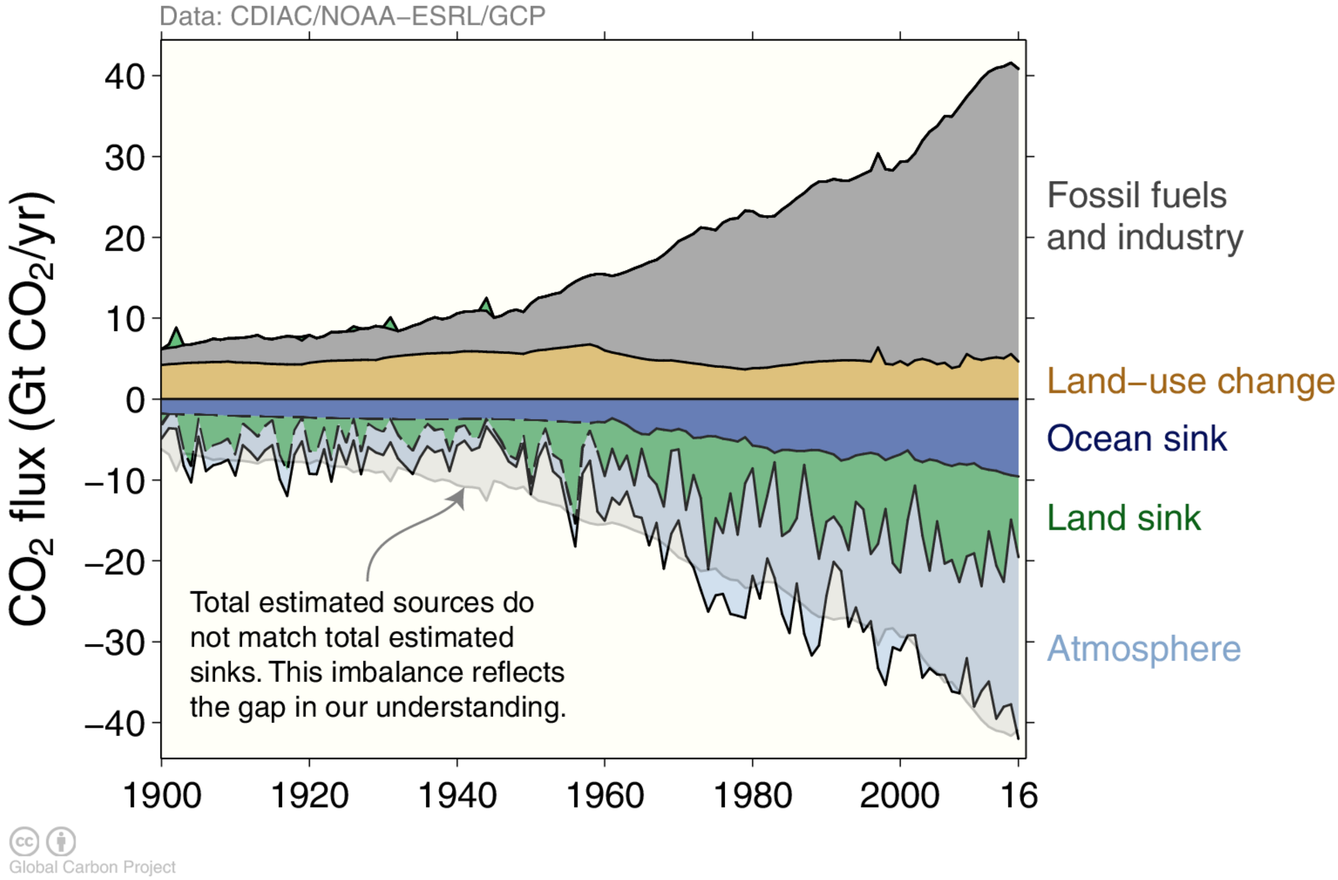


Figure 3.7 Global carbon dioxide fluxes (changes) from 1900 to 2016 (source: Global Carbon project 2017).

3.1.2.4 Carbon

Carbon is important because it occurs in various forms in the atmosphere, vegetation, soils, ocean, and in the sediment and rocks. Our carbon focus tends to be on the atmosphere and above-ground vegetation, but the greatest carbon reservoir is by far the sediments and rocks. The largest carbon exchange is estimated to be the transfer of carbon from the atmosphere to the earth's vegetation (Figure 3.8)

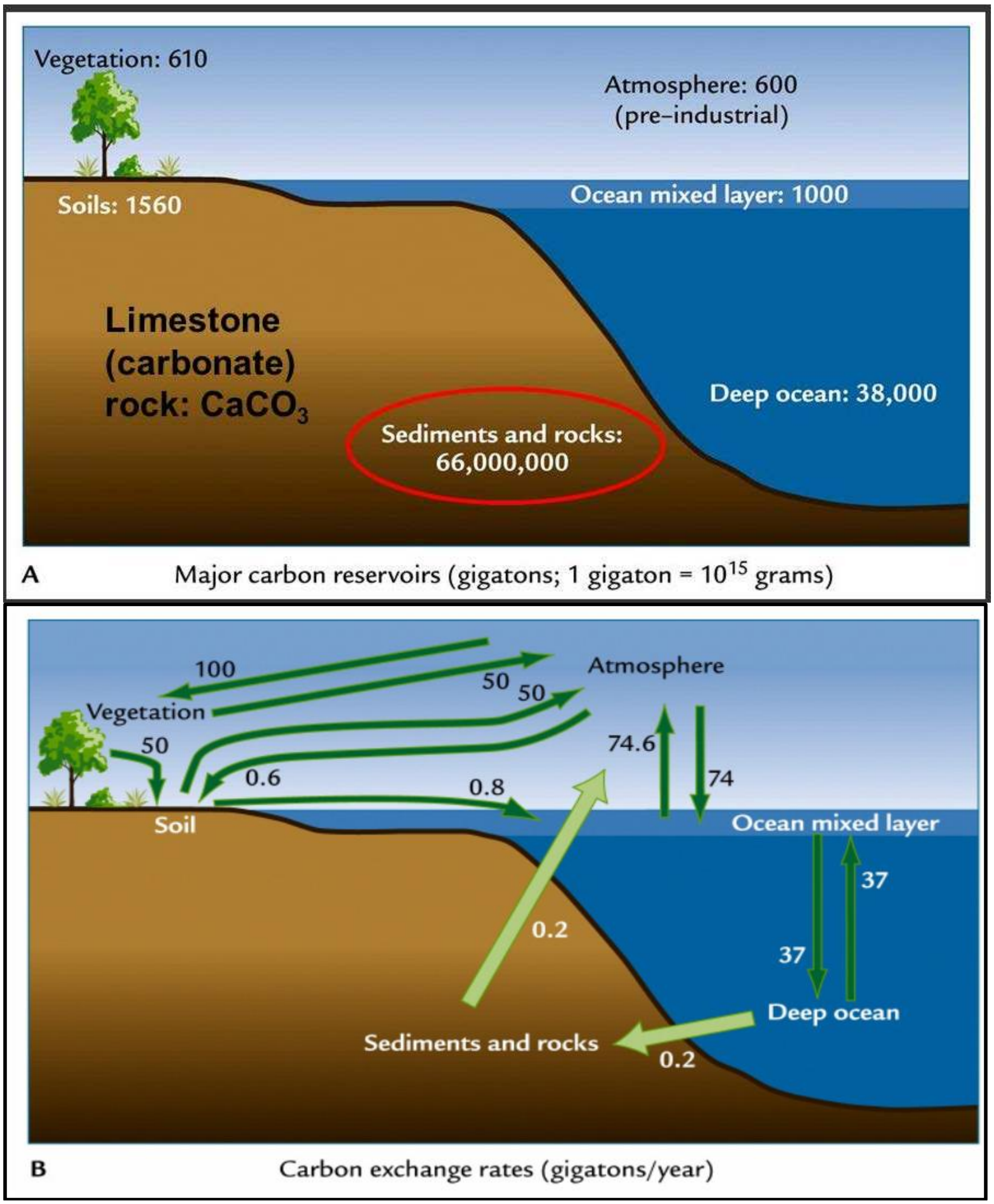


Figure 3.8 Carbon reservoirs and carbon exchange rates (source: atmosedu.com).

3.1.2.5 Air Quality Health Index

The federal and provincial governments quantify an Air Quality Health Index (AQHI) and alerts people to health risks posed by air pollution. The AQHI uses a scale of 1 to 10. The higher the number, the greater the health risk associated with local air quality. In Manitoba, AQHI is monitored in both Winnipeg and Brandon. Health messages for each of the AQHI Health Risk Categories for 'at risk' individuals and the general public are shown in Table 3.5.

Air Quality Health Index measures common air pollutants that are known to harm human health. These pollutants include Ground-level Ozone (O_3), Particulate Matter ($PM_{2.5}$), and Nitrogen Dioxide (NO_2). The AQHI does not measure the health effects of odour, pollen, dust, heat or humidity. Other air pollutants, such as sulphur dioxide and carbon monoxide, are not included in the index because their health effects are largely predicted by measures of ground-level ozone, nitrogen dioxide, and particulate matter.

Table 3.5 Air Quality Health Index Categories and Health Messages (Environment Canada).

Health Risk	Air Quality Health Index	At Risk Population* Health Messages	General Population Health Messages
Low	1 - 3	**Enjoy** your usual outdoor activities.	**Ideal** air quality for outdoor activities.
Moderate	4 - 6	**Consider reducing** or rescheduling strenuous activities outdoors if you are experiencing symptoms.	**No need to modify** your usual outdoor activities unless you experience symptoms such as coughing and throat irritation.
High	7 - 10	**Reduce** or reschedule strenuous activities outdoors. Children and the elderly should also take it easy.	**Consider reducing** or rescheduling strenuous activities outdoors if you experience symptoms such as coughing and throat irritation.
Very High	Above 10	**Avoid** strenuous activities outdoors. Children and the elderly should also avoid outdoor physical exertion.	**Reduce** or reschedule strenuous activities outdoors, especially if you experience symptoms such as coughing and throat irritation.

*persons with breathing or heart difficulties

Weather conditions can affect the Air Quality Health Index. Wind speed plays a role in diluting pollutants. Generally, strong winds disperse pollutants. However, light winds can result in stagnant conditions that allow pollutants to build up over an area, increasing the AQHI. An inversion or stagnant layer of air at ground level may trap pollutants near the ground and will not be dispersed until the wind speed increases. Clear, cloudless skies allow more sunlight to penetrate the Earth's surface that may result in higher levels of ground-level ozone, increasing the AQHI.

Forest fire smoke can spread and travel over a wide area. Smoke from grass fires, stubble burning, or building fires may also increase levels of particulate matter, but do not carry as far as forest fire smoke. Both kinds of fires increase pollutants that are measured on the Air Quality Health Index and will reduce air quality.

3.1.3. Surficial Geology

This section provides a synthesis of the surficial geology, topography, and landforms for the area within Forest Management Licence #3.

The FML #3 area is bisected by the Manitoba escarpment and dominated by the Duck Mountain. Historically, the area has contained a mixture of open prairie grasslands and forests dominated by hardwoods, mixedwoods, and softwoods. During the last century, much of the grassland was converted to agricultural use by cultivation, or as pasture.

3.1.3.1 Surficial Geology

FML #3 consists of eastward-facing bedrock escarpments, culminating in cuestas that form the Manitoba Escarpment. Above the Manitoba Escarpment in the Duck Mountain, the landscape is dominated by hummocky moraine or dead-ice topography, streamlined topography and glacial spillways (Figure 3.9). Many areas are covered by thick sequences of glacial till representing numerous glacial episodes. The most recent glacial advances were from the northwest. Glacial till tends to be clay rich.

Till deposits are commonly clay-textured soils with mixed (limestone and granitic) coarse fragments in the Duck Mountain. Tills south and east of the Duck Mountain tend to be silty, with limestone coarse fragments.

Glaciolacustrine deposits include Lake Agassiz beach ridges along the east toe slope of the Duck Mountain and were formed by waves at the margin of glacial Lake Agassiz. Provincial highway #10 closely follows these glaciolacustrine features. Offshore glaciolacustrine sediments, typically clay, were formed from clay suspended in glacial lake water. This process formed layers of clay.

Organic deposits occur as peat in moisture-receiving depressional areas. The type of mineral soil deposit below the peat varies.

Glaciofluvial sediment deposits were formed by sediment-laden meltwater flowing into glacial Lake Agassiz, forming outwash fans of sediment and consist of sand, gravel, or thin layers of silt or clay. Proximal glaciofluvial sediments consist of sand and gravel in esker ridges or kames, and are much less common than glaciofluvial sediments.

Colluvium is composed of landslide debris and deposits associated with the steep slopes along the escarpment. The Shell Valley Spillway also has minor amounts of colluvium.

Alluvial deposits are floodplains and reworked channel and streambank material, which are found along most river systems.

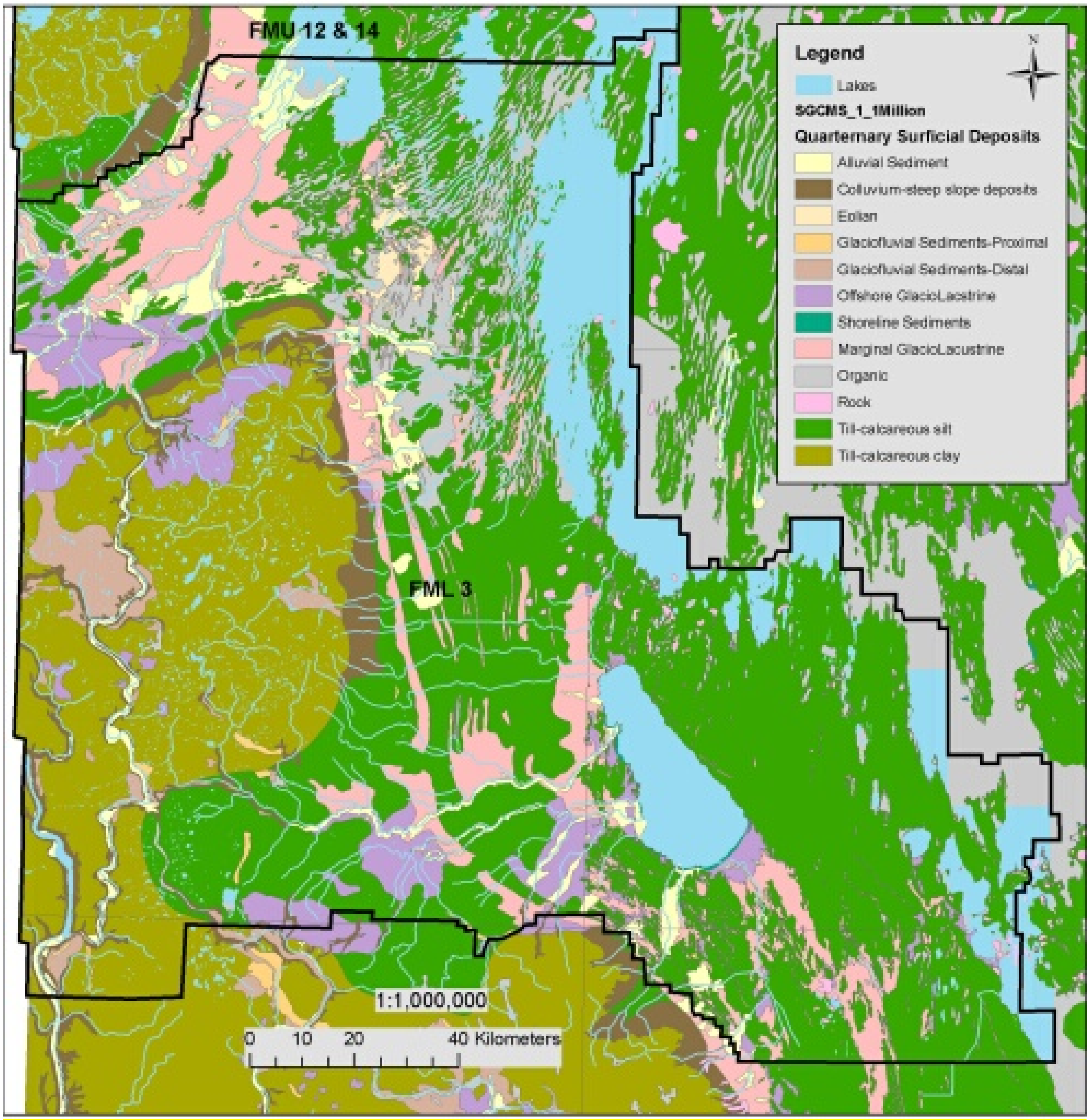


Figure 3.9 Surficial Geology in FML # 3 (Matile and Keller, 2004).

3.1.3.2 Enduring Features Description

Enduring features are a collection of landscape types characterized by a unique combination of soils and surficial geology (landforms). Enduring features are very stable over long periods of time and are likely to be occupied by characteristic plant and animal communities. Application of this coarse filter approach to the selection of areas requires that the characteristics used in defining enduring features be indicative of the composition and diversity of biological communities across landscapes.

Significant enduring features in FML #3 include:

- Manitoba escarpment
- Shell River glacial spillway
- Baldy Mountain – highest elevation in Manitoba

All organisms share a connection to the landscapes in which they are found. Unlike plants and animals, soils and landforms are more stable and endure over geologic time. When an ecological process such as fire passes through an area, the area's biodiversity is temporarily changed. However, there is potential for the area to return to its previous state because the soils and landforms remain. As a result, it is much easier to define these somewhat more permanent enduring features than to identify the complex biodiversity occupying a given site over time as natural ecological processes such as succession occur.

"Representation" is the term used to describe the proportion of each enduring feature that is protected within an ecoregion and the confidence that ecological integrity is likely to be maintained over time. Representation is assessed as adequate, moderate, partial, or not captured.

The Protected Areas Initiative routinely conducted a gap analysis to evaluate representation with regards to protected areas planning on a regional basis. The representation map of Manitoba's enduring features gives an indication of where Manitoba's enduring features are adequately, moderately, partially, and not represented.

Although there is still work to be done before the network of protected areas within Manitoba is complete, the Protected Areas Initiative has made significant progress towards the goal of representing the biodiversity across Manitoba.

Note that the Duck Mountain Provincial Forest and Duck Mountain Provincial Park receive Parks Branch highest rating 'Adequately Captured', similar to Riding Mountain National Park. The portion of FML #3 outside the Duck Mountain is ranked as 'Partially Captured', 'Not Captured', and 'Moderately Captured'.

3.1.3.3 Landforms

Landforms are physical features largely defined by their surface form. Landforms within FML #3 were influenced by the glaciation and deposition of materials as the glaciers receded. The Duck Mountain consists mostly of hummocky moraine, with clay loam as the dominant soil texture. Occasionally, lacustrine silt and clay were deposited on top of the clay loam moraine. Outwash deposits consisting mainly of bedded silt, sand and gravel are also present. Small to medium-sized inclusions of fens and marshes occur across the Duck Mountain, wherever low spots occur and water flow is impeded.

Landform Mapping

Detailed soil and landform mapping for the Duck Mountain was completed at a scale of 1:60,000 during the creation of the Forest Lands Inventory (2002). Due to the complexity of some areas, some landform polygons contain two or three surface expressions (dominant, codominant1, and codominant2). Please note that FMUs 10 and 11 have not yet been landform mapped to this standard. The surface expression was mapped (Figure 3.10) and categorized in general terms (*e.g.* floodplains, hummocky, valleys, organic, *etc.*).

The western side of the Duck Mountain has a lot of undulating and hummocky terrain. The Shell River spillway is characterized by depositional floodplains near the river, and inclined plains along the banks. The top of the Duck Mountain is hummocky and undulating with occasional organic areas. The east edge of the Duck Mountain, which is part of the Manitoba Escarpment, has two kinds of valleys running east: i) V-shaped erosional valleys; and, ii) wide valleys. These valleys dissect the inclined plains of the escarpment, which generally run in a south-south-east direction.

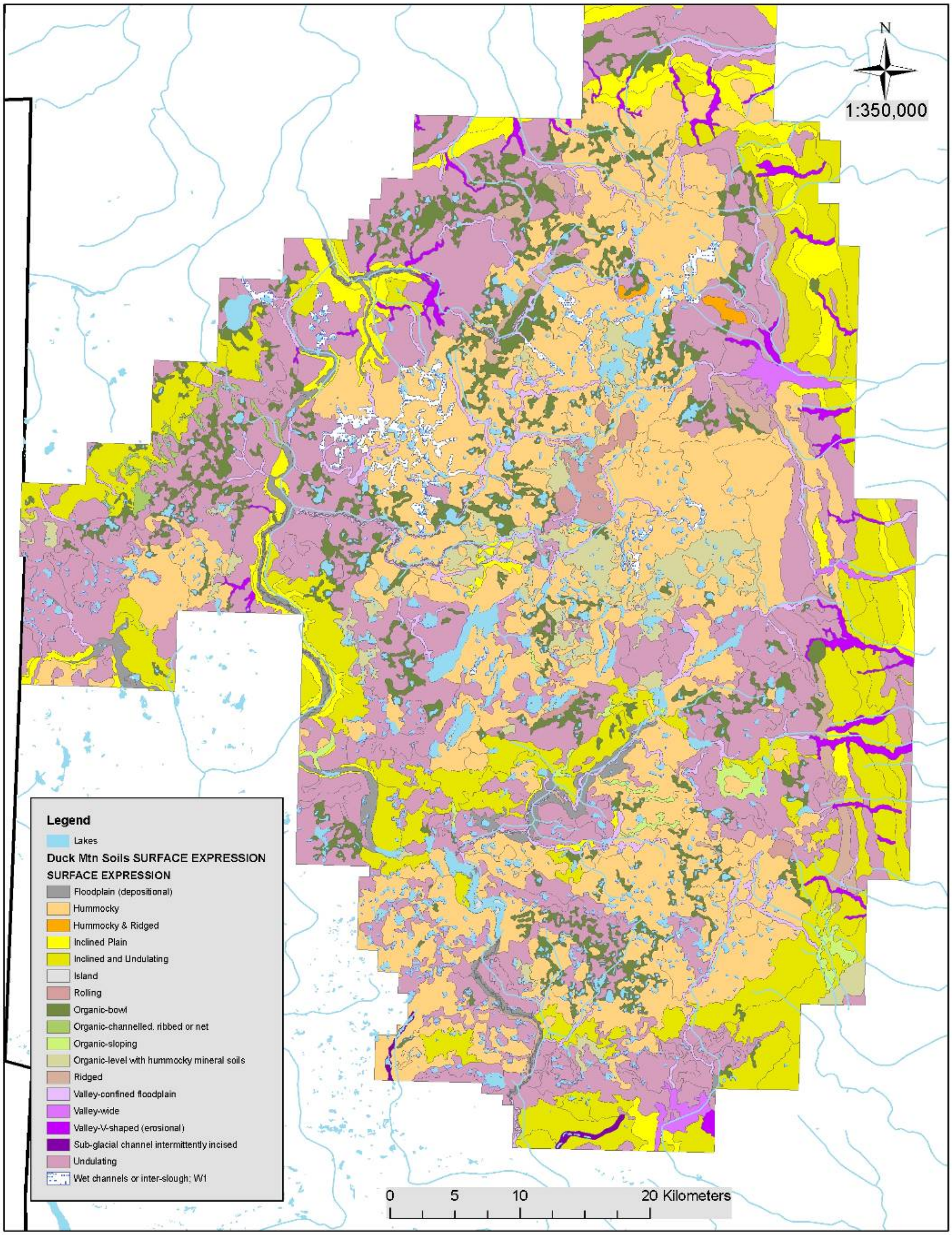


Figure 3.10 Surface expression of the Duck Mountain (The Forestry Corp 2004).

3.1.3.4 Elevation

The highest point in FML #3 and all of Manitoba is Baldy Mountain (Figure 3.11), located within the Duck Mountain Provincial Park at 831 m above sea level. The lowest point is 275 m above sea level in the extreme eastern part of the Duck Mountain area called the Westlake plain. The Assiniboine River plain runs along the Saskatchewan border with steep east facing slopes that form a part of the Manitoba Escarpment. This formation is responsible for the steep drop from 670 m to 425 m over 7 to 10 km to the Westlake plain. Part of the northwesterly slope near the Swan River plain is also an abrupt drop, falling from 610 to 275 m in about 6 km (Klassen, 1979).

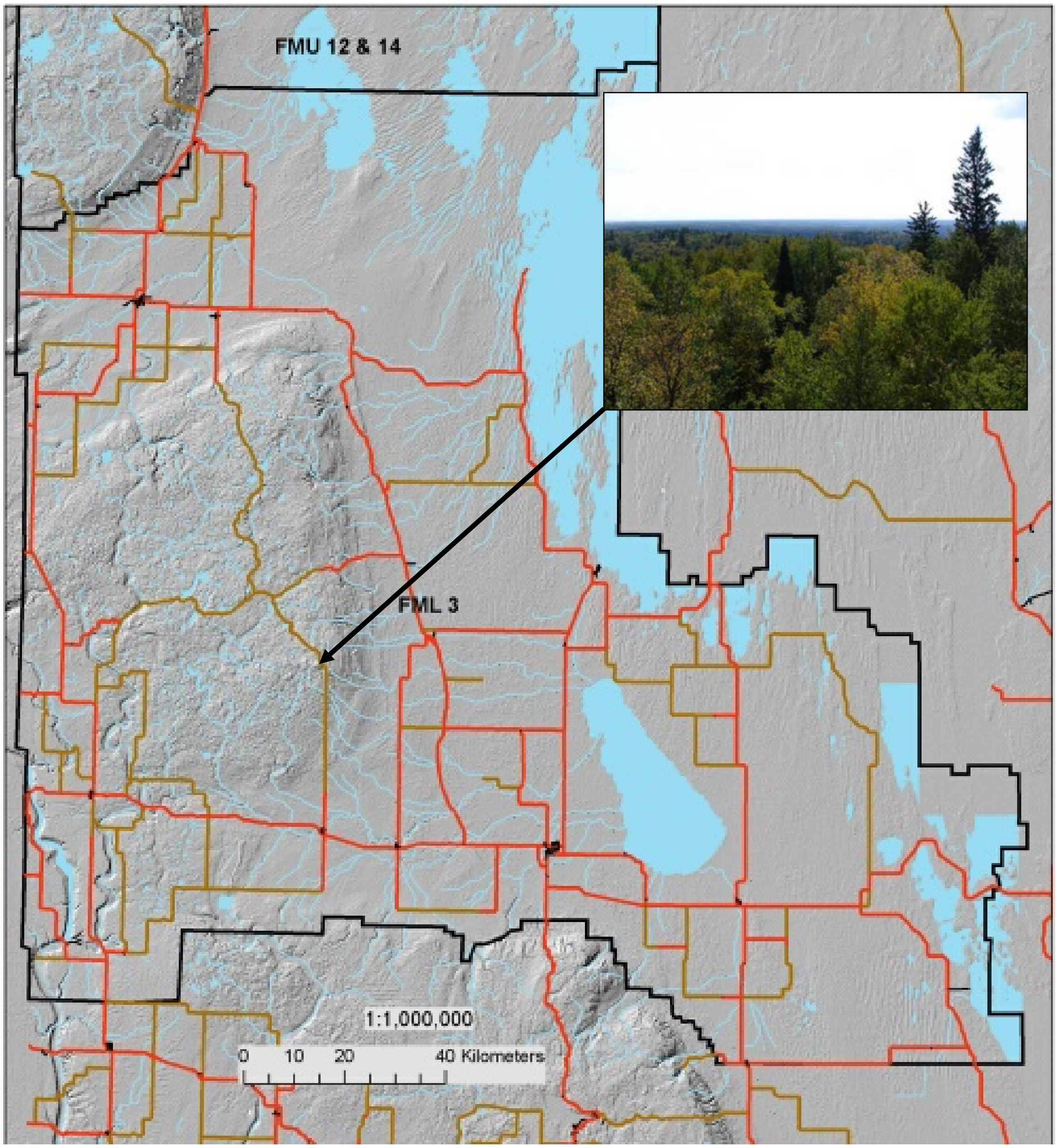


Figure 3.11 Map of elevations in FML #3, inset picture from Baldy Mountain lookout tower.

3.1.3.5 Topography

Swan River Plain (north)
This plain has the nearly flat or gently irregular till. Almost everywhere the surface is slightly eroded by glacial lakes and streams. Several patches of outwash occur to the north and northeast. These patches are, in part, pitted and consist of coarse fragments, gravel, and sand, or else the surface is gently rolling with finer deposits.

Lacustrine silt and sand give a nearly flat or gently rolling surface to portions of the northeastern part of the Swan River plain. The straight part of Swan Valley terminates at the western apex of a gently rolling sand plain between Swan Valley and Benito. An end moraine ridge, one to three km wide and 8 to 15 m high, trends east for about 26 km. This moraine marks the transition from the till of the Arran Formation on the Swan River plain to the till of the Zelena Formation on the Duck Mountain upland, and to the till of the Lennard Formation on the Assiniboine River plain.

Spillways, meltwater channels, and partly buried valleys occur in abundance within the Swan River plain.

Duck Mountain Upland (central)
The Duck Mountain Upland consists mostly of hummocky moraine. The eastern boundary with the Westlake plain is a steep drop from about 670 to 425 m above sea level over 7 to 10 km. Part of the northwesterly slope near the Swan River plain also drops abruptly, falling from 605 to 425 m in about 6 km. Elsewhere the slopes are more gradual, and the boundaries with the Assiniboine plain, Riding Mountain upland, and Valley River plain lie between 460 and 580 m (Klassen, 1979).

Lacustrine deposits consisting mainly of thinly bedded or varied silt and clay and outwash deposits of bedded silt, sand, and gravel are present. The surface of both lacustrine and outwash deposits resembles hummocky moraine. Till knolls, ridges and depressions form a belt from 1 to 2.5 km wide and up to 8 m high that extends nearly continuously for about 56 km to the Grifton township.

The heavy tree cover over essentially all of the Duck Mountain upland make the identification of glacial features, such as eskers, kames, and moraine plateaus, difficult and uncertain. Some prominent meltwater channels and buried valleys cross parts of this upland. The presence of ice contact deposits within some valleys indicate that they predate the last glacier advance, but on the other hand, similar sized valleys have no ice contact deposits and pronounced V-shaped slumping occurs on the sides, suggesting they were formed in late glacial time. Large lakes occupying the uplands were formed by glacial drainage.

Valley River Plain (south)
The Valley River plain is a triangular area of gently rolling or nearly flat till and lake plain between the Riding Mountain upland and Duck Mountain upland. About half of this till plain was eroded by water. These were inundated by short-lived glacial lakes that left the plain slightly eroded or veneered with silty clay typically less than 0.3 m thick.

Lacustrine plain areas vary considerably in size and have a sporadic distribution. They generally consist of silt and clay that cover the minor irregularities of the underlying till plain to give a nearly flat surface. A boulder pavement occurs locally in the western part of the plain. The drift is generally thin, and bedrock outcrops are common on the southern part of the plain.

Tills of the Zelena and Arran formations occur on the plain as well as undivided drift of possibly the Tee Lakes or Minnedosa formations. The Zelena Formation generally is present where the till succession is more than 8 m thick. It commonly lies over shale bedrock and under till of the Arran Formation. In the southwestern part of the plain where the drift is thin, a boulder pavement with west trending furrows marks the contact between the tills of these formations.

Assiniboine River Plain (west and southwest)

The Assiniboine River Plain covers more than 14,000 km^2 adjacent to much of the Qu'Appelle and Assiniboine valleys in Manitoba and Saskatchewan. Tills of the Largs, Tee Lakes, Shell, Minnedosa and Lennard formations underlie the Plain. The Largs Formation seems to be restricted mostly to buried valleys where it is more than 30 m thick. The surface till is from the Lennard Formation, although in places west it is thin and patchy.

Bedrock plains occur in several belts and localized areas. Ice flow features, including drumlins, drumloids and flutings, form both prominent hills and subdued features on the Plain. Gently irregular till plains marked by ridges and knolls generally less than 3 m high cover half the Plain. Pockets of silt and sand commonly occur within the till where it is exposed by dugouts and road cuts (Klassen, 1979).

Corrugated moraine covers portions to the west. The outwash forms a smooth plain, except for some sand dunes. The dunes were built by the northwesterly winds that are still the prevailing winds today. Some dunes may have been built in late Wisconsin period by winds blowing from the glacier situated to the northwest, but the majority of dunes are postglacial in age. Their forms show the controlling influence of recent vegetation.

To the south of Shellmouth small ridges formed by retreating glaciers, or kames, occur along the margin of a narrow pitted belt of outwash. Here the outwash is gravely.

A flat lacustrine plain occurs east of Big Boggy Creek. The deposits consist of veneers of massive clay that probably was deposited in a small, pre-glacial lake along the northeastern margin of the Assiniboine ice lobe. Esker ridges are scattered here and there either singly or as complexes, but most are near or within outwash plains. Highway cuts in the esker ridge exposes typical ice-contact deposits of silt, sand, gravel, and till (Klassen, 1979). Kames occur in isolated hills or in chains of hills and knolls beside or within meltwater channels. They are mostly gravel, sand, and wedges of till. Scattered boulders are also present but are more common near the surface (Klassen, 1979).

Buried valleys are fairly common but are either completely masked and traceable only by subsurface mapping of the bedrock topography, or are only partly buried and readily traced on air photos. These valleys have floors of hummocky moraine. Most are less than 1 km wide. Where several valleys meet they may be twice as wide. The fill in the valleys consists of sand, gravel and till, with till over the gravel or else grading laterally into it.

Many road ditches in the bedrock plains and till plains expose a nearly horizontal boulder pavement. In places, the boulders are in till of the Lennard Formation, but generally they are in the underlying till sand, gravel, or shale. The boulder pavement formed may well have formed in conditions unique to the east-central Saskatchewan and southwestern Manitoba regions where they are most extensive. The boulders in a boulder pavement from southwestern Manitoba may have been deposited under the ice during ice stagnation and produced the pavement when the ice was rejuvenated.

Westlake Plain (east)
The plain is nearly flat or gently irregular. In most places it reflects the topography of the underlying Mesozoic sandstones and shales. The plain slopes gradually eastward along the boundary with the Valley River Plain and Duck Mountain Upland. Flights of distinct abandoned beaches trend south along the western boundary of the plain, and more subdued ones mark much of the cultivated southern part. Peatlands and mixed forest mask small glacial features in the northern half.

Tills of the Zelena and Arran formations are present. However, where the drift is thin, only Arran Formation till occurs and lies directly over bedrock.

An extensive lake plain is present in the eastern part of the plain, and smaller ones are found elsewhere on the plain. Lacustrine plains occur below the main beach complexes and apparently most of these sediments were derived from the deglaciated region into the west by stream erosion rather than from meltwater off the continental glacier to the northeast. The complex is mostly sand and fine gravel generally 1.5 to 3 m thick beneath the ridge crests and a veneer of sand, silt and clay over till or bedrock between the ridges.

3.1.4. Soils

Soils in the Forest Management Licence #3 area vary greatly, and have been heavily influenced by post-glaciation processes, as described in the above surficial geology section. Soils are the 'hub' of ecosystems. Soil characteristics have a significant and permanent influence on ecosystems, and have been found to be ecologically significant in every ecological classification system across Canada. Soils are important part of Ecosystem-Based Management and forest management in general. For example, it is important to know where the wet soils are, and schedule winter only harvest on wet soils. Conversely, summer harvest needs dry or mesic soils. Soils support forests, wetlands, prairies, and grassland biodiversity.

Soil plays a vital role in boreal forest ecosystems, and are essential for life, because soils provide a medium for plant growth, are habitat for many insects and other organisms, act as a filtration system for surface water, store carbon, and contribute to the maintenance of atmospheric gases. Soils are home to micro-organisms that fix nitrogen, decompose organic matter, and to animals such as insects and microbes.

Soil is important in providing an adequate water supply and maintaining its quality. Soil and the vegetation it supports catch and distribute rainwater and play a key role in the water cycle and supply. Soil distribution can impact rivers, lakes, and streams by changing their shape, size, capacity, and direction. Soil filters rainwater and regulates the discharge of excess rainwater, reducing flooding. Soil filters water, making aquifers or underground water one of the purest sources of water.

Soils help regulate atmospheric carbon dioxide (CO_2) by acting as a carbon store. Decomposition of trees and their leaves store carbon in the soil, although the majority of carbon returns to the atmosphere. During humification, soil organisms form complex and stable organic matter. Some organic matter breakdown does not occur completely, especially in soils like peat, because peat has a high acidity and water content, restricting respiration. Soils contain more carbon than the above-ground vegetation. Organic matter accumulates in the soil, forming the LFH layer and a black Ah horizon, high in carbon content. Nitrogen, phosphorus, potassium, and many other nutrients necessary for plant growth, are transformed and cycled in the soil.

3.1.4.1 *Soil Mapping*

Soil mapping is a very important step in ecosystem-based management. Soils help define the ecosystem strata for the Forest Management Plan. There is a need to know *what* the soil characteristics are, and also *where* the different soil types are located. In Forest Management Licence #3, soils have been mapped and described at different scales, using different methods, and are based on different soil characteristics (Table 3.6).

Table 3.6 Soil mapping efforts in FML #3 and surrounding area.

	Forest Lands Inventory	Manitoba Agriculture	Manitoba Geological Society	CanSIS (Canadian Soils Survey Information System)
scale(s)	1:60,000 and 1:15,000	Reconnaissance Survey 1:125,000; Detailed surveys 1:20,000	1:250,000 1:1 million	1:3.5 million and 1:1.5 million
focus	mapping landforms and forest soils	Soil survey with agricultural interpretations	surficial geology	Canada-wide mapping of soils polygons, aggregated upward to form EcoRegions and EcoZones
web address	none	http://www.gov.mb.ca/agriculture/crops/cropproduction/gaa01d08.html	http://www.gov.mb.ca/stem/mrd/geo/gis/surfgeomap.html	http://sis.agr.gc.ca/cansis/
Mapping method	top-down using photos, combined with ground-up from field sampling)	ground-up (field survey and photos)	top-down	top-down

3.1.4.1.1 *Soil mapping in the Forest Lands Inventory*

Landscape and soil mapping for the Duck Mountain and Porcupine Mountain Provincial Forests was completed at a scale of 1:60,000 during the creation of the Forest Lands Inventory (2002). Soil orders were mapped (Figure 3.12), utilizing both aerial photography and ground observations. The majority of the Duck Mountain are Luvisols, followed by Gleysols and Organic soils. Part of the east escarpment are Brunisolic soils.

Soil texture class was assigned to each of the soil polygons (Figure 3.13). Soil texture is ecologically important in defining ecosystems, and is the X-axis on the edatopic grid of every ecological classification system across Canada. The Duck Mountain contain mostly fine-textured or clay soils. Some of the clay soils are layered over coarse-textured soils. The eastern portion of Duck Mountain is characterized by medium-textured and layered soils where coarse-textured soils are the upper-most layer. Organic soils are found throughout the Duck Mountain, in low-lying areas, and are typically moisture-receiving bottoms of short hills in the hummocky terrain.

Soil moisture regime classes are mapped (Figure 3.14). Soil moisture regime is ecologically important when defining ecosystems, and is the Y-axis on the edatopic grid of every ecological classification system across Canada.

3.1.4.1.2 *Agricultural Soil Maps*

In the agricultural area of FML #3, soils were mapped using a bottom-up approach. Eight to 16 soil pits per quarter-section were dug and described. The information was aggregated upwards and used to generate soils maps. These maps are now available digitally.

3.1.4.1.3 *Manitoba Geological Society*

The Manitoba Geological Society produced surficial geology maps at a scale of 1:250,000. Top-down mapping utilized field observations and aerial photography.

3.1.4.1.4 *Canadian Soils Survey Information System*

The Canadian Soils Survey Information System (CanSIS) soils polygons form the Ecoregions described in the Ecological Land Classification System section.

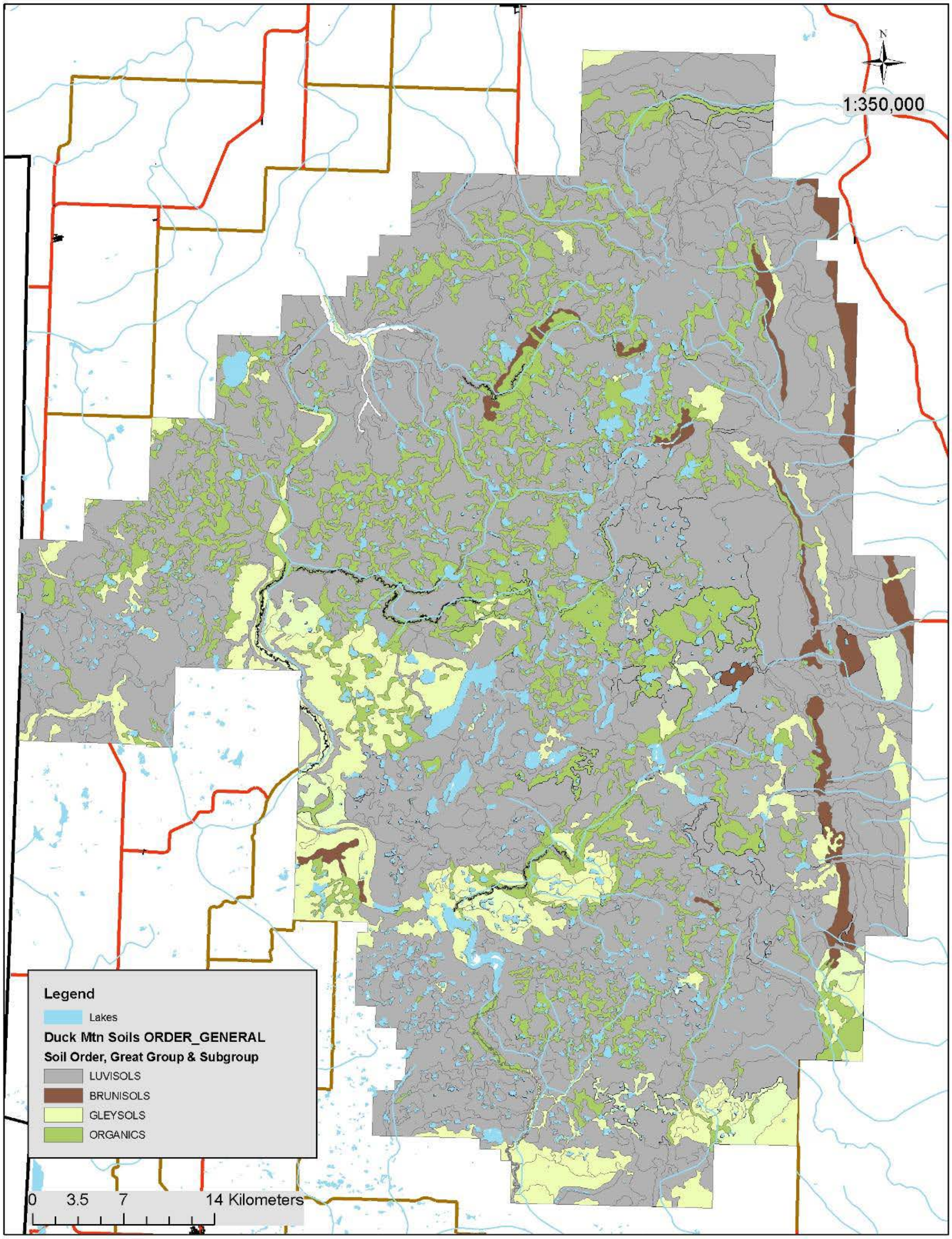


Figure 3.12 Soil orders in the Duck Mountain.

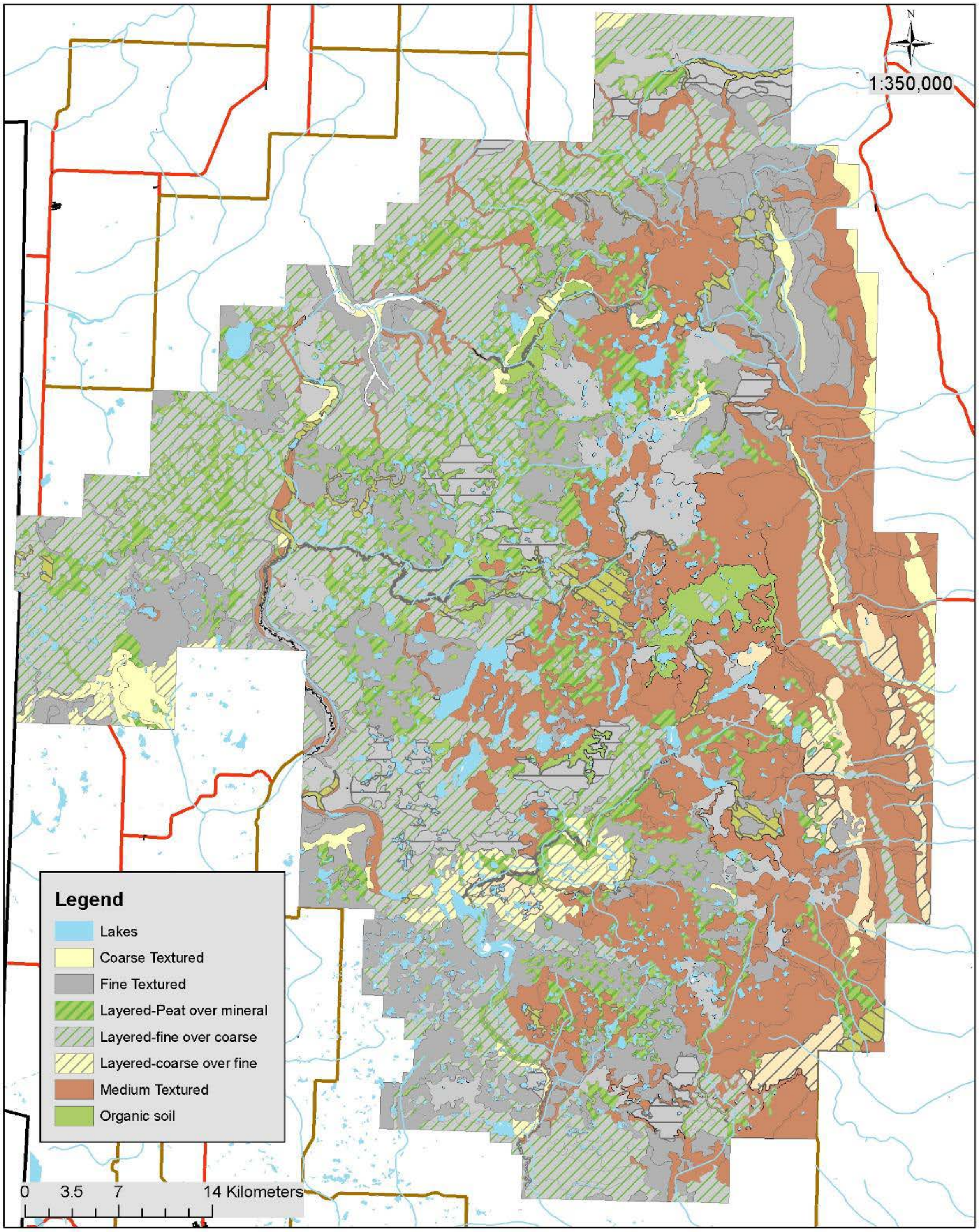


Figure 3.13 Soil texture classes in the Duck Mountain.

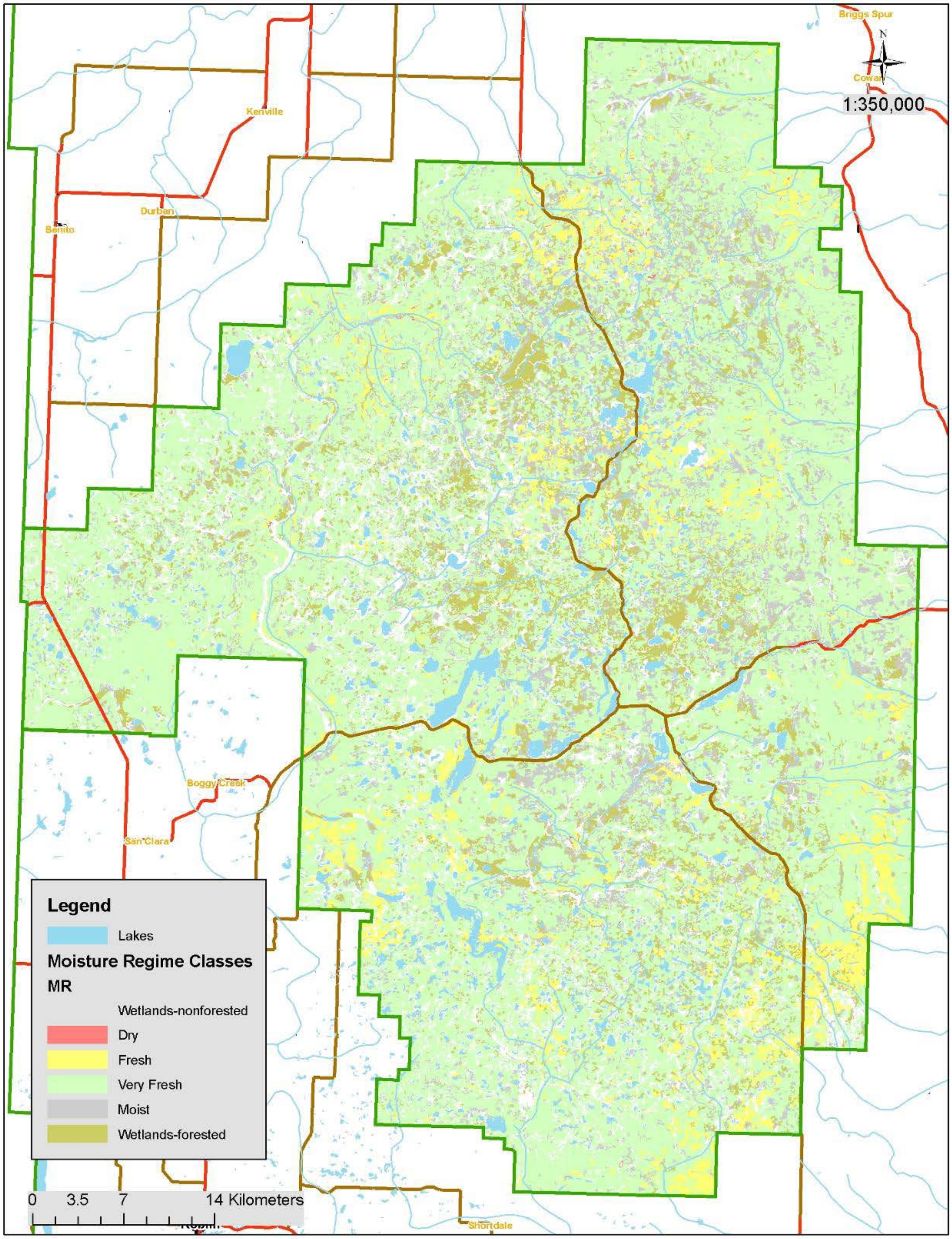


Figure 3.14 Soil moisture regime classes in the Duck Mountain.

3.1.4.2 Soil Conservation

Soil stability is typically a reference of the potential for soil to erode by either wind or water. Stability is influenced by soil type, slope, aspect, amount of rainfall, season, runoff, and ground cover. Conserving soil in the forest is achieved by minimizing erosion through reducing disturbance to the vegetation and litter or duff layer, and maintaining the soil profile. Wind and water are the main eroding forces that need to be considered when implementing forest operations with respect to conserving soils.

Wind erosion potential

There is a negligible potential for wind erosion in the Duck Mountain, because forest vegetation (*i.e*. trees, shrubs, forbs, mosses, and their roots) prevents the soil from being exposed to the wind. Cultivated farm land has a much higher wind erosion potential. Harvest blocks are not left bare of vegetation, they retain shrubs, forbs, and mosses in addition to the regenerating the trees. This prevents any long-term potential for wind erosion.

Manitoba Land Resource Unit produced a map (scale 1:1,000,000) that indicates that there is negligible potential for wind erosion in the Duck Mountain. To ensure that the risk of wind erosion remains low, the following Best Management Practices are implemented on the forest:

- Retain surface organic matter and vegetation (Arnup, 2000);
- Promptly regenerate trees; and,
- Decommission in-block roads by ‘rolling back’ the organic matter, tree stumps, and slash.

Water erosion potential

The risk of water erosion is a consideration for management of areas where topography is complex, slopes are steep, and soils are silty to sandy. Areas of high water erosion risk are associated with steep slopes, including V-shaped valleys and gullies on the edges of the uplands. These higher risk areas will require very special care and attention if harvested.

Water erosion risk on roads and water crossings is minimized in the forest by re-establishing a vegetative cover of grass, willows, shrubs, or trees. In addition, non-vegetative Best Management Practices of preventing erosion on roads and water crossings include:

- 'Armouring' water crossings with rip rap (stones);
- Use of a silt fence;
- Runoff ditches to divert water off slopes and into standing timber;
- Use of ‘pipe bundles’ to protect the stream bed when crossing a stream to install a bridge;
- Use of erosion control blankets and straw / gently sloping cut banks; and
- Installing of wing walls on portable bridges for fill containment.

Best Management Practices are followed to reduce water erosion risk on cutovers, including:

- Avoiding long steep slopes, greater than 40%;
- Harvesting on moist or wet soils in the winter only (frozen ground);
- Shutting down summer and fall operations after a heavy rainfall, reducing rutting and compaction;
- Skidding trees downhill or going around small hills to prevent soil exposure on a slope (Sutherland, 2003; Sutherland, 2005);
- Skidding on many trails instead of concentrating skidder traffic on only one trail;
- Minimizing road development within a cutblock;
- Spreading slash and debris along roads;
- Maintaining tree and shrub vegetation along wetlands, water courses, and swales inside cutblocks; and,
- Training operators and contractors to be aware of and follow all the above Best Management Practices (Sutherland, 2005).

3.1.4.3 Carbon in the Soil

The current forest condition of carbon stocks for upland ecosystems was calculated by applying Johnston's (2005) upland carbon yield curves to the land base. It is estimated that there are approximately 52.5 million tonnes of upland carbon in the Duck Mountain Provincial Forest Table 3.7. There is a very significant amount of carbon in the upland soils (72%), compared to the amount of carbon in trees (28%).

Table 3.7 Upland and wetland carbon estimates for the Duck Mountain Provincial Forest.

Ecosystem Portion	Tonnes Carbon	Proportion of Total Carbon (%)
* **UPLANDS** (80% of land base)		
Soil C	37,781,300	72%
Tree stem Biomass C	11,136,823	21%
Tree roots, stump, top, branches Biomass C	3,570,245	7%
Upland subtotal	**52,488,368**	**100%**
** **WETLANDS** (20% of land base)		
Soil C	39,604,185	88%
Vegetation –above ground C	5,187,810	12%
Wetland subtotal	**44,791,995**	**100%**
TOTAL	**97,280,363**	

*314,093 ha within FMU 13 - utilizing the Forest Lands Inventory

**79,417 ha within FMU 13 -utilizing the Enhanced Wetland Classification by Ducks Unlimited

Carbon calculations for organic soils in wetlands were quantified from the carbon in wetlands project. Although there is less wetlands area in FML #3 that uplands, wetlands account for approximately 70% of the carbon in the Duck Mountain (Figure 3.15).

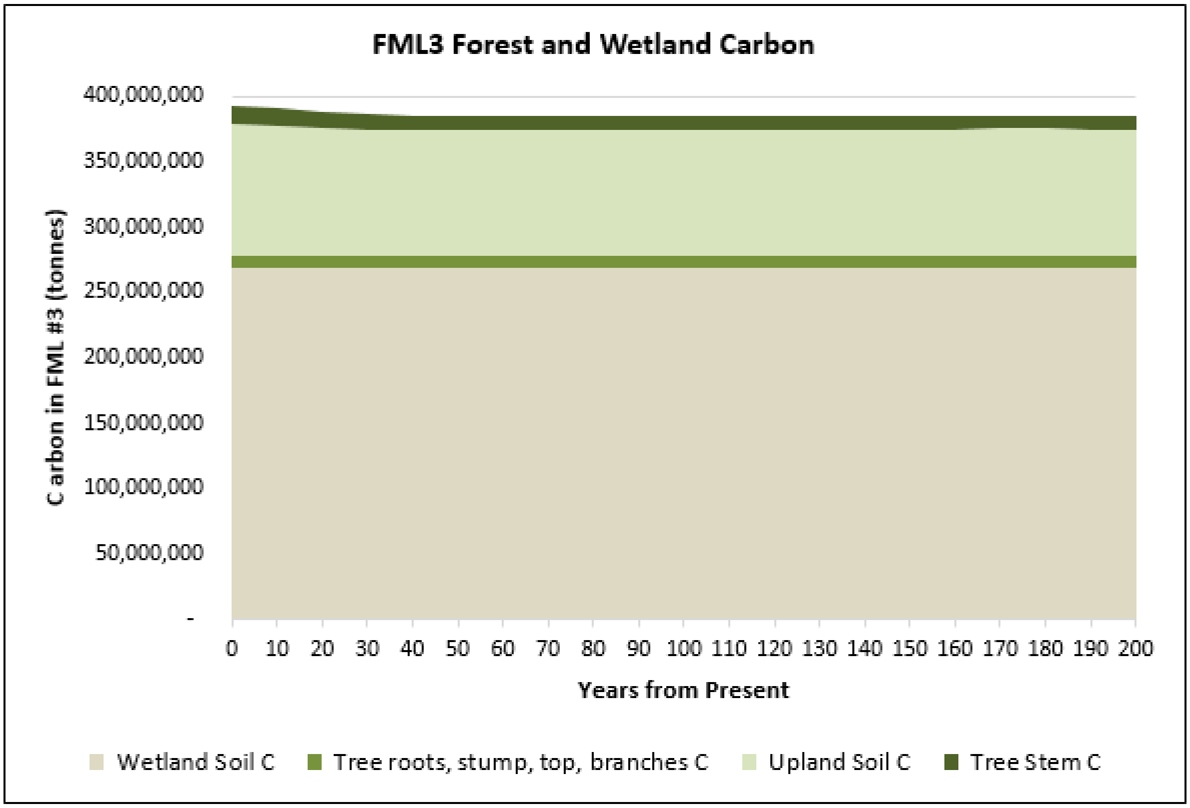


Figure 3.15 Combined upland and wetland carbon stocks in FML #3.

The majority of wetland carbon is in the peat (organic soil). Average peat depths by major wetland type were 2.5 m, 2.4 m, and 0.9 m for bogs, fens, and swamps, respectively. Note that grasslands, shallow open water, and agricultural land were not sampled, nor estimated for carbon content. A carbon density map for FML 3# is shown in Figure 3.16.

It is relevant to note that when softwood and hardwood harvesting occurs, only the stem biomass portion of upland forest is removed from the site. Both softwood lumber and hardwood siding are used to build homes. The average carbon sequestration period for these homes is 100 years. Overall, forest harvesting for durable wood products such as construction materials, removes or sequesters atmospheric carbon because the subsequent regenerating forest will absorb large amounts of carbon.

Living forests and their soils contain a significant portion of the earth's carbon reservoir (Moore 1977). Watson *et al.* (1990) estimate that forest biomass contains about two-thirds as much carbon as the atmosphere, and detritus and soil organic carbon pools contain about twice as much carbon as the atmosphere. Hence, forest management and harvesting activities must consider the effects on atmospheric carbon dioxide concentrations.

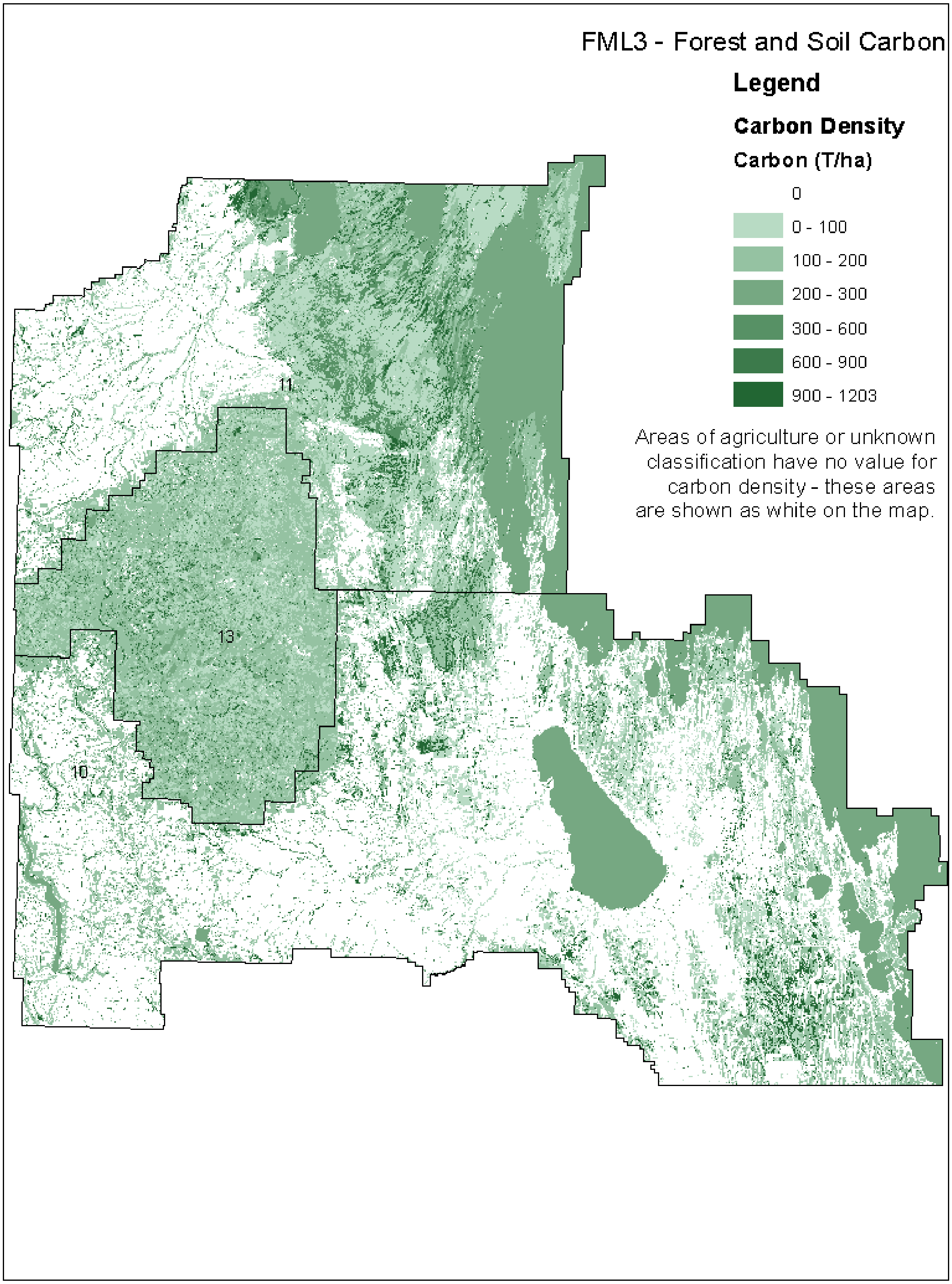


Figure 3.16 Carbon density map of upland and wetland ecosystems across FML # 3.

Moore (1977) notes that the removal of old forests and their replacement with young, actively growing forests results in a net loss of atmospheric carbon. Most natural forests, he notes, are at or near their climax or equilibrium, that represents "a no-growth situation…its carbon uptake will be equalled by its carbon loss." Kurz *et al.* (1992), however, state that the old growth forest continues to transfer carbon to the soil through deposits of litter and coarse woody debris.

Moore (1977) concludes: "If one were to consider forest clearance purely from the point of view of global carbon balance…it represents the creation rather than the destruction of a carbon sink in that it revitalizes successional processes."

The Canadian Federal Standing Committee on Environment (SCE) (1990) noted that young forests absorb more atmospheric carbon than older, mature stands. Plantation forests in the southern US or Pacific Northwest absorb more than 5.4 tonnes of C/ha annually (Standing Committee on Environment 1990). Woodwell (1989) notes that a vigorous program of reforestation removes up to nine tonnes a hectare of atmospheric carbon annually.

Although the SCE noted the ecological significance of maintaining old growth forests, they recommended, as a strategy to combat global warming, the maximization of carbon absorption "through programs designed to develop and maintain vigorously growing forest stands. This can be done by ensuring prompt regeneration of harvested areas, either through planting or by natural means, and reducing the extensive losses of stands to wildfire, insects, and disease."

Activities associated with the forest sector, particularly for construction materials, like result in a net accumulation of carbon. This is particularly significant when compared to natural disturbances. A study by Kurz *et al.* (1992) shows that wildfire adds the most carbon to the atmosphere. Thus, suppressing fires, using mature and overmature trees for construction products and regenerating highly productive hardwood and mixedwood stands in FML #3 should result in a net accumulation of carbon from the atmosphere.

3.1.5. Ecological Land Classification

Ecological Land Classification (ELC) is a process of delineating and describing ecologically distinctive areas based on landforms, soils, vegetation, and climate in an ecologically meaningful way. The ELC system involves an integration of all these components and is not simply an overlay of them. Expressing ecosystems as units on a map provides a basis for understanding their structure and composition (Wiken 1996). This holistic approach to land classification can be applied incrementally on a scale-related basis from site-specific ecosystems to very broad ecosystems.

3.1.5.1 Canadian Ecological Land Classification

The Canadian Ecological Land Classification (ELC) system is based on a hierarchy, with ecosystems nested within ecosystems, providing hierarchical units (Table 3.8). These ecosystems form part of a "nested hierarchy" at multiple scales, where smaller ecosystems are encompassed within successively larger ecosystems.

Table 3.8 Canadian Ecological Land Classification system hierarchy (highest to lowest level).

Ecological Land Classification Level and number of polygons in Canada	**Mapped by**	**Description**
Ecozones 15 terrestrial & 5 marine ecozones	Canadian Ecological Land Classification	The most generalized level (*e.g.* Boreal Plain ecozone). Global or continental climate as reflected by vegetation.
Ecoprovince 53		A sub-division of ecozones. Encompasses areas of uniform climate, geological history, and physiography. *Note*: boundaries of the ecoprovinces do not correspond to the political borders of Canadian provinces
Ecoregions 194		Large order landforms as expressed through similar climate, soils, and vegetation (*e.g.* Mid-Boreal Upland ecoregion).
Ecodistricts 1021		sub-division of ecoregions characterized by distinctive assemblages of relief, geology, landform, soils and vegetation (e.g. EcoDistrict polygon # 715 - Duck Mountain)
Ecoassociations	**base polygons** for Soil Landscapes of Canada	mappable entity. Stand aggregates. Scale 1:50,000+ a repeating pattern of landform, topography, soils and vegetation throughout an ecodistrict
Ecosites	Forest Lands Inventory 2002	Stand-level. Mappable entity at operational scales (1:15,000 or 1:20,000). Soils <u>and</u> vegetation combined.
Ecoelements	not mapped (field guide only)	(V-types) vegetation-types and S-types (soil-types) below the stand level (applies to a 0.01 ha area - 10 m X 10 m) *e.g.* Forest Ecosystem Classification for Manitoba (Zoledeski *et al.* 1995)

3.1.5.1.1 Ecozones

Ecozones are the most generalized, and highest-level of ecological land classification. Figure 3.15 shows the various Ecozones of Canada.

Figure 3.17 Terrestrial ecozones of Canada, showing the Boreal Plain (light green) and Prairie (yellow) ecozones.

Only two Ecozones are present within FML #3 (Figure 3.16), the Boreal Plain Ecozone and the Prairie Ecozone.

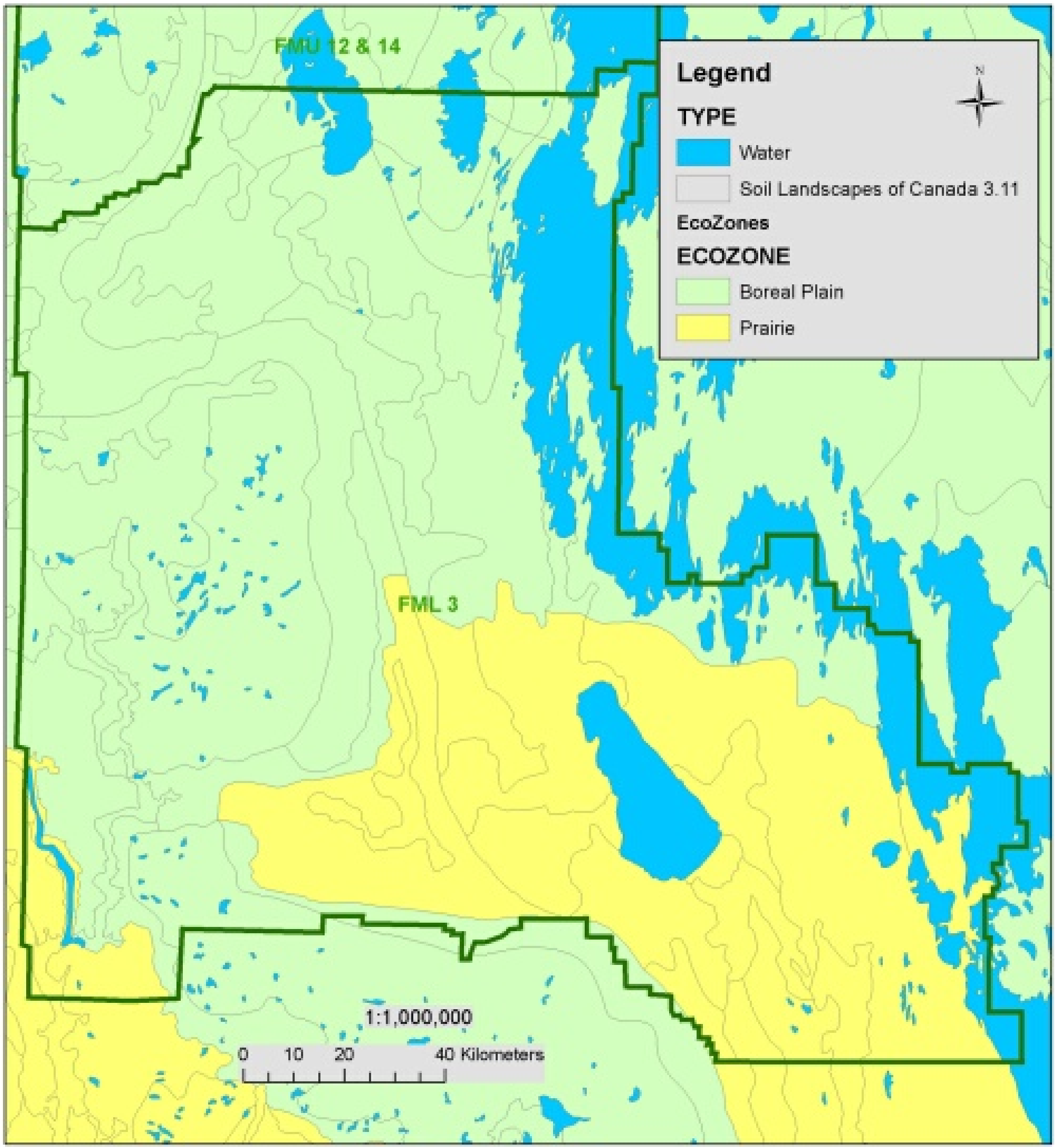


Figure 3.18 Boreal Plain and Prairie ecozones within FML #3.

3.1.5.1.2 Ecoprovince

An Ecoprovince is a biogeographic unit smaller than an ecozone and contains one or more ecoregions. An ecoprovince encompasses areas of uniform climate, geological history and physiography (*i.e.* mountain ranges, large valleys, plateaus). Their size and broad internal uniformity make them ideal units for the implementation of natural resource policies.

3.1.5.1.3 Ecoregions

Within the Boreal Plain ecozone, lies the Mid-Boreal Upland ecoregion, which encompasses the Duck Mountain Provincial Forest. Other ecoregions with FML #3 include the Boreal Transition, Interlake Plain, Lake Manitoba Plain, and a small portion of the Mid-Boreal Lowlands (Figure 3.17). Within the Prairie ecozone is a single ecoregion, the Aspen Parklands.

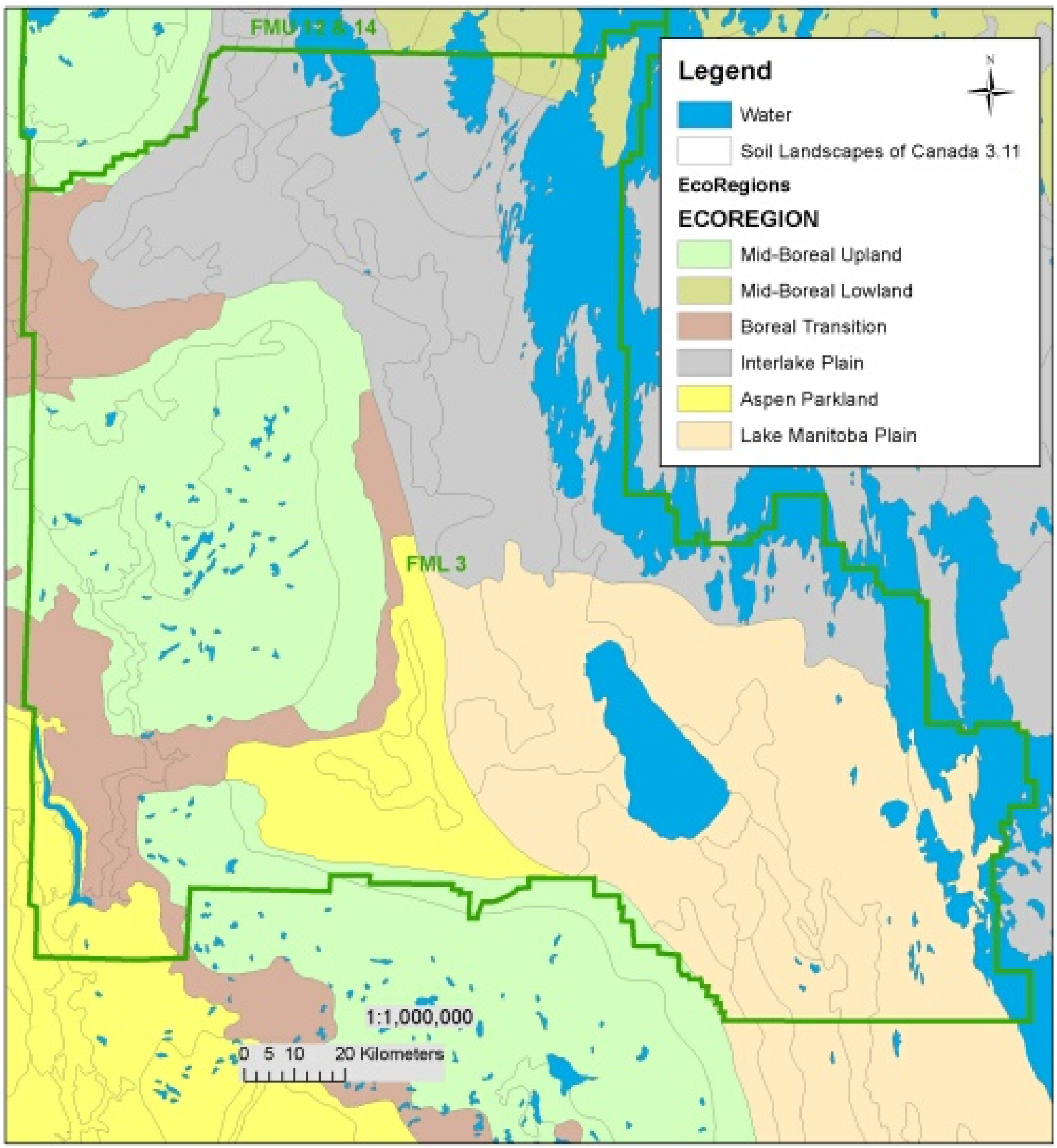


Figure 3.19 Ecoregions within FML #3.

3.1.5.1.4 Ecodistricts

Ecodistricts are subdivisions of ecoregions. There are 1021 mapped ecodistricts across Canada. The ecodistricts selected for use in describing Canadian forests are those featuring ecosystems that have predominantly woody vegetation, and does not take into consideration the commercial value of the trees. Ecodistricts also include wetlands. Note that the Duck Mountain forms a single, unique ecodistrict (Figure 3.18).

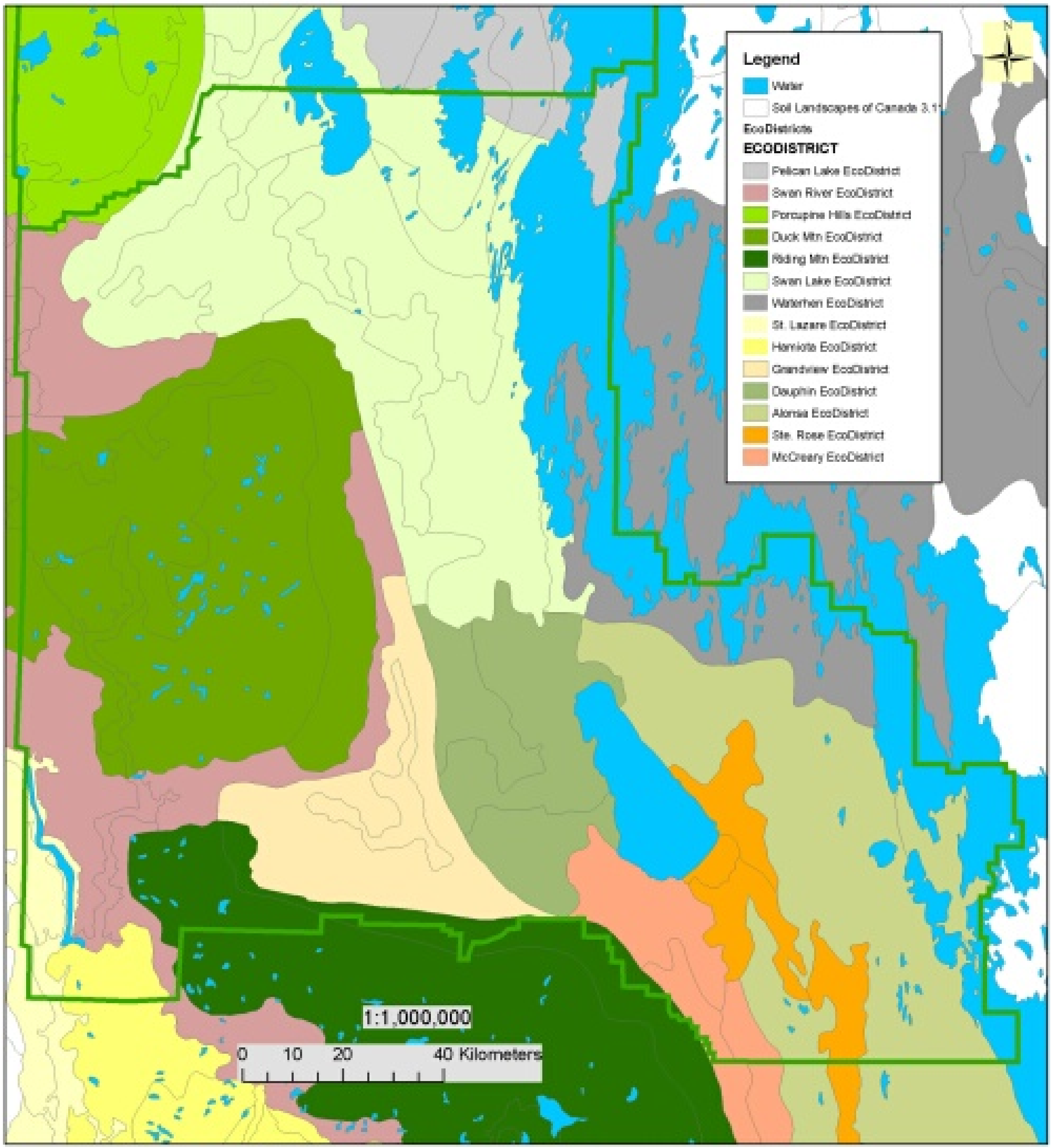


Figure 3.20 Ecodistricts within FML # 3.

3.1.5.1.5 Ecoassociations

Ecoassociations are a repeating pattern of landform, topography, soils, and vegetation. Ecoassociations are the lowest level polygons in the Ecological Land Classification hierarchy. Higher-order polygons (*i.e.* ecozones, ecoprovinces, ecoregions, and ecodistricts) are created by aggregating similar ecoassociation polygons. The ecoassociations of FML # 3 are shown in Figure 3.19.

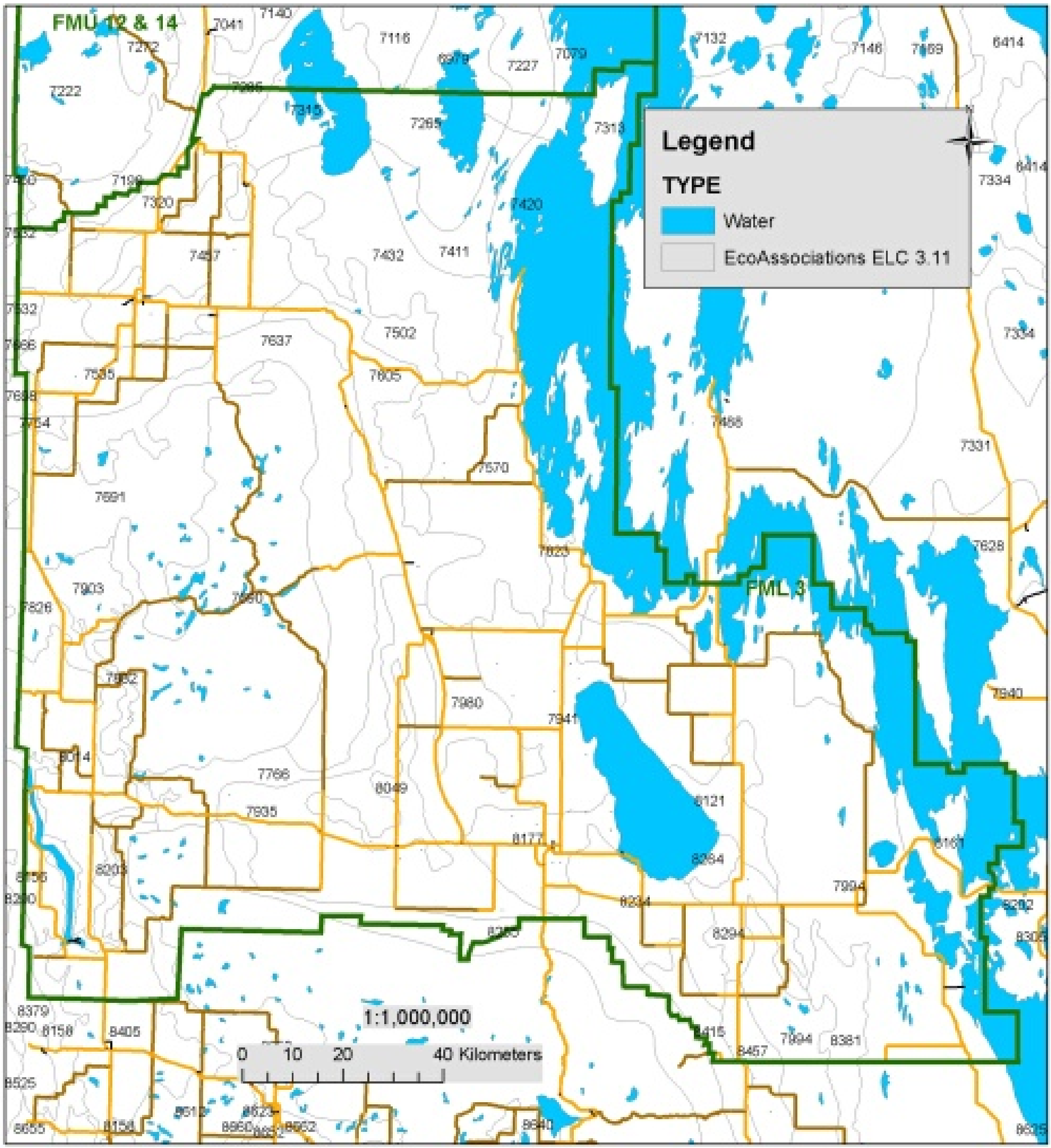


Figure 3.21 Ecoassociations within FML # 3.

3.1.5.2 FML #3 Ecological Land Classification

Localized Ecological Land Classification (ELC) was developed for the Duck Mountain Provincial Forest (Arnup *et al*. 2006) in conjunction with the creation of the Forest Lands Inventory (2002). This work was developed at the ecosite or stand level, within the Canadian Ecological Land Classification described in the above section.

3.1.5.2.1 Ecosites

Ecosites are a hierarchical unit within the Canadian Ecological Land Classification system, but are not mapped across Canada by the Canadian ELC system. Ecosites are groupings of soils and vegetation that are mappable at an operational scale (1:15,000) or stand-level. Mapped ecosites in the Duck Mountain range from 2 to 200 hectares in size, although some wetland ecosites are smaller.

An ecosite classification system and ecosite mapping system was developed (Table 3.9) for ecosites of the Mid-Boreal Upland Ecoregion of Manitoba (Arnup *et. al.* 2006). This work was done in conjunction with an ecological inventory of the same area (Forest Lands Inventory, 2002).

Table 3.9 Summary table of all ecosite characteristics.

	Ecosite Number	Soil Moisture Class	Soil Texture Class	Vegetation
non-forested wetlands	**W1**	wet	n/a	Open Bog (low shrub)
	W2	wet	n/a	Open Poor Fen (low shrub)
	W3	wet	n/a	Open Rich Fen
	W4	wet	n/a	Thicket Swamp
	W5	wet	n/a	Shore Fen
	W6	wet	n/a	Meadow Marsh
	W7	wet	n/a	Sheltered Marsh
	W8	wet	n/a	Exposed Marsh
	W9	wet	n/a	Open Water Marsh (floating leaf - peat substrate)
	W10	wet	n/a	Open Water Marsh (submergent - mineral substrate)
forested uplands	**11**	Dry-Fresh	sandy	TA-BA hardwood
	12	Dry-Fresh	sandy	TA-JP-Spruce mixedwood
	13	Dry-Fresh	sandy	JP-BS feathermoss
	21	Fresh	coarse loamy-silty	WB mixedwood
	22	Fresh	coarse loamy-silty	TA hardwood
	23	Fresh	coarse loamy-silty	TA-WS mixedwood
	24	Fresh	coarse loamy-silty	JP-BS mixedwood
	31	Fresh	Clayey (lacustrine)	TA-BA hardwood / mixedwood
	32	Fresh	fine loamy (till or stratified)	TA-BA hardwood
	33	Fresh	fine loamy (till or stratified)	TA-BA mixedwood
	34	Fresh	fine loamy (till or stratified)	WS-BF mixedwood
	35	Fresh	fine loamy (till or stratified)	JP-BS mixedwood

	Ecosite Number	Soil Moisture Class	Soil Texture Class	Vegetation
	36	Fresh	fine loamy (till or stratified)	BS-JP-(WS-BF) Labrador tea-feathermoss
	41	Moist	sandy to silty	TA-BA hardwood
	42	Moist	sandy to silty	WS (BF) mixedwood
	43	Moist	sandy to silty	BS-JP-feathermoss
	44	Moist	coarse loamy to clayey	Other hardwoods (AG-AE-MM)
	51	Moist	fine loamy to clayey	TA-BA hardwood
	52	Moist	fine loamy to clayey	TA-WS-JP mixedwood
	53	Moist	fine loamy to clayey	BS-feathermoss-Labrador-tea
forested wetlands	**61**	Wet	fibric-mesic organic	BS-(WS) -Lab tea - Fmoss - Sphagnum
	62	Wet	mesic organic	BS-Alder-Herb Rich
	63	Wet	fibric organic	TL-BS-Sedge (Treed Fen)
	64	Wet	fibric organic	BS-(JP)-Ericaceous-Sphagnum
non-forested uplands	**71**	Dry - Moist	any mineral soil texture	Open Shrub
	72	Dry - Moist	any mineral soil texture	Closed Shrub
	73	Dry - Moist	any mineral soil texture	Grassland

Figure 3.20 shows the how the landbase was split into non-forested uplands, forested uplands, non-forested wetlands, and forested wetlands based on soil moisture regime and crown closure. Soil Moisture Regime (SMR) separates wetlands (SMR 7, 8, & 9) from uplands (SMR theta to 6). Crown closure separates forested (6% to 100%) from non-forested (0% to 5% crown closure).

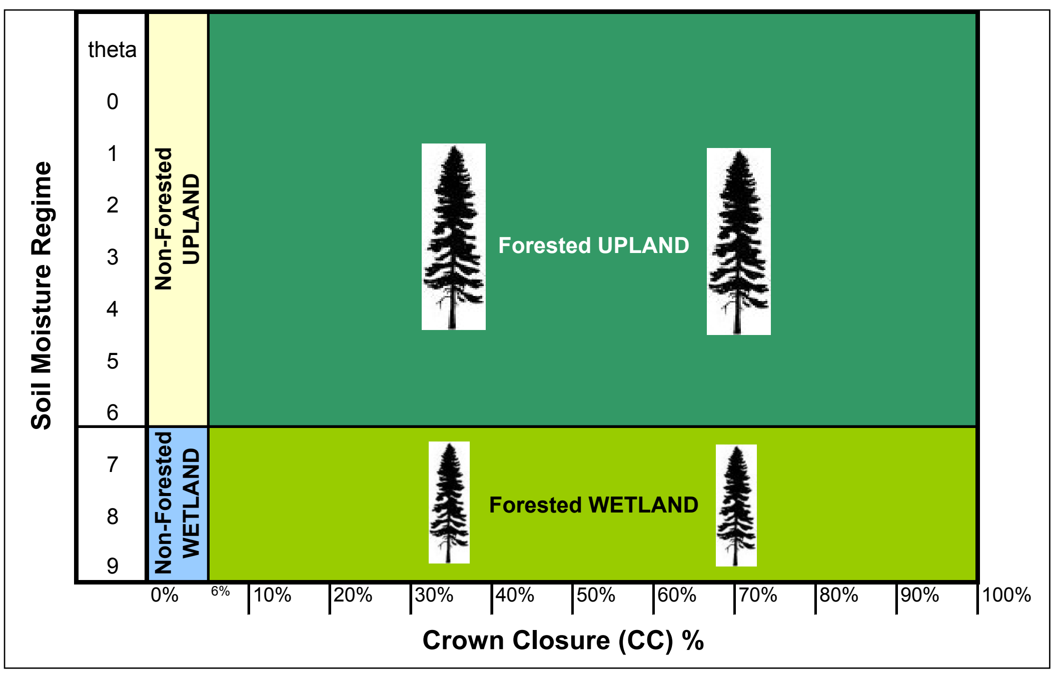


Figure 3.22 Division of entire Duck Mountain landbase into combinations of upland or wetland, and forested or non-forested.

Table 3.10 ranks the mapped ecosites from most common (greatest % area) to rare (least % area).

Table 3.10 Total and percent area by ecosites, sorted from abundant to rare in the Duck Mountain Provincial Forest and Park.

Ecosite Frequency	Ecosite Number	Vegetation	Total Area (ha)	Percent
Abundant	32	TA-BA hardwood	99,838.4	26%
Abundant	33	TA-BA mixedwood	46,577.7	12%
Abundant	31	TA-BA hardwood / mixedwood	37,087.2	10%
Moderate	53	BS-feathermoss-Labrador-tea	26,436.8	7%
Moderate	36	BS-JP-(WS-BF) Labrador tea-feathermoss	24,691.6	7%
Moderate	6	meadow marsh	17,172.6	5%
Moderate	61	BS-(WS) -Lab tea - Fmoss - Sphagnum	17,080.7	5%
Moderate	34	WS-BF mixedwood	15,394.3	4%
Infrequent	22	TA hardwood	7,518.3	2%
Infrequent	63	TL-BS-Sedge (Treed Fen)	6,462.1	1.7%
Infrequent	52	TA-WS-JP mixedwood	6,444.7	1.7%
Infrequent	23	TA-WS mixedwood	6,186.2	1.6%
Infrequent	35	JP-BS mixedwood	6,126.9	1.6%
Infrequent	7	sheltered marsh	5,350.0	1.4%
Infrequent	64	BS-(JP)-Ericaceous-Sphagnum	5,239.7	1.4%
Infrequent	4	thicket swamp	4,248.3	1.1%
Infrequent	72	Closed Shrub	4,116.2	1.1%
Infrequent	62	BS-Alder-Herb Rich	3,799.2	1.0%
Infrequent	51	TA-BA hardwood	3,606.8	1.0%
Infrequent	24	JP-BS mixedwood	3,151.2	0.8%
Infrequent	21	WB mixedwood	2,941.9	0.8%
Infrequent	5	shore fen	2,591.6	0.7%
Infrequent	43	BS-JP-feathermoss	1,854.1	0.5%
Infrequent	9	open water marsh - floating leaved/peat substrate	1,787.3	0.5%
Infrequent	73	grassland, prairie savannah	1,734.4	0.5%
Infrequent	2	open poor fen - low shrub	1,479.1	0.4%
Rare	10	open water marsh - submergent mineral substrate	919.0	0.2%
Rare	42	WS (BF) mixedwood on moist, coarse soil	859.9	0.2%
Rare	3	open rich fen	772.2	0.2%
Rare	8	exposed marsh	636.4	0.2%
Rare	41	TA-BA hardwood on moist, coarse soil	475.3	0.1%
Rare	11	TA-BA hardwood on dry, coarse soil	374.1	0.1%
Rare	71	Open Shrub	148.3	0.0%
Rare	12	TA-JP-Spruce mixedwood on dry, coarse soil	125.6	0.0%
Rare	1	open bog - low shrub	64.8	0.0%
Rare	13	JP-BS feathermoss on dry, coarse soil	1.2	0.0%
Rare	44	Other hardwoods (Green Ash-American Elm-Manitoba Maple)	0.0	0.0%

Areas by ecosite are summarized in Table 3.11.

Table 3.11 Area summary by ecosite for the Duck Mountain Provincial Forest and Park.

	Forest Management Unit 13 Duck Mountain Provincial Forest		Duck Mountain Provincial Forest	Duck Mountain Provincial Park			
				Backcountry Zone	Recreation Zone	Resource Zone	
	Ecosite	Ecosite Description	Area (ha)	Area (ha)	Area (ha)	Area (ha)	Total Area (ha)
Non-Forested Wetlands	1	open bog - low shrub	55	2	0	8	**65**
	2	open poor fen - low shrub	974	91	8	405	**1,479**
	3	open rich fen	704	12	4	53	**772**
	4	thicket swamp	2,708	827	67	640	**4,242**
	5	shore fen	1,922	89	30	547	**2,588**
	6	meadow marsh	10,224	2,560	212	4,162	**17,158**
	7	sheltered marsh	4,270	288	168	619	**5,346**
	8	exposed marsh	570	29	0	37	**636**
	9	open water marsh - floating leaved/peat substrate	693	107	48	939	**1,787**
	10	open water marsh - submergent mineral substrate	817	35	17	50	**919**
Forested Uplands	11	TA-BA hardwood	308	36	0	29	**373**
	12	TA-JP-Spruce mixedwood	47	12	3	63	**126**
	13	JP-BS feathermoss	0	0	0	1	**1**
	21	WB mixedwood	2,670	59	26	177	**2,931**
	22	TA hardwood	6,241	843	35	322	**7,442**
	23	TA-WS mixedwood	4,574	1,017	75	511	**6,177**
	24	JP-BS mixedwood	1,431	357	1	1,363	**3,152**
	31	TA-BA hardwood / mixedwood	17,877	7,209	636	11,342	**37,064**
	32	TA-BA hardwood	73,346	12,971	1,471	11,687	**99,474**
	33	TA-BA mixedwood	32,358	5,475	1,568	7,132	**46,533**
	34	WS-BF mixedwood	10,376	1,932	474	2,611	**15,392**
	35	JP-BS mixedwood	2,610	483	159	2,874	**6,126**
	36	BS-JP-(WS-BF) Labrador tea-feathermoss	12,013	1,895	396	10,386	**24,690**
	41	TA-BA hardwood	404	52	0	15	**471**
	42	WS (BF) mixedwood	562	197	6	93	**858**
	43	BS-JP-feathermoss	1,032	123	12	684	**1,851**
	44	Other hardwoods (AG-AE-MM)	0	0	0	0	**0**
	51	TA-BA hardwood	2,544	686	26	339	**3,596**
	52	TA-WS-JP mixedwood	4,495	883	111	952	**6,442**
	53	BS-feathermoss-Labrador-tea	12,199	2,315	610	11,298	**26,422**

		Forest Management Unit 13 Duck Mountain Provincial Forest	Duck Mountain Provincial Forest	Duck Mountain Provincial Park Backcountry Zone	Recreation Zone	Resource Zone	
Forested Wetlands	61	BS-(WS) -Lab tea - Fmoss - Sphagnum	6,150	1,250	169	5,187	**12,757**
	62	BS-Alder-Herb Rich	1,313	237	11	1,318	**2,879**
	63	TL-BS-Sedge (Treed Fen)	2,934	604	79	2,841	**6,458**
	64	BS-(JP)-Ericaceous-Sphagnum (Treed Bog)	2,282	1,040	112	1,804	**5,238**
Non-Forested Uplands	71	Open Shrub	148	0	0	1	**148**
	72	Closed Shrub	2,470	578	155	906	**4,109**
	73	grassland, prairie savannah	953	277	18	482	**1,730**
	82	cutbanks	1	0	0	0	**1**
	88	lakes and ponds	8,443	2,176	1,836	4,401	**16,855**
	89	rivers	72	37		6	**115**
	92	transmission lines, tower sites, other cleared land	173	7	21	73	**274**
	93	roads, gravel pits, other	863	147	184	369	**1,563**
		Totals	**233,826**	**46,938**	**8,749**	**86,728**	**376,240**

3.1.5.2.2 Non-Forested Wetland Ecosites

Ten non-forested wetland ecosites (Table 3.12) were based on the Canadian Wetland Classifications System (1997). The non-forested wetland ecosites were photo-interpreted at a scale of 1:15,000 across the Duck Mountain landbase (Figure 3.21). Ecosite primary data (*e.g.* soil moisture, soil texture, vegetation) were mapped by photo interpretation. Field data from 152 non-forested wetland plots collected by Locky *et al*. (2005) were used to populate fact sheet summaries for the 10 wetland ecosites.

Table 3.12 List of Non-Forested Wetland Ecosites.

Wetland Class (Canadian Wetlands Classification System 1997)	**Ecosite Number**	**Description**
OPEN BOGS	WE 1	open bog – low shrub
ISOLATED FENS	WE 2 WE 3	open poor fen – low shrub open rich fen
TERRESTRIAL THICKET SWAMPS	WE 4	thicket swamp
FENS & MARSHES ADJACENT TO WATER FEATURES	WE 5 WE 6 WE 7 WE 8	shore fen meadow marsh sheltered marsh exposed marsh
OPEN WATER MARSHES	WE 9 WE 10	open water marsh – floating leaved/peat substrate open water marsh – submerged mineral substrate

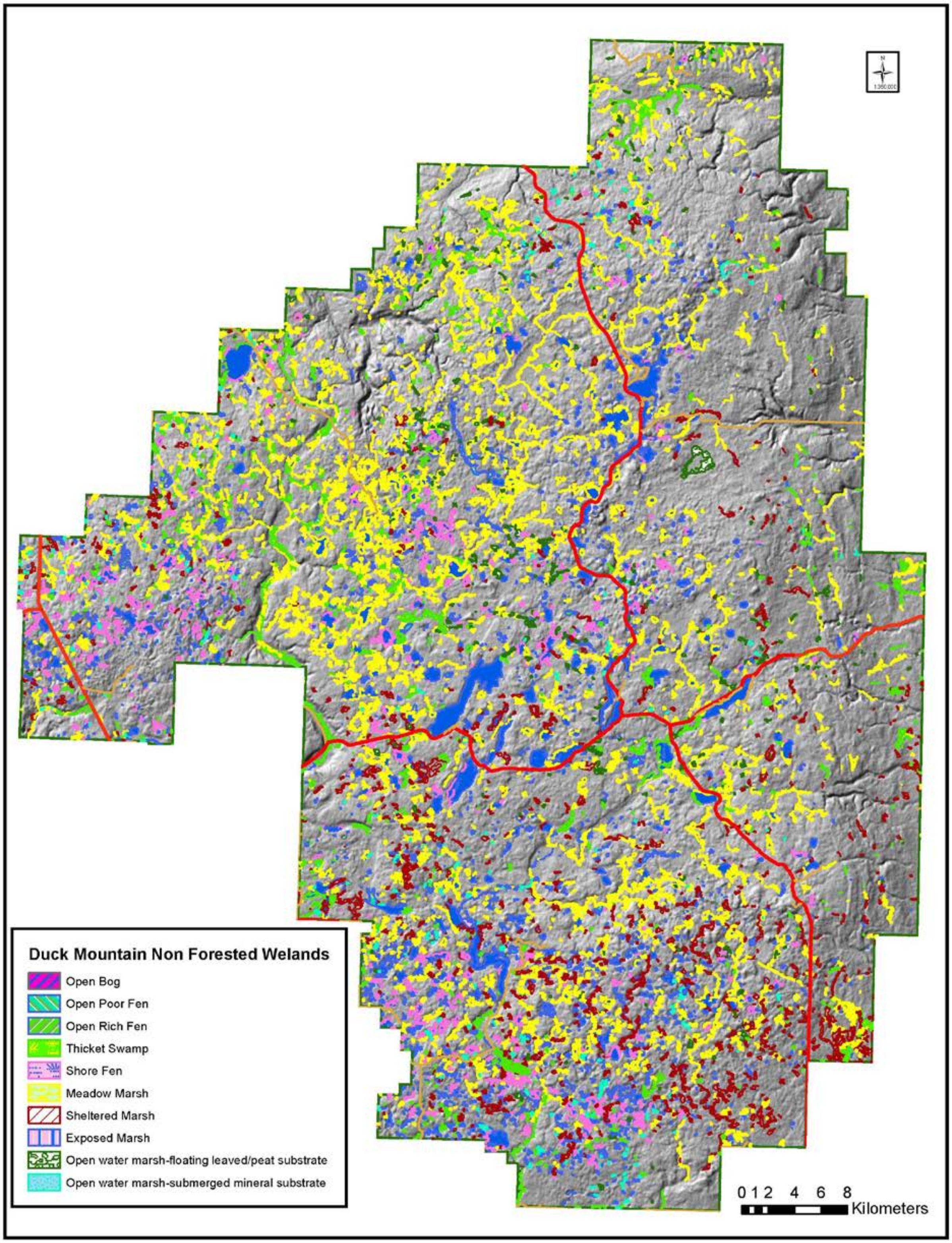


Figure 3.23 Non-forested wetlands in the Duck Mountain Provincial Forest.

Ducks Unlimited Canada classified uplands and wetlands (Smith, 2005). The satellite imagery was 30 m resolution LANDSAT images taken in 2003.

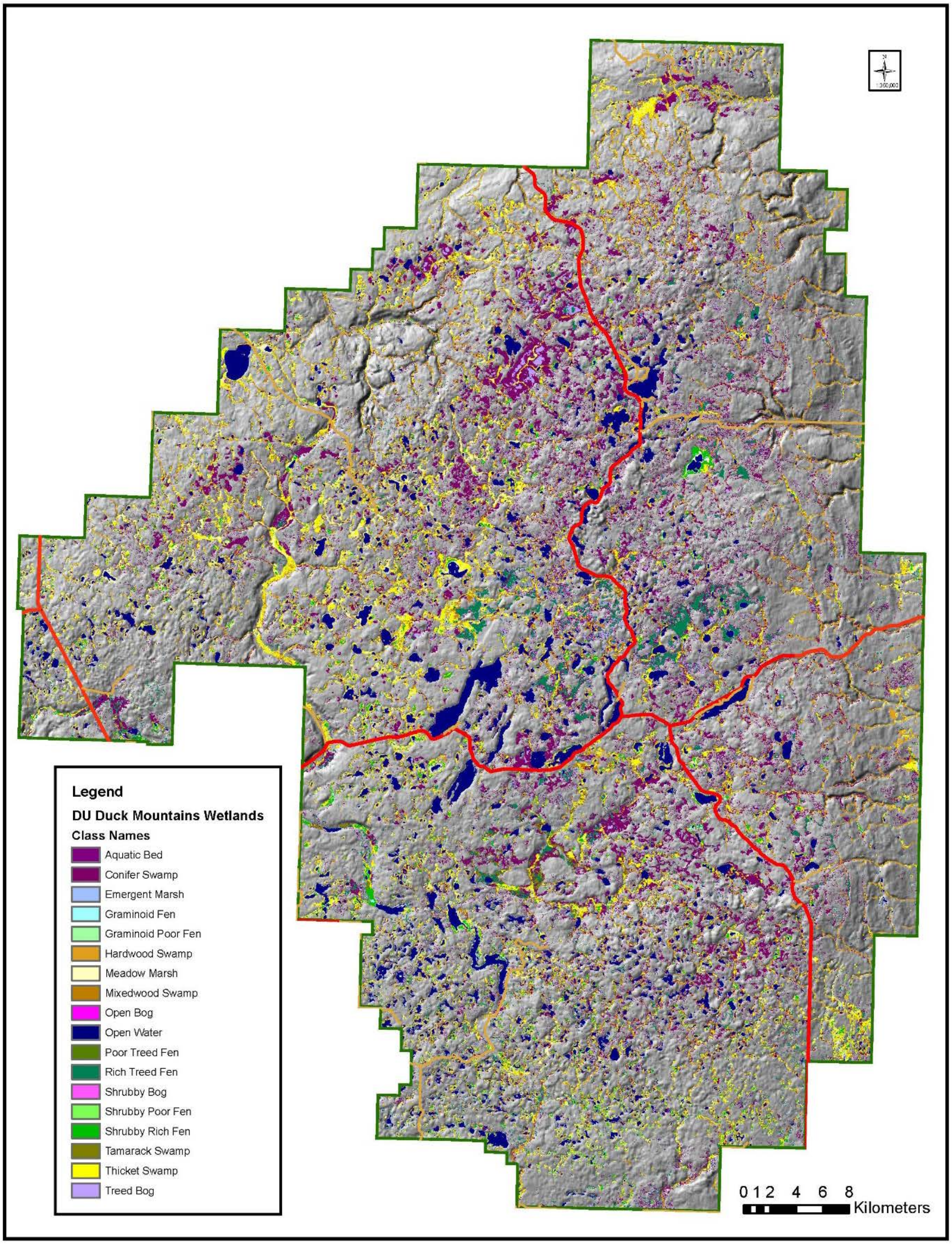


Figure 3.24 Types and Distribution of Wetland Classes within the Duck Mountain Provincial Forest (Ducks Unlimited Canada).

Wetlands provide a wide variety of habitat types, and are rich in both plant and animal biodiversity. Wetlands are also very important in regulating surface and ground water flow within watershed systems. These systems purify water by removing excess nutrients and other pollutants from surface and subsurface water sources.

Wetland Types

Key characteristics of each of the wetland types provided by Smith *et al.* 2007 have been summarized below.

Peat Soil Wetlands

Bogs

Bogs have been created through the accumulation of peat (primarily weakly decomposed *Sphagnum* mosses). This accumulation creates a raised surface compared to the surrounding area. Bogs are hydrologically isolated, bacause the only water input is precipitation, and no surface or groundwater flows enter the bogs. The water table is generally at or just below the surface of the bog. Bogs can be treed (ecosite 64), shrubby or open (ecosite WE 1) depending on the interaction between the soils, water and nutrient supply. Bogs are not common in the Duck Mountain Provincial Forest, and are frequently adjacent to fens (Figure 3.23).

Figure 3.25 Example of open wet bogs (ecosite WE 1) (left photo: Ducks Unlimited Canada)

Fens

Isolated fens are also created through the accumulation of peat. However, fens are level with the surrounding terrain, while bogs are raised. The water table in fens is not stagnant, but moves through the peat very slowly by seepage. Mineral-rich water, through surface or groundwater sources, flows through the fens. The nutrient inputs can create a range of environmental conditions related to fen development. For instance, fens that are in close contact with mineral rich water sources have been classified as rich fens (ecosite WE 3). Rich fens are generally comprised of more brown mosses with some *Sphagnum* mosses. Fens that are in less contact with nutrient rich water sources are poor fens (ecosite WE 2 Figure 3.24), which are typically comprised of *Sphagnum* mosses, ericaceous shrubs, and black spruce, but may also contain tamarack and bog birch. Treed fens (ecosite 63) are dominated by mixtures of black spruce and tamarack trees, and commonly have sedges.

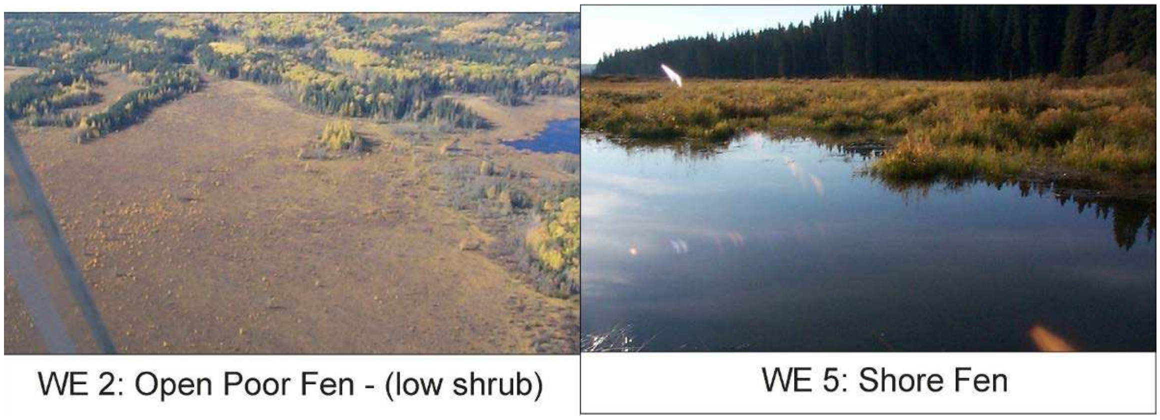


Figure 3.26 Examples an open poor fen (left) and a shore fen (right).

Shore fens are peat deposits on the shore of open water. The surface peat is usually greater than 2 m in depth, does not float, and is firmly anchored. Shore fens usually contain moderately to well-decomposed sedge, and bryophytic or aquatic vascular plants. Mosses or herbaceous plants occur closest to the water and trees. Shrubs, if present, are farther away from the lake or pond edge.

Mineral Soil Wetlands

Swamps

Swamps are areas that are in contact with minerotrophic water in either peatland or mineral soils. Swamps are dominated by woody vegetation (trees or shrubs) in percentages greater than 30% and up to 100% of canopy cover. Treed swamps (ecosites 61 and 62) have black spruce trees and a variety of understory plants. Shrub or thicket swamps (ecosite WE 4) are dominated by shrub species such as willows, alders, and swamp birch (Figure 3.25).

Figure 3.27 Examples of thicket swamps (oblique photo - left) and ground-level photo - right.

The presence of woody vegetation in swamps is generally due to the increased influence or contact with water, nutrients, and aerated soils. Peat soils in swamps are highly decomposed (humic peat) compared to the fibric and mesic peat in bogs and fens. Swamps fluctuating water tables allow for more oxygen, and therefore increased decomposition.

Marshes

Marshes are mineral wetlands (Figure 3.26) that are subjected to temporal periods of flooding (seasonal to annual). Water inputs within a marsh may come from a variety of sources, such as inflows, surface runoff, groundwater discharge, precipitation, and/or flooding. The dissolved minerals and aeration provide the conditions for high productivity and decomposition of vegetative material. Marshes are commonly associated with shallow/open water classes or lacustrine or riverine systems in depressions or low-lying areas. Emergent macrophytes such as reeds, grasses, sedges, broad-leaved emergents, floating-leaved emergents, and submergent vegetation are most common in these wetlands.

Figure 3.28 Examples of different kinds of marshes (top left) meadow marsh; (top right) sheltered marsh; and (bottom left) an exposed marsh.

Shallow Open Water

Shallow open water wetlands are transitional areas between the emergent marsh within the littoral zone of waterbodies and the profundal/ benthic zone or permanent deep waterbodies (Figure 3.27). Shallow open water wetlands are flooded perennially and may be vegetated with floating or submerged vegetation or can be observed as mudflats during seasonal drawdown periods.

Figure 3.29 An example of shallow and open water within the Duck Mountain.

3.1.5.2.3 Forested Wetland Ecosites

There are four forested wetland ecosites (Table 3.13). All four forested wetlands have conifers on organic soil, and have different levels of decomposed organic soils, and different understory vegetation (Figure 3.28). A map of the forested wetland ecosites across the Duck Mountain is shown in Figure 3.29

Table 3.13 Forested wetland ecosite characteristics.

	Ecosite Number	Soil Moisture Class	Soil Texture Class	Vegetation
forested wetlands	**61**	Wet	fibric-mesic organic	BS-(WS) -Lab tea - Feathermoss - Sphagnum
	62	Wet	mesic organic	BS-Alder-Herb Rich
	63	Wet	fibric organic	TL-BS-Sedge (Treed Fen)
	64	Wet	fibric organic	BS-(JP)-Ericaceous-Sphagnum (Treed Bog)

Figure 3.30 Forested wetland ecosites 61, 62, 63, and 64 (clockwise from top left).

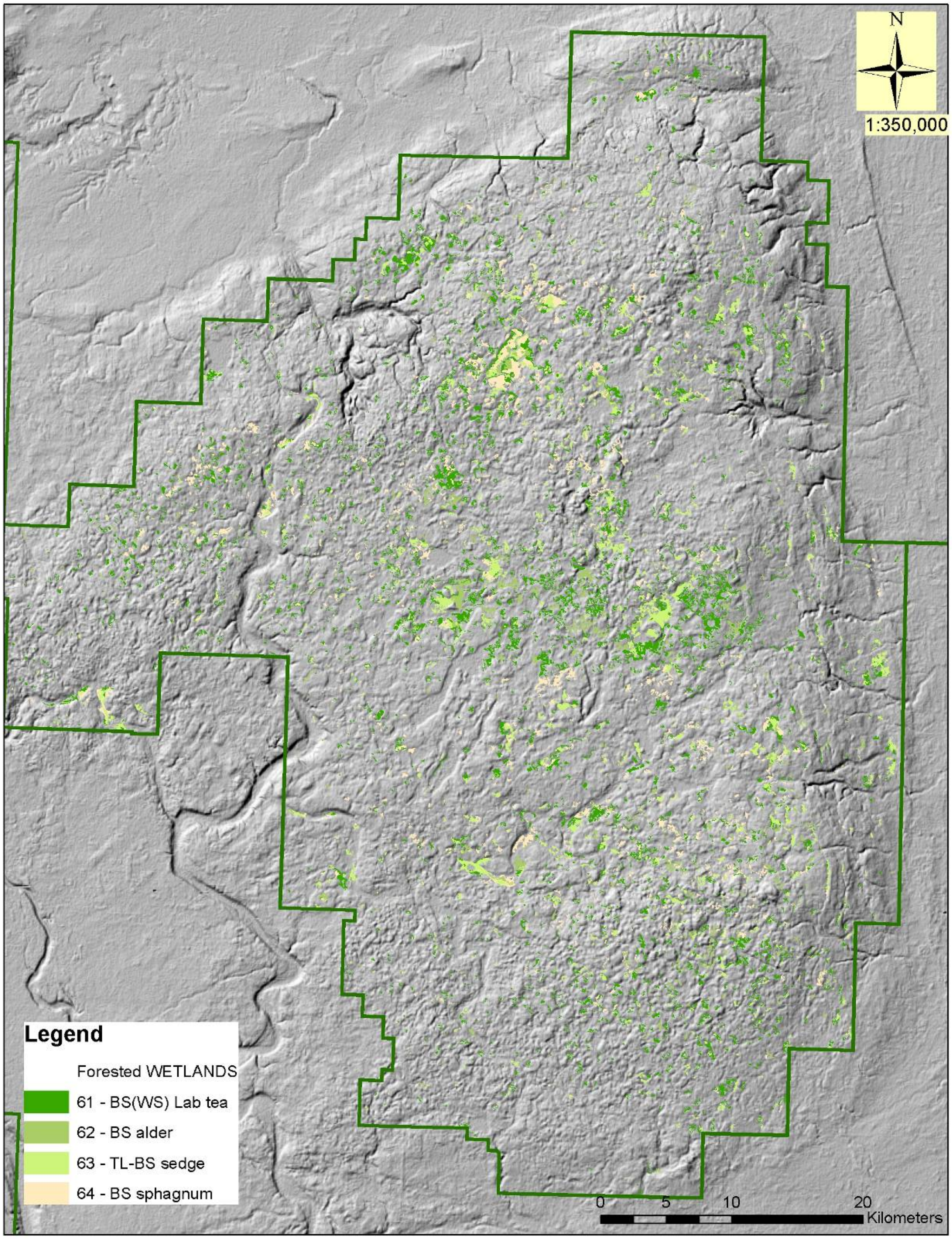


Figure 3.31 Forested wetland ecosites of the Duck Mountain.

3.1.5.2.4 Forested Upland Ecosites

Ecosite plot data on 536 forested wetland and forested upland plots were also collected and used to create 24 distinct and unique forested ecosites (Table 3.14). A field key was created, based on the classification results. The forested ecosites (Figure 3.30) are summarized in fact sheets (Figure 3.31). Ecosite assignments are available for all forested polygons in the Forest Lands Inventory using ecosite primary data and an ecosite key.

Table 3.14 Forested upland ecosite characteristics.

	Ecosite Number	Soil Moisture Class	Soil Texture Class	Vegetation
forested uplands	11	Dry-Fresh	sandy	TA-BA hardwood
	12	Dry-Fresh	sandy	TA-JP-Spruce mixedwood
	13	Dry-Fresh	sandy	JP-BS feathermoss
	21	Fresh	coarse loamy-silty	WB mixedwood
	22	Fresh	coarse loamy-silty	TA hardwood
	23	Fresh	coarse loamy-silty	TA-WS mixedwood
	24	Fresh	coarse loamy-silty	JP-BS mixedwood
	31	Fresh	Clayey (lacustrine)	TA-BA hardwood / mixedwood
	32	Fresh	fine loamy (till or stratified)	TA-BA hardwood
	33	Fresh	fine loamy (till or stratified)	TA-BA mixedwood
	34	Fresh	fine loamy (till or stratified)	WS-BF mixedwood
	35	Fresh	fine loamy (till or stratified)	JP-BS mixedwood
	36	Fresh	fine loamy (till or stratified)	BS-JP-(WS-BF) Labrador tea-feathermoss
	41	Moist	sandy to silty	TA-BA hardwood
	42	Moist	sandy to silty	WS (BF) mixedwood
	43	Moist	sandy to silty	BS-JP-feathermoss
	44	Moist	coarse loamy to clayey	Other hardwoods (AG-AE-MM)
	51	Moist	fine loamy to clayey	TA-BA hardwood
	52	Moist	fine loamy to clayey	TA-WS-JP mixedwood
	53	Moist	fine loamy to clayey	BS-feathermoss-Labrador-tea

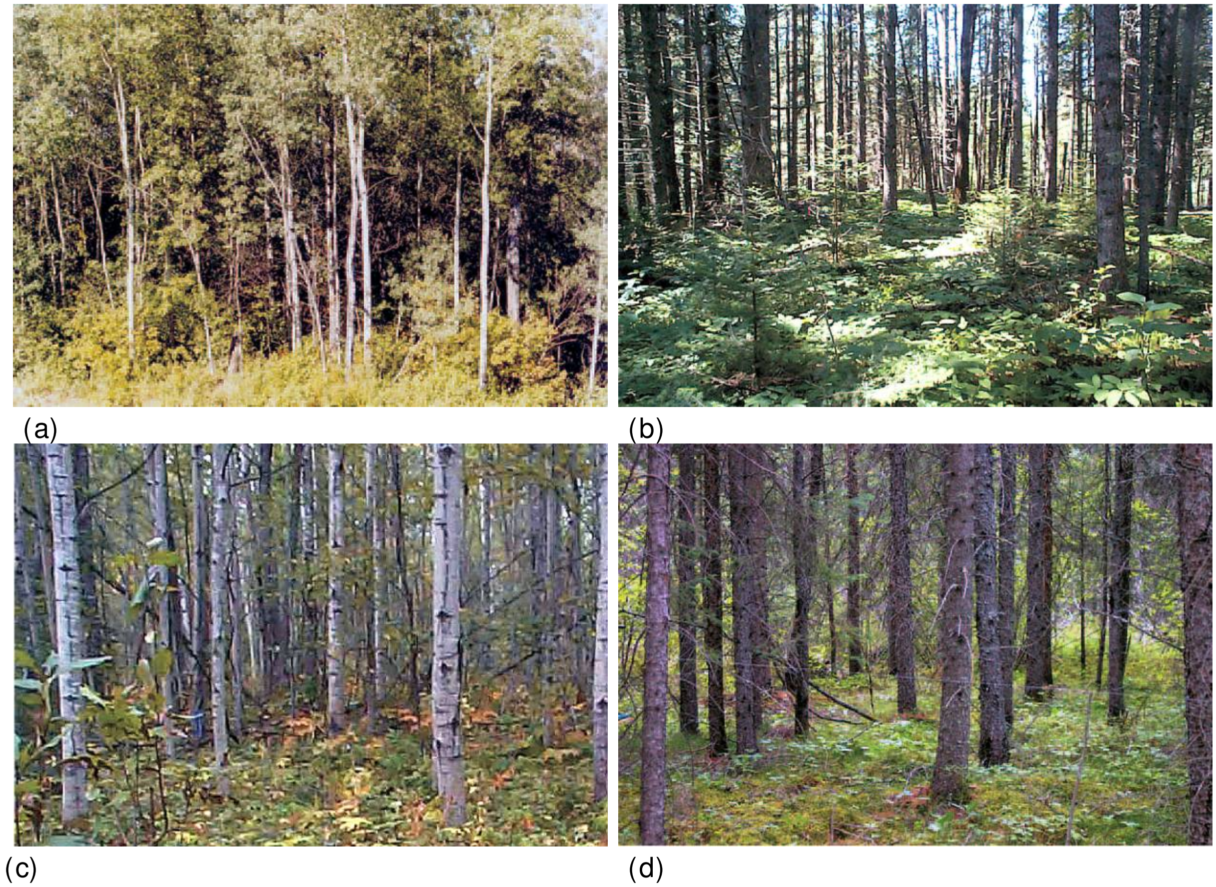
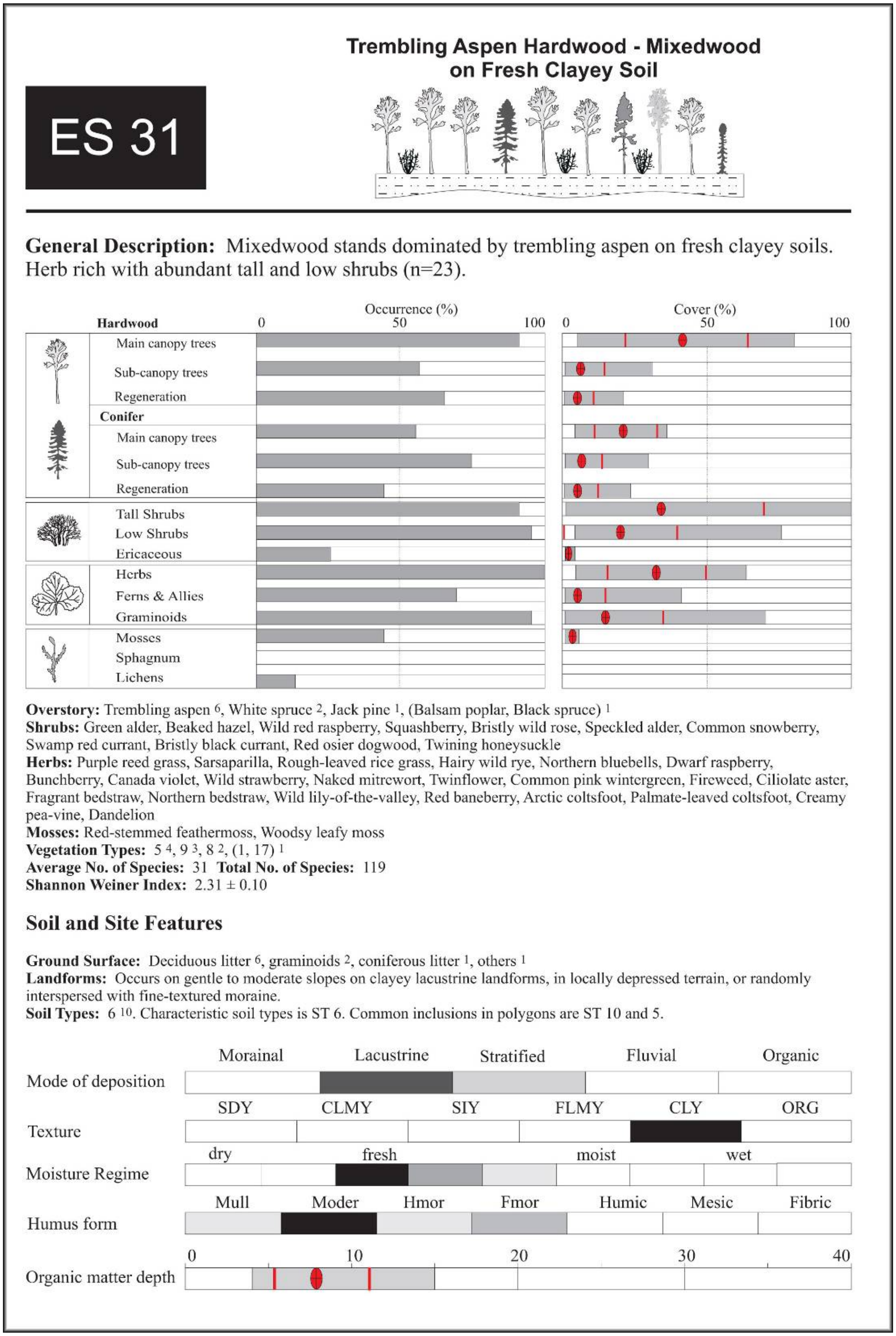


Figure 3.32 Examples of common forested upland ecosites within FML #3 (a. ecosite 32 – aspen on mesic clay; b. ecosite 34 – white spruce mixedwood; c. ecosite 31 – aspen on clay, and d. ecosite 53 – spruce-jack pine on moist soils).



General Description: Mixedwood stands dominated by trembling aspen on fresh clayey soils. Herb rich with abundant tall and low shrubs (n=23).

Overstory: Trembling aspen [6], White spruce [2], Jack pine [1], (Balsam poplar, Black spruce) [1]
Shrubs: Green alder, Beaked hazel, Wild red raspberry, Squashberry, Bristly wild rose, Speckled alder, Common snowberry, Swamp red currant, Bristly black currant, Red osier dogwood, Twining honeysuckle
Herbs: Purple reed grass, Sarsaparilla, Rough-leaved rice grass, Hairy wild rye, Northern bluebells, Dwarf raspberry, Bunchberry, Canada violet, Wild strawberry, Naked mitrewort, Twinflower, Common pink wintergreen, Fireweed, Ciliolate aster, Fragrant bedstraw, Northern bedstraw, Wild lily-of-the-valley, Red baneberry, Arctic coltsfoot, Palmate-leaved coltsfoot, Creamy pea-vine, Dandelion
Mosses: Red-stemmed feathermoss, Woodsy leafy moss
Vegetation Types: 5 [4], 9 [3], 8 [2], (1, 17) [1]
Average No. of Species: 31 **Total No. of Species:** 119
Shannon Weiner Index: 2.31 ± 0.10

Soil and Site Features

Ground Surface: Deciduous litter [6], graminoids [2], coniferous litter [1], others [1]
Landforms: Occurs on gentle to moderate slopes on clayey lacustrine landforms, in locally depressed terrain, or randomly interspersed with fine-textured moraine.
Soil Types: 6 [10]. Characteristic soil types is ST 6. Common inclusions in polygons are ST 10 and 5.

Figure 3.33 Example ecosite fact sheet (Arnup *et al.* 2006).

3.1.5.2.5 Non-Forested Upland Ecosites

Three non-forested uplands ecosites were classified (Table 3.15), and include open shrub, closed shrub, and grasslands (Figure 3.32).

Table 3.15 Non-forested upland ecosite characteristics.

	Ecosite Number	Soil Moisture Class	Soil Texture Class	Vegetation
non-forested uplands	**71**	Dry - Moist	any mineral soil texture	Open Shrub
	72	Dry - Moist	any mineral soil texture	Closed Shrub
	73	Dry - Moist	any mineral soil texture	Grassland

Figure 3.34 Closed shrub (left) and grassland (right) ecosites within the Duck Mountain.

Grasslands account for 0.5% of the area of the Duck Mountain Provincial Forest. These grasslands in the Duck Mountain Provincial Forest and Duck Mountain Provincial Park are relatively permanent. These ecosystems have coarse, dry soils where grasses have a competitive advantage, and tree species struggle for survival.

Natural succession has been occurring in the absence of natural disturbances, such as fires in the grassland ecosystems. Areas such as Jumper Plains have seen succession of trees into the grassland areas.

3.1.5.2.6 Ecoelements

Ecoelements are the smallest entity in the Ecological Land Classification hierarchy. Operationally, they are smaller than a forested stand, because typically, there are multiple ecoelements within a forested stand. Ecoelement efforts in Canada are included in the Forest Ecosystem Classification (FEC) guides in western and central Canada. FEC plots are 10 m X 10 m (or 100 m^2 area), which is much smaller than most forest stands. Manitoba has a FEC guide (Zoladeski *et al*. 1995) that was adapted from the northwestern Ontario FEC guide (Sims *et al*. 1990). However, vegetation and soil-types are described, but not mapped. The user must use the guide to field map the vegetation and soil-types. Field mapping works well with existing field efforts such as pre-harvest surveys. However, it is impractical and prohibitively expensive to field map large areas.

Vegetation-type incorporates characteristics of forest overstory and understory vegetation. Plots may be assigned to a vegetation type using a dichotomous classification key. The key is primarily based on the overstory species and major understory components. 33 forest vegetation types across all of Manitoba are described by Zoladeski *et al*. 1995, including:

- Predominantly hardwood (V1 to V5);
- Hardwood mixedwood (V6 to V10);
- Conifer mixedwood (V11 to V18); and,
- Predominantly conifer (V19 to V33).

A set of factsheets in the FEC manual for Manitoba describes each of the 33 vegetation types in Manitoba. The factsheets list the most important characteristics of each type in terms of forest composition, stratification, and relationship to other types.

Soil-type incorporates soil moisture and soil texture. Soils are allocated to a soil type using a soil key. The soil type key is almost identical across FEC guides in Alberta, Saskatchewan, Manitoba, Ontario, and some Maritime Provinces. The major criteria used in soil type recognition include soil depth, texture, moisture regime and parent material. 22 soil types are defined across Manitoba (Zoladeski *et al.* 1995), including:

- Deep soils (> 1 m soil) that are dry-very fresh moisture (S1 to S6);
- Deep soils (> 1 m soil) that are moderately moist to very moist (S7 to S11);
- Deep soils (> 1 m soil) that are wet organic (S12F and S12S); and
- Shallow soils (< 1 m soil) (SS1 to SS9).

Soil type factsheets describe soil and site details, typical soil profiles, and forest management interpretations (i.e. soil compaction hazard, puddling hazard, and erosion hazard).

The FEC system uses units of vegetation and soil types to organize ecological silvicultural and practical forest management knowledge. The FEC V-types and S-types can be aggregated or considered in various combinations for forest management interpretations.

Canadian Forest Ecosystem Classification

The Canadian Forest Ecosystem Classification is standardizing the classification of Canadian forest and woodland ecosystems at the ecoelement level of the vegetation community. The objective of the Canadian Forest Ecosystem Classification is to correlate the 4,000 forest and woodland community types across Canada into a common national system. It is also standardizing definitions and descriptions that will provide a common framework for the exchange of ecological information about Canadian forest and woodland conditions at regional and national scales for a broad range of applications, by exchanging forest management information across provincial and territorial boundaries and identifying ecosystems with high potential for biodiversity conservation: http://cnvc-cnvc.ca/

3.1.6. Habitat Element Strata

There are over 100,000 ecosystem polygons in FML #3. In order to model and manage all these polygons, we needed to combine similar ecosystems into meaningful groups. The choice of stratifying the ecosystem polygons need to be meaningful both now and up to 200 years in the future. Therefore, ecosites were chosen as the Forest management Plan strata, due to their combination of soils (texture and moisture) being ecologically meaningful and having long-term stability. Ecosites also define meaningful vegetation groups (*e.g.* aspen-hazel), in addition to the soils (e.g. clay).

There are 24 forested ecosites, which was deemed too many strata or too much detail for landscape-level long-term modeling. Therefore the 24 ecosites were combined into 13 ecological strata (Figure 3.33 and

Table 3.16) for the 20-year Forest Management Plan. The mapping of ecosystems in the Forest Lands Inventory (2002), allowed the various planning teams (modeling, water, biodiversity, soils, and climate change) to utilize the very robust ecologically-based strata. The modeling planning team fells ecological strata is a significant step forward in Ecosystem-Based Management.

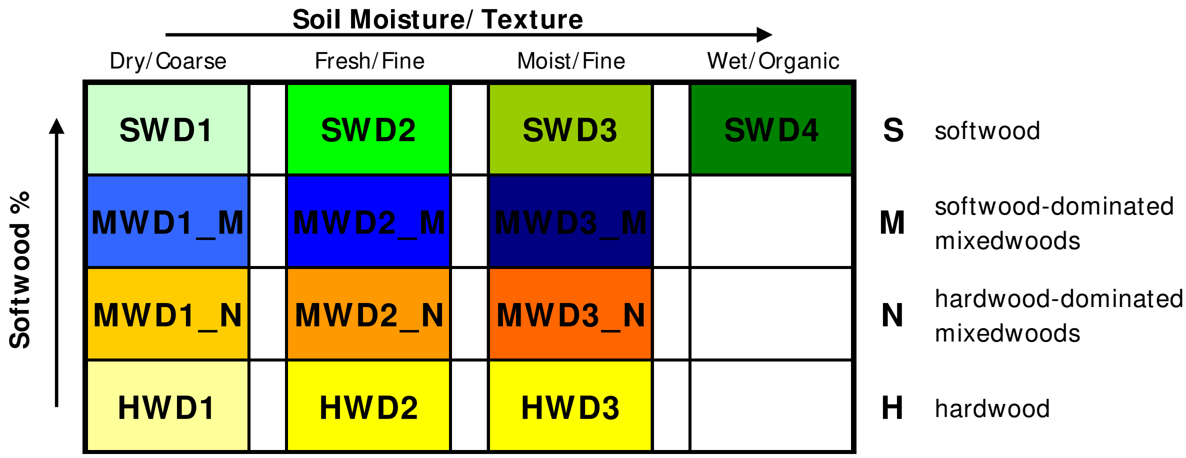


Figure 3.35 Habitat Element Curve (HEC) ecological strata used in all aspects of modeling in the 20 Year Forest Management Plan.

Table 3.16 Description of ecosites aggregated into Habitat Element Strata.

Upland or Wetland	Forested or Non Forested	Eco Series	ECOSITE NUMBER	Soil Moisture Class	Soil Type	Soil Texture Class	Description	Cover Group	Habitat Element Curve Strata
Upland	Forested	10	**11**	Dry-fresh	MINERAL	sandy	**TA-BA hardwood**	H	**HWD1**
Upland	Forested	20	**21**	Fresh	MINERAL	coarse loamy-silty	**WB mixedwood**	H	**HWD1**
Upland	Forested	20	**22**	Fresh	MINERAL	coarse loamy-silty	**TA hardwood**	H	**HWD1**
Upland	Forested	30	**32**	Fresh	MINERAL	fine loamy (till or stratified)	**TA-BA hardwood**	H	**HWD2**
Upland	Forested	40	**41**	Moist	MINERAL	sandy to silty	**TA-BA hardwood**	H	**HWD3**
Upland	Forested	40	**44**	Moist	MINERAL	coarse loamy to clay	**Other hardwoods (AG-AE-MM)**	H	**HWD3**
Upland	Forested	50	**51**	Moist	MINERAL	fine loamy to clay	**TA-BA hardwood**	H	**HWD3**
Upland	Forested	10	**12**	Dry-fresh	MINERAL	sandy	**TA-JP-Spruce mixedwood**	N	**MWD1_N**
Upland	Forested	20	**23**	Fresh	MINERAL	coarse loamy-silty	**TA-WS mixedwood**	N	**MWD1_N**
Upland	Forested	30	**31**	Fresh	MINERAL	clay (lacustrine)	**TA-BA hardwood / mixedwood**	N	**MWD2_N**
Upland	Forested	30	**33**	Fresh	MINERAL	fine loamy (till or stratified)	**TA-BA mixedwood**	N	**MWD2_N**
Upland	Forested	50	**52**	Moist	MINERAL	fine loamy to clay	**TA-WS-JP mixedwood**	N	**MWD3_N**
Upland	Forested	30	**34**	Fresh	MINERAL	fine loamy (till or stratified)	**WS-BF mixedwood**	M	**MWD2_M**

Upland or Wetland	Forested or Non Forested	Eco Series	ECOSITE NUMBER	Soil Moisture Class	Soil Type	Soil Texture Class	Description	Cover Group	Habitat Element Curve Strata
Upland	Forested	30	**35**	Fresh	MINERAL	fine loamy (till or stratified)	**JP-BS mixedwood**	M	**MWD2_M**
Upland	Forested	40	**42**	Moist	MINERAL	sandy to silty	**WS (BF) mixedwood**	M	**MWD3_M**
Upland	Forested	10	**13**	Dry-fresh	MINERAL	sandy	**JP-BS feathermoss**	S	**SWD1**
Upland	Forested	20	**24**	Fresh	MINERAL	coarse loamy-silty	**JP-BS mixedwood**	S	**SWD1**
Upland	Forested	30	**36**	Fresh	MINERAL	fine loamy (till or stratified)	**BS-JP-(WS-BF) Labrador tea-feathermoss**	S	**SWD2**
Upland	Forested	40	**43**	Moist	MINERAL	sandy to silty	**BS-JP-feathermoss**	S	**SWD3**
Upland	Forested	50	**53**	Moist	MINERAL	fine loamy to clay	**BS-feathermoss-Labrador-tea**	S	**SWD3**
Wetland	Forested	60	**61**	Wet	ORGANIC	fibric-mesic organic	**BS-(WS) -Lab tea - Fmoss - Sphagnum**	S	**SWD4**
Wetland	Forested	60	**62**	Wet	ORGANIC	mesic organic	**BS-Alder-Herb Rich**	S	n/a
Wetland	Forested	60	**63**	Wet	ORGANIC	fibric organic	**TL-BS-Sedge (Treed Fen)**	S	n/a
Wetland	Forested	60	**64**	Wet	ORGANIC	fibric organic	**BS-(JP)-Ericaceous-Sphagnum (Treed Bog)**	S	n/a
Upland	Non-Forested	70	**71**	Dry to Moist	MINERAL	sand to clay	**Shrub - open**	n/a	n/a
		70	**72**	Dry to Moist	MINERAL	sand to clay	**Shrub - closed**	n/a	n/a
		70	**73**	Dry to Moist	MINERAL	sand to clay	**grassland**	n/a	n/a

>= 6% crown closure is forested

<=5% crown closure is non-forested

Habitat element curve strata were mapped across the forested areas of FML #3 (Figure 3.34).

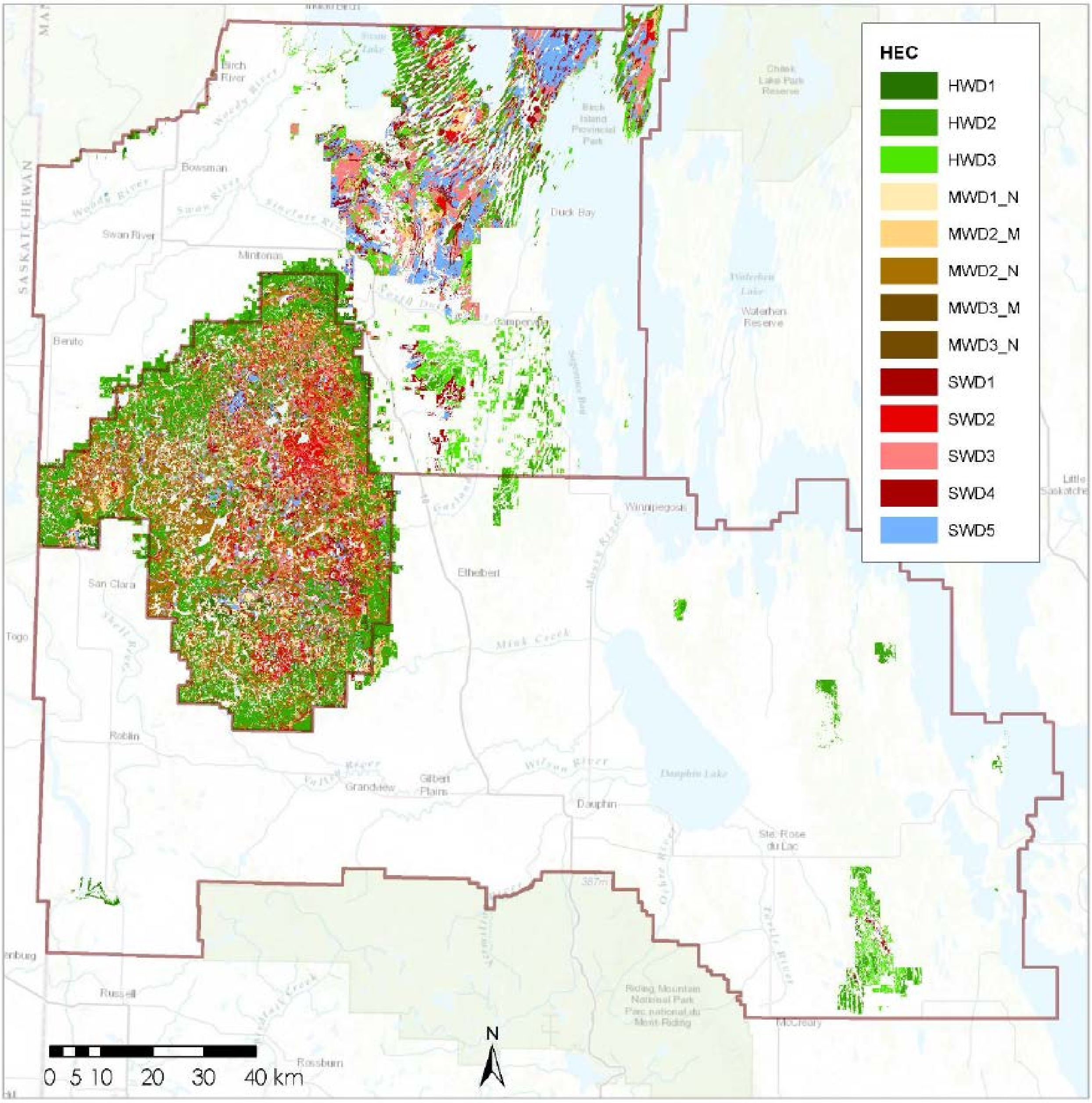


Figure 3.36 Map of Habitat Element Curve strata in FML #3 (ForSite Consulting, 2018) for open crown land.

3.1.7. Wetlands

Wetlands are defined as:

> *"…land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrophytic [water loving] vegetation and various kinds of biological activity which are adapted to a wet environment…" (National Wetlands Working Group 1988)*

Wetlands cover 25% of the area in Duck Mountain Provincial Forest, and are important ecosystems. Wetlands provide significant ecological goods and services such as water storage, moderation of flow, filtration, biodiversity, bird habitat, moose habitat, *etc*.

3.1.7.1 Wetlands Classification

The Canadian wetlands classification system (Warner and Rubec, 1997) has five major wetland types:

1. Bogs (organic soil)
2. Fens (organic soil)
3. Swamps (mineral soil)
4. Marshes (mineral soil)
5. Open Water (mineral soil)

Bogs are organic soil peatlands that are hydrologically isolated and stagnant, which means that they receive water only through precipitation or rainfall. There is no horizontal flow of water through a bog. The surface of a bog is typically very dry, but the thick peat below (average of 2.6 m, but ranging from 0.1 to 6 m deep in the Duck Mountain) is permanently saturated. Bogs are very nutrient poor. Sphagnum moss is always found on the surface of bogs. Stunted trees (black spruce and sometimes jack pine but rarely tamarack) are found on treed bogs (Figure 3.35). On shrubby bogs, shrubs include crowberry, Labrador tea, leatherleaf, and bog-laurel. There are also open bogs, with neither stunted trees, nor shrubs.

Fens are organic soil peatlands that do have a horizontal flow of water, often flowing slowly just below the surface. This earns fens the nickname of 'green rivers'. Fens have a wet surface, and average peat depths of 2.3 m in the Duck Mountain, but can range from 0.2 to 6.2 m in depth. Fens support tamarack trees on site (Figure 3.35), because of the nutrients in the flowing water. Indicator plants for fens include tamarack trees, birch shrubs, sweet gale, willow, buck bean, wire sedge, and brown moss.

Figure 3.37 Organic soil wetlands (bog-left; fen-right).

Swamps have mineral soil underneath some organic matter. Swamps are highly variable in their water flow, and fluctuate from dry to seasonally flooded. Water movement can be stagnant or dynamic. Swamps also have a hummocky surface (Figure 3.36) with windows or pools of water in between the hummocks.

Marshes are mineral soil wetlands with a shallow amount of organic soil over the mineral soil. Marshes dry out seasonally, and have variable dynamic water, depending on the upland and upstream runoff. In the forest, meadow marshes with sedges (Figure 3.36) commonly connect wetland areas. In the Parklands area, cattail marshes are common in low areas.

Shallow Open Water is also a mineral soil wetland, but is usually flooded with less than two meters of water. These look like shallow lakes (Figure 3.36) and often contain pond-lily and pond weed.

Figure 3.38 Mineral soil wetlands (swamp-left; marsh-middle; shallow open water –right).

The five major wetland types have been further sub-divided into 19 minor wetland classes (Figure 3.37). The minor wetland classes help reduce the significant amount of variability within a major wetland class. Common stratifiers of organic wetland types include treed, shrub, and open (*e.g.* bogs are stratified into treed bogs, shrubby bogs and open bogs). Fens are also further sub-divided into rich and poor. Swamps have the most variability of any wetland type, and are divided into five minor wetland classes.

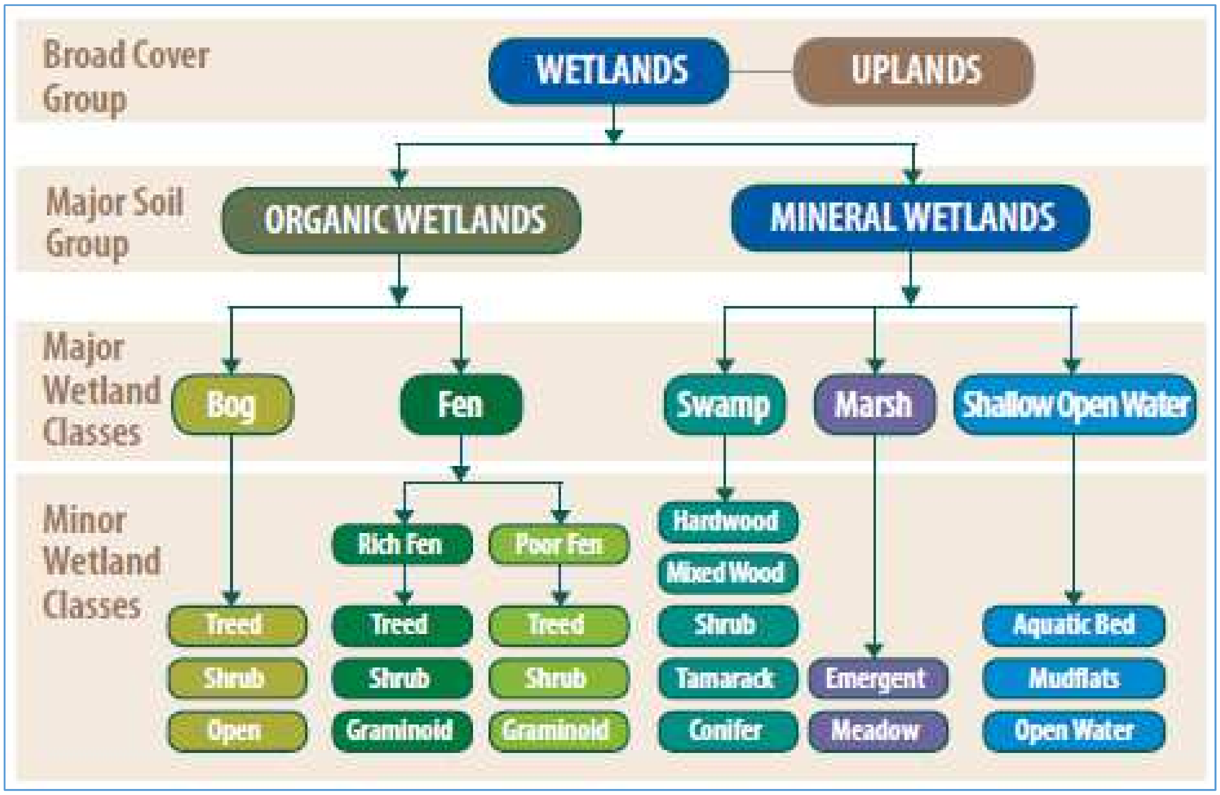


Figure 3.39 Major and minor wetland classes (Ducks Unlimited Canada 2014).

3.1.7.2 Wetlands Mapping

Wetlands mapping is a significant gap in Canada. However, there have been two wetlands mapping efforts FML #3.

In 2002, an ecosite key was developed for photo interpretation of non-forested wetlands, as part of the Forest Lands Inventory. The photo key used easily-observable and reliable features including:

- presence/absence of tall shrubs;
- amount of open water;
- amount of emergent vegetation;
- proportion of black spruce to tamarack;
- ground water movement patterns; and,
- shoreline sheltered vs. exposed.

The Forest Lands Inventory (2002) wetland mapping effort covers both the Duck and Porcupine Mountain Provincial Forests, an area of approximately 600,000 ha. The other portions of FML #3, such as the surrounding Parklands, were not mapped by this project.

The second wetlands mapping effort in FML #3 is the Ducks Unlimited Canada Enhanced Wetland Classification (Smith *et al.* 2007). This mapping effort used 30 X 30 m LANDSAT satellite imagery (Figure 3.38), and provided broad coverage across western Canada. A significant amount of ground-truthing guided the satellite classification.

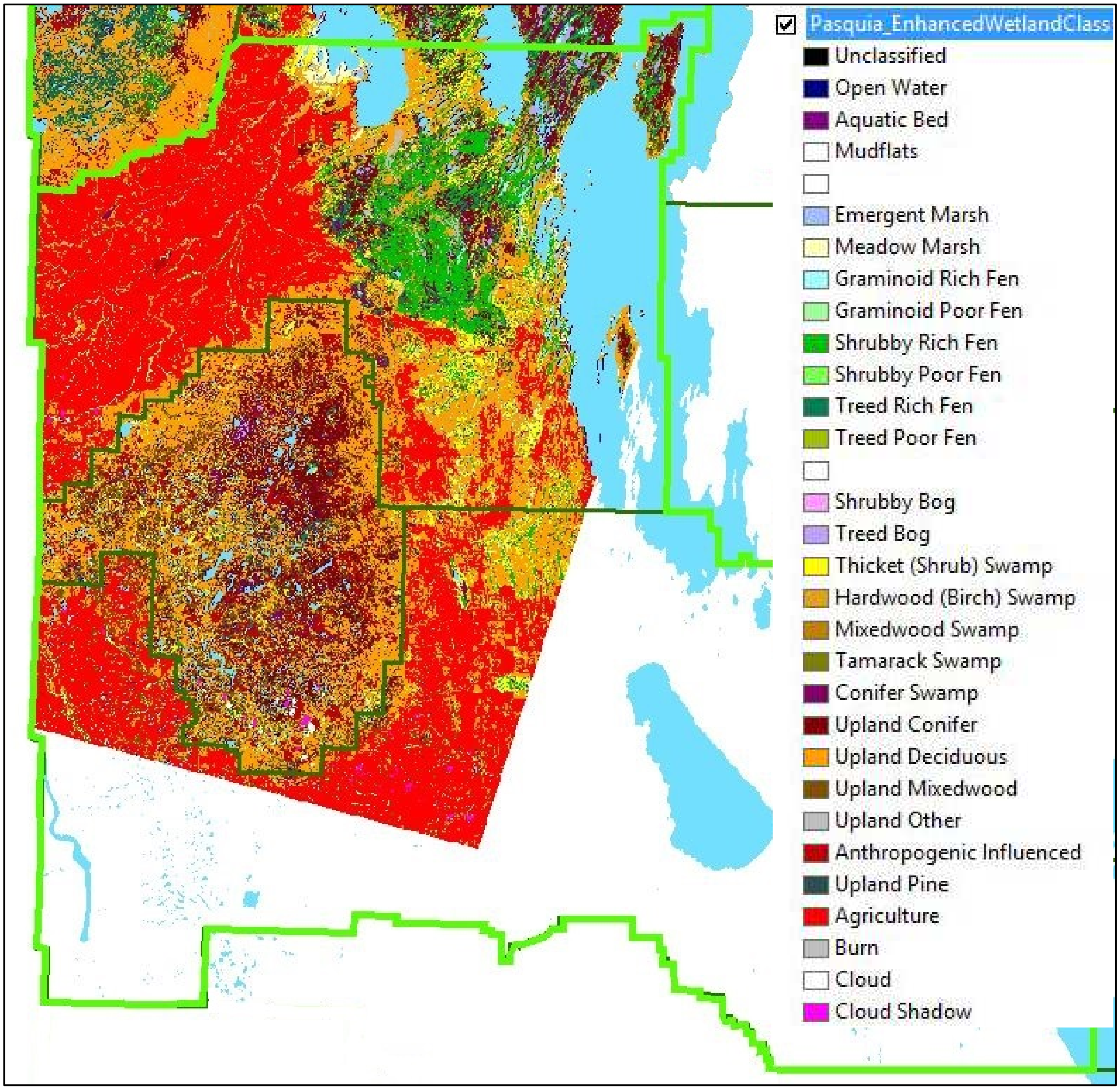


Figure 3.40 Enhanced Wetland Classification inventory in FML #3 (Smith *et al.* 2007).

3.1.8. Water

Water is important part of Forest Management Licence #3. Water forms many different kinds of features, including lakes, shallow open water, rivers, streams, wetlands, and ground water. The Duck Mountain and the Riding Mountain are the headwaters for many rivers. They start in the forested mountains, and then flow through agricultural land into Lake Winnipegosis.

Water features are important factors that contribute to the diversity and uniqueness of boreal plain ecosystems. The interspersion of both terrestrial and aquatic features on the landscape, and the riparian areas where they intersect, should be managed in a framework that recognizes the structural and process-based relationships between each element. These relationships in terms of biodiversity, the underlying processes involved in the hydrologic cycle, and maintenance of boreal forest ecosystems are related through time and space, and must be considered when planning.

The primary goal of many water conservation strategies is maintaining water quality and water quantity within and around forested ecosystems. Both natural disturbances and forest management activities may cause potential increases in water quantity, peak flows, dissolved nutrients in stream water, and increased siltation in aquatic environments. These potential changes can be mitigated through policies and implementation of best management practices and guidelines (*e.g.* buffer guidelines) around aquatic ecosystems.

3.1.8.1 Watersheds

Watersheds are defined topographically as areas of land where all water drains to a common point. Watersheds within Forest Management Licence #3 are shown in Figure 3.39. Watersheds often cross administrative and provincial boundaries. In Manitoba, Conservation Districts use watershed boundaries as their primary planning unit. This allows the Conservation Districts to address water quality and quantity issues in both the upstream and downstream portions of a watershed beyond the scope of single jurisdictions like towns or municipalities. FML #3 has five integrated management plans wholly or partially in its boundaries, as detailed in the land use section Integrated Watershed Management Plans.

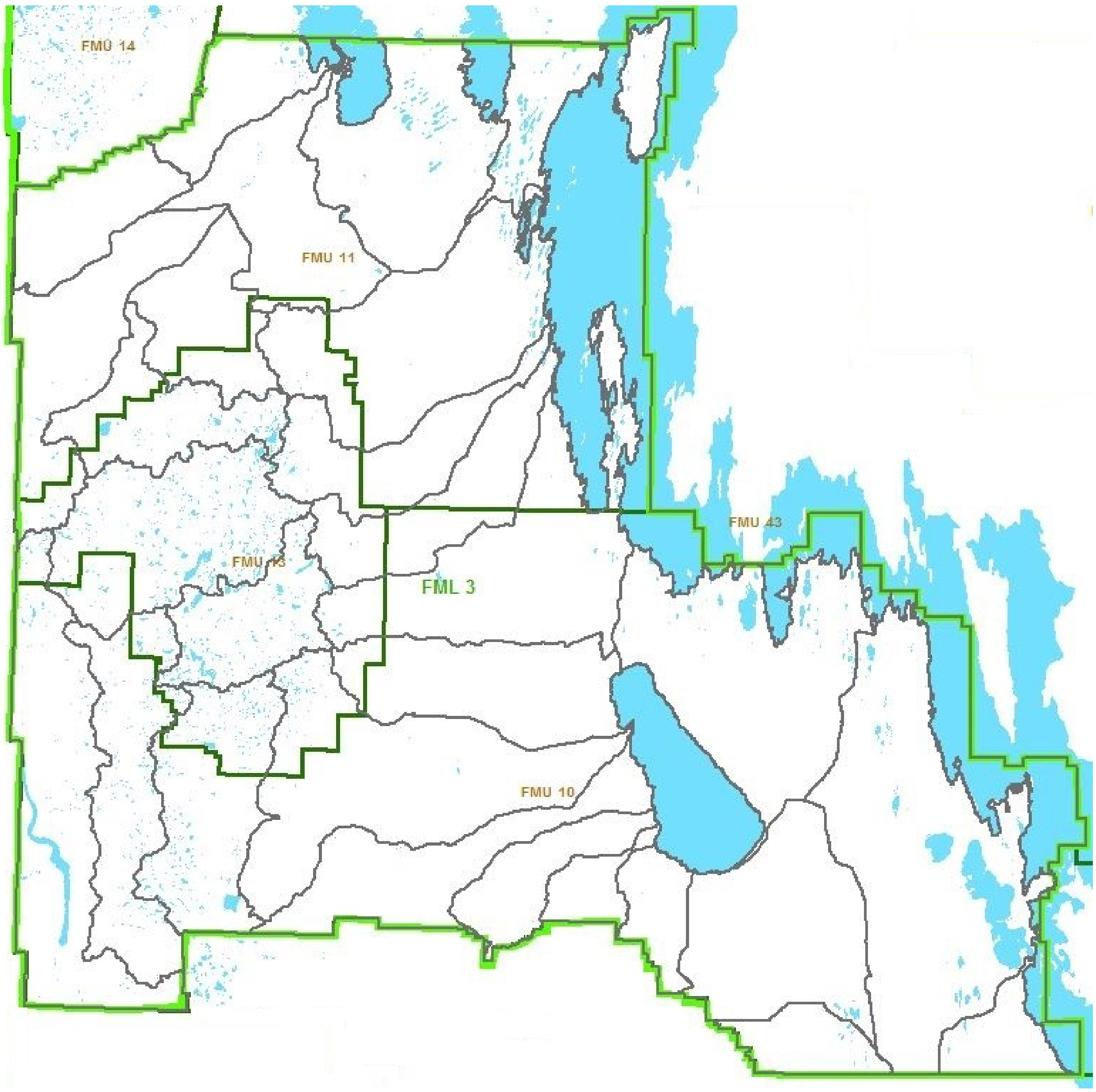


Figure 3.41 Watersheds in Forest Management Licence #3.

The Duck Mountain Provincial Forest has an Environment Act Licence condition of 30% maximum of a watershed in a harvested state. Cut blocks were considered to be in a 'harvested state' for five years following harvest for hardwood species, and 10 years post-harvest for softwood species. After successful regeneration, cut blocks were considered forested and no longer in a 'harvested state'. This 30% upper limit is meant to limit the risk of very rapid snow melt due to young forest not shading the ground and moderating the spring snow melt. The current condition of all watersheds in a harvested state (Figure 3.40) is well below the 30% maximum threshold.

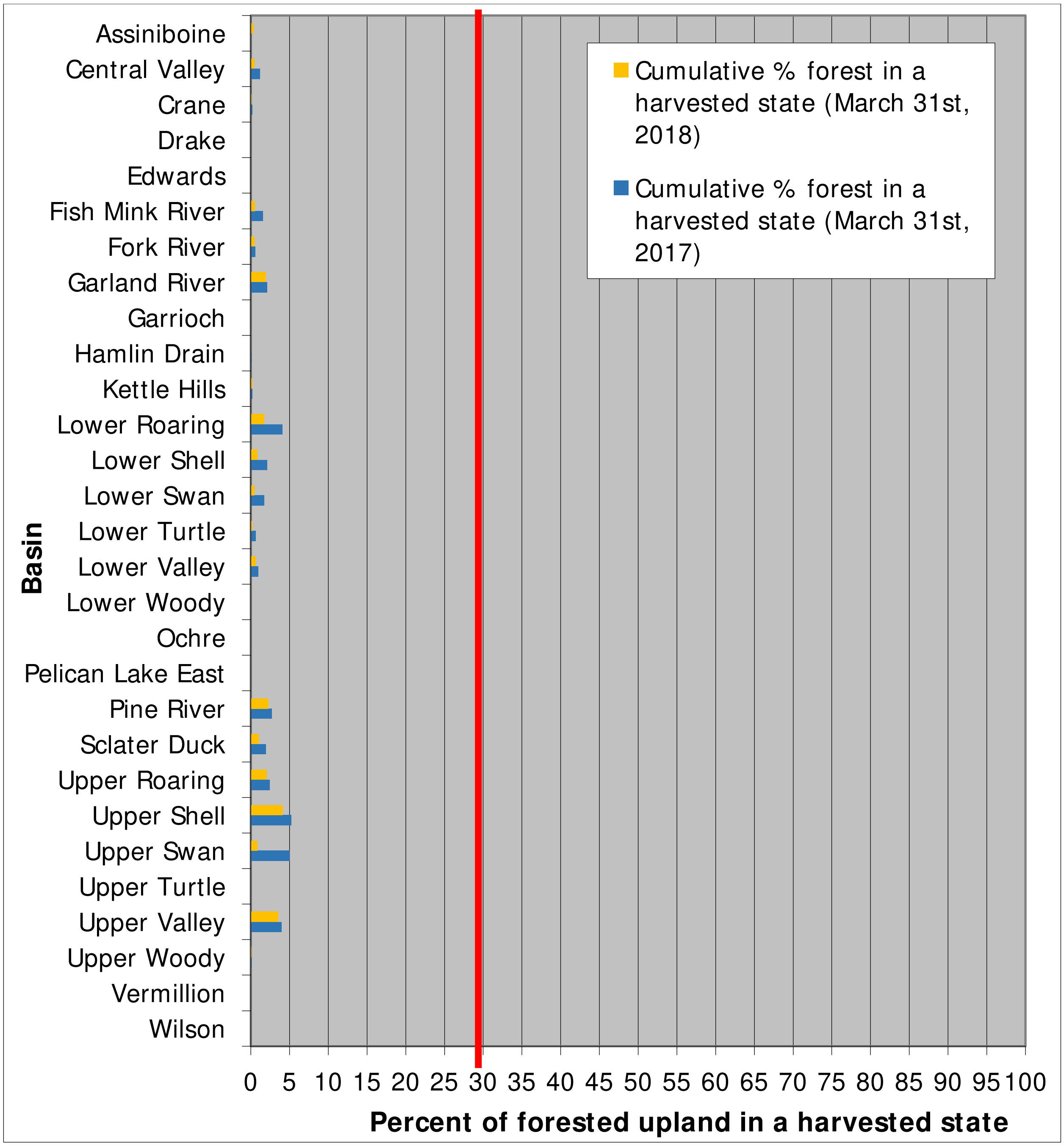


Figure 3.42 Percent of forested upland in the Duck Mountain Provincial Forest in a harvested state as of Mar. 31, 2018.

3.1.8.2 Rivers

The Duck and Riding Mountains are the headwaters of many rivers in FML #3 (Figure 3.41). In the Swan Valley, the Woody River flows north-east into Swan Lake. The Swan River also flows north-east into Swan Lake, but the Roaring, East Favel, West Favel, and Sinclair Rivers flow first into the Swan River.

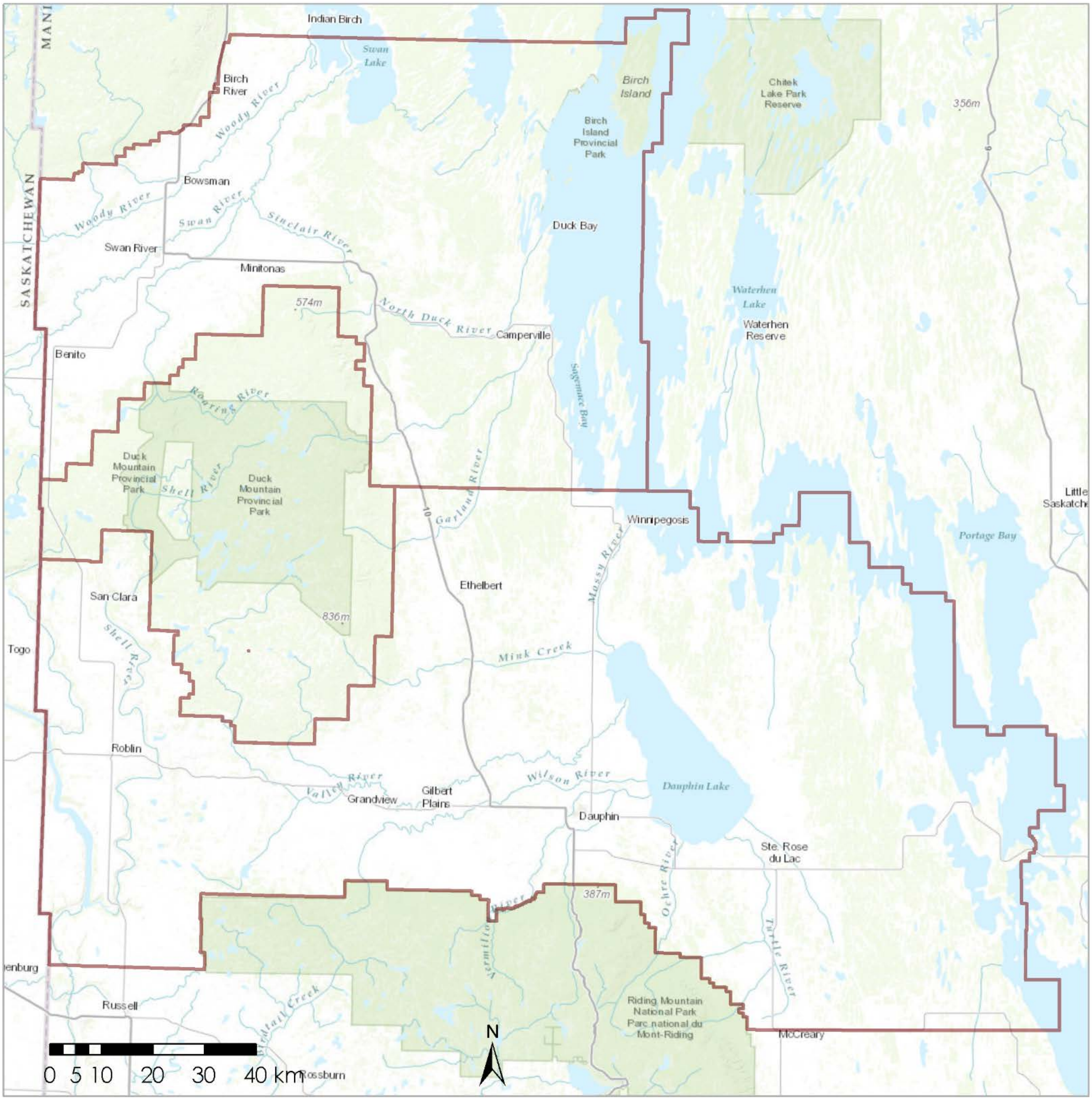


Figure 3.43 Rivers in the Forest Management Licence area (ForSite consulting).

There are many rivers on the east side of the Duck Mountain. Most of these rivers begin in the Duck Mountain and flow east into Lake Winnipegosis. This includes the following rivers (in order of north to south):

- North Duck River (hydrometric gauge station 05LG004 at Cowan)
- Sclater River
- South Duck River
- North Pine River (hydrometric gauge station 05LG001)
- South Pine River
- Garland River (hydrometric gauge station 05LG006)
- Point River
- Fork River
- Fishing River
- Mink Creek
- Drifting River

Rivers on the east side of the Duck Mountain that flow in Lake Dauphin include:

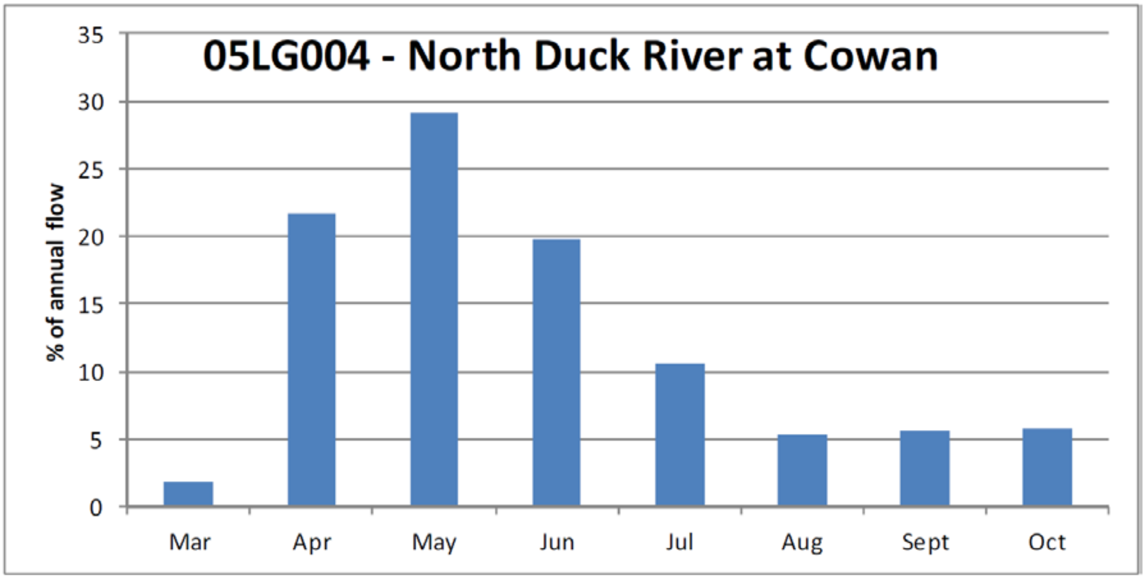
- Valley River
- Wilson River

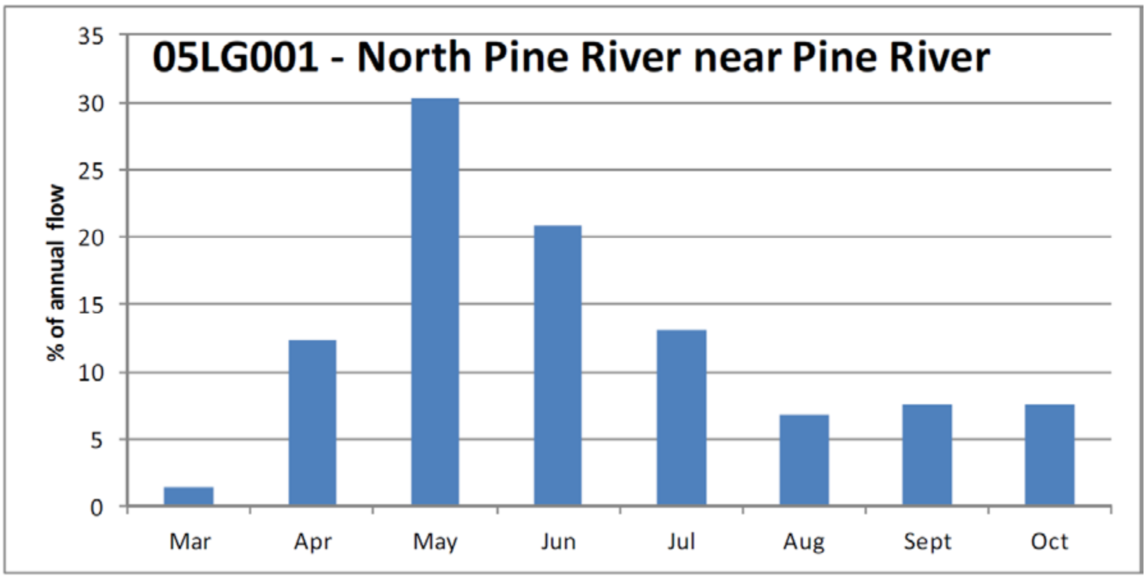
The Mossy River flows out of Lake Dauphin and into Lake Winnipegosis. The Shell River starts in the Duck Mountain glacial spillway and flows south into the Assiniboine River.

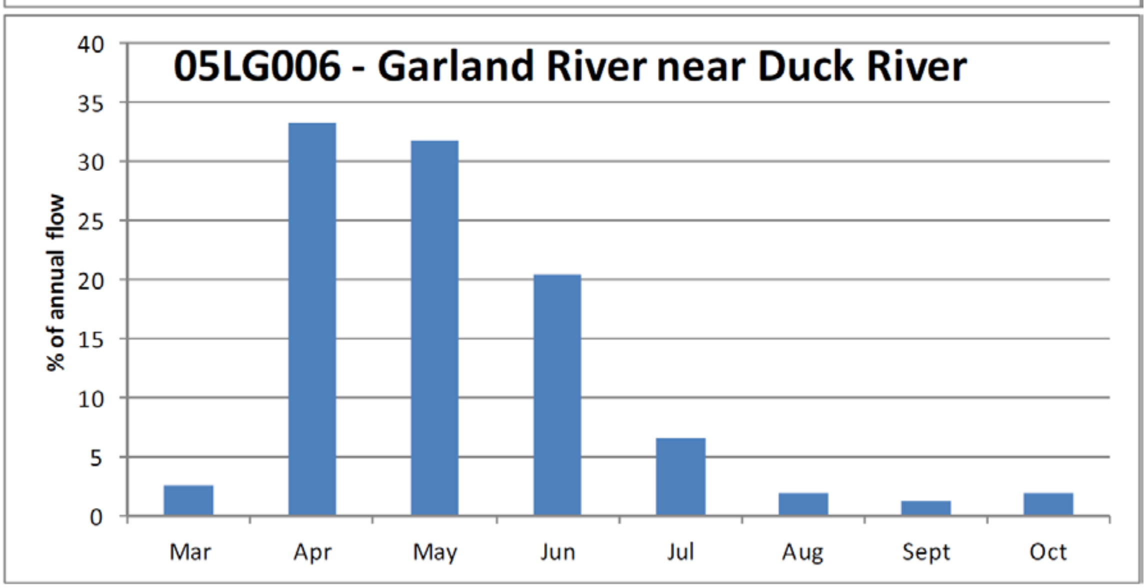
Riding Mountain is the headwaters for:

- Vermillion River
- Ochre River
- Turtle River

The local rivers have significant water flow in the spring months, due to both snow melt and rain contribute to spring runoff in the months of April and May (Figure 3.42). Flow reduces over the summer, and usually reduces even further in fall and winter. Extreme rain events with heavy precipitation can dramatically, but temporarily, increase river flow volume. Percent of annual flow by month are shown for rivers with a gauge station (Figure 3.42).


05LG004 - North Duck River at Cowan
% of annual flow
35
30
25
20
15
10
5
0
Mar
Apr
May
Jun
Jul
Aug
Sept
Oct


05LG001 - North Pine River near Pine River
% of annual flow
35
30
25
20
15
10
5
0
Mar
Apr
May
Jun
Jul
Aug
Sept
Oct


05LG006 - Garland River near Duck River
% of annual flow
40
35
30
25
20
15
10
5
0
Mar
Apr
May
Jun
Jul
Aug
Sept
Oct

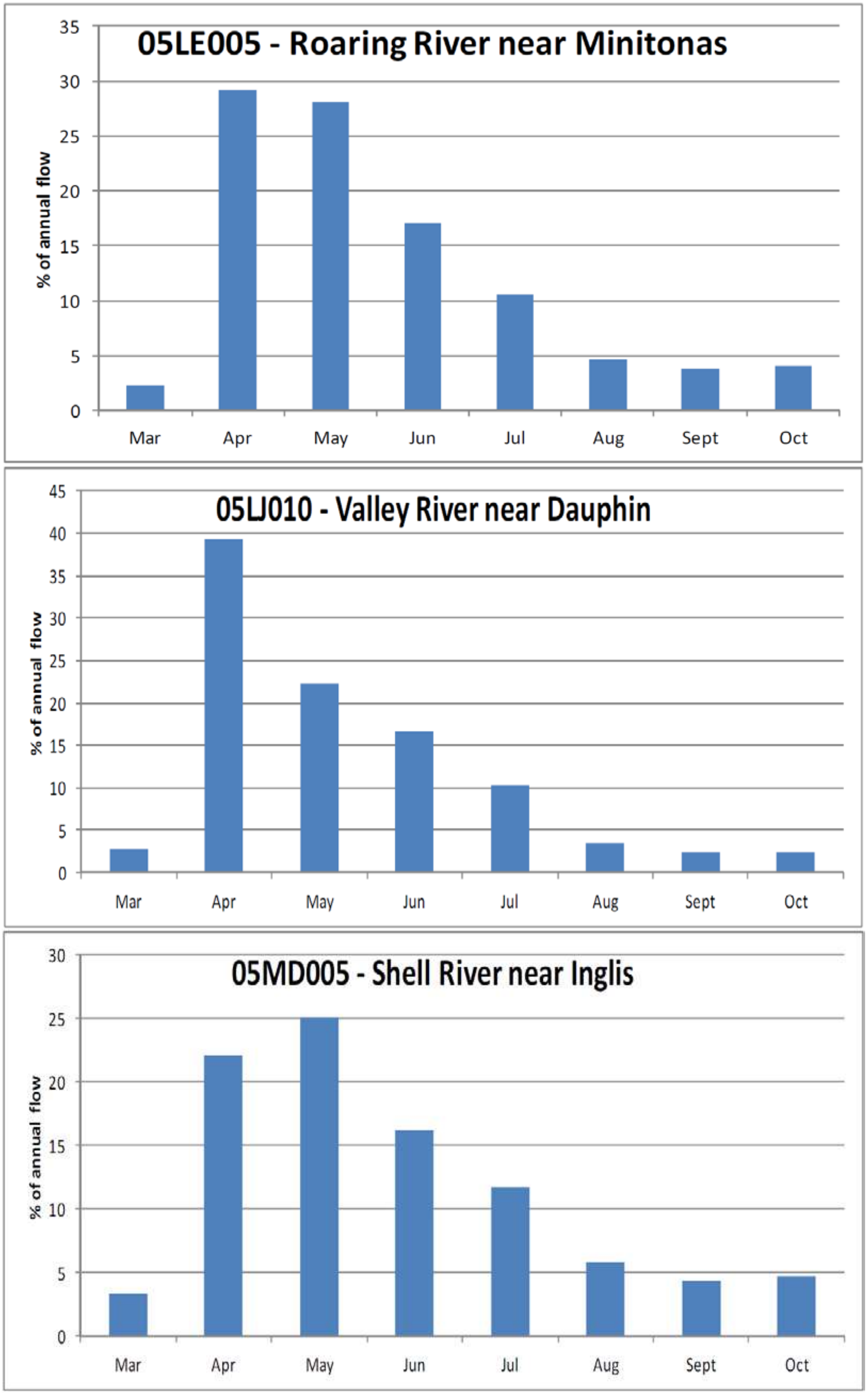


Figure 3.44 Percent of annual flow by month for rivers with hydrometric gauges (Lee 2014).

3.1.8.3 Streams and Stream Classification

Streams are smaller than rivers, but often flow into rivers. For planning purposes within Forest Management Licence #3, there are two kinds of steams: 1) mapped streams; and 2) unmapped streams. Unmapped streams cannot be seen through leaf cover in summer imagery, and cannot be seen in leaf-off imagery in the fall, because they are often dry. Whether mapped or unmapped, streams will have defined or undefined channels.

Streams with a channel

Streams with a defined channel are either permanent streams with a year-round flow (Figure 3.43) or intermittent streams with intermittent flow (*i.e.* are dry and have no water for part of the year).

Figure 3.45 Example of a permanent stream with a defined channel (left - EAF-C19) and an intermittent stream with a defined channel (right- CWC-C04)

Streams without a channel

Many of the water courses or small streams in FML #3 are undefined, meaning they are not mapped in a GIS system, and are not visible from aerial imagery. These features are usually found during field surveys. Most of these features have no defined channels or banks (Figure 3.44). These features typically have very little flow, and have organic substrate and alder/willow vegetation associated with them. Some of these features are the result of overland flooding. In some cases, the flow goes underground and resurfaces downstream. Some are also sedge meadows, beaver floods, or old roads that have become water courses.

Figure 3.46 Small watercourse not mapped (top left CWC-C45); small watercourse, not mapped (top right TEL-C21); no channel, water intermittent (middle left ARL-C07); overland flow from flood (middle right DFR-C10); black spruce, alder - small watercourse (bottom left VMR-C16); Old road which is now a watercourse (bottom right RTH-C07).

3.1.8.4 Waterbodies

There are many waterbodies within Forest Management Licence # 3. The largest waterbody is Lake Winnipegosis, which is on the eastern edge of FML # 3 (Figure 3.45). Other significant waterbodies include Swan Lake and Pelican Lake to the north, Lake Dauphin in the south, and Lake of the Prairies to the west. All of these lakes have significant commercial fishing and/or recreational angling.

Smaller lakes occur in the Duck Mountain, but the recreational potential of these lakes are not limited by their size. Wellman/Glad Lakes, Child's Lake, and Singush Lake are all part of the Duck Mountain Provincial Park Recreation Zone. Other lakes in the Duck Mountain, such as Burrows Lake, are not in the park. Many small lakes exist in the Duck Mountain, because the clay soils and hummocky terrain form lakes at low spots in the terrain.

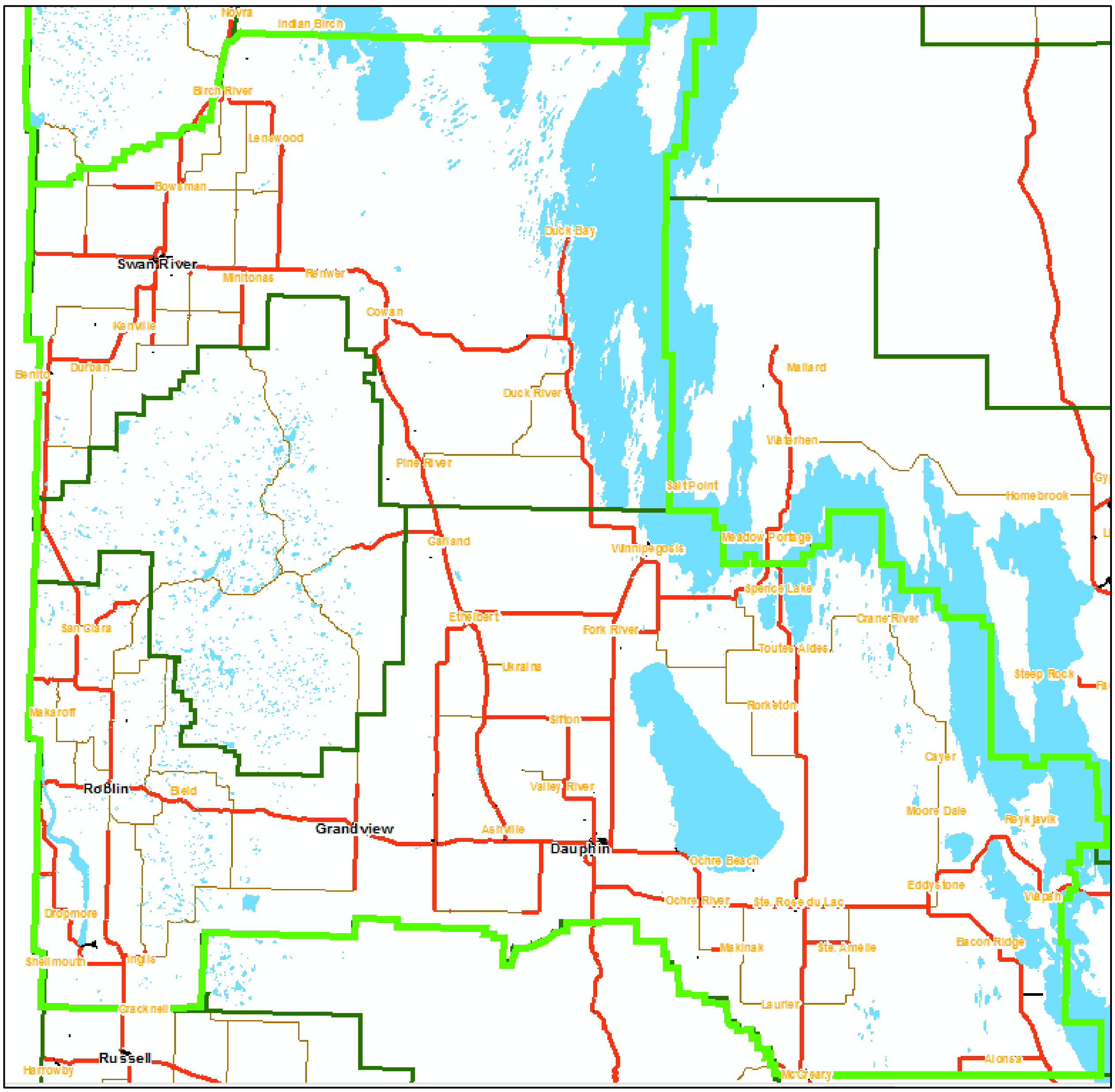


Figure 3.47 Waterbodies in the Forest Management Licence # 3 area.

A summary of the hydrometric data available in the watershed shows that the area surrounding the East Duck Mountain has been experiencing wetter than normal conditions in the last 10 years. This has resulted in Lake Winnipegosis reaching record high levels in 2010 and 2011 (Figure 3.46), approximately 1.0 m higher water levels than average.

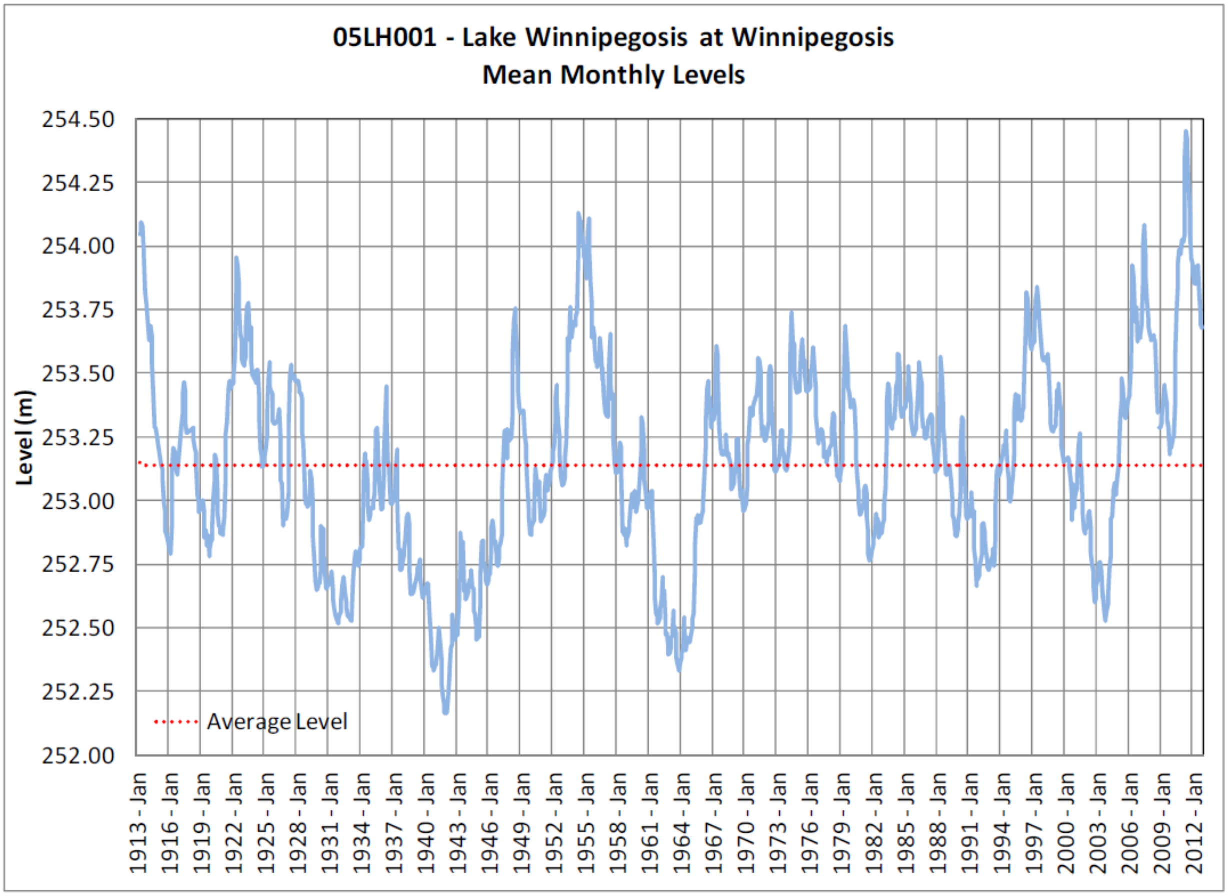


Figure 3.48 East Duck Mountain Hydrology report (Lee 2014).

Waterbodies can be generally categorized as large lakes, small lakes, and beaver floods (Figure 3.47). All of these waterbodies are usually 2 m deep or deeper.

Figure 3.49 Loons on East Blue Lake (top left) and Swan Lake (top right); small lakes (middle row); and beaver ponds (bottom row).

Shallow open water (Figure 3.48) is a wetland and a waterbody less than 2 m deep. The shallow water often freezes near the bottom, killing any fish that may be present.

Figure 3.50 Shallow open water in the Duck Mountain.

Oligotrophic Lakes
An oligotrophic lake is a lake with low primary productivity as a result of low nutrient content. These lakes have low algal production and consequently, often have very clear waters with high drinking-water quality. The bottom of such lakes typically have ample oxygen and so support many fish species such as lake trout, which require cold, well-oxygenated waters. The oxygen content is likely to be higher in deep lakes, owing to their larger hypolimnetic volume. Oligotrophic lakes are most common in cold regions that are underlain by igneous rocks, especially granitic bedrock or sterile sand.

Mesotrophic Lakes
Mesotrophic lakes are lakes with an intermediate level of productivity. These lakes are commonly clear water lakes and ponds with beds of submerged aquatic plants and moderate levels of nutrients.

Eutrophic Lakes
A eutrophic body of water, commonly a lake or pond, has high biological productivity. Due to excessive nutrients, especially nitrogen and phosphorus, these water bodies are able to support an abundance of aquatic plants. Usually, the water body will be dominated either by aquatic plants or algae. When aquatic plants dominate, the water tends to be clear. When algae dominate, the water tends to be darker. Photosynthesizing algae supplies oxygen to the fish and biota which inhabit these waters. Occasionally, an excessive algal bloom will occur and can result in fish death because the decomposition of the algae reduces the amount of oxygen available to fish.

Hypereutrophic

Hypereutrophic lakes are very nutrient-rich and are characterized by frequent and severe nuisance algal blooms and low transparency. Hypereutrophic lakes have a visibility depth of less than one meter, and have high chlorophyll and phosphorus concentrations. The excessive algal blooms can also significantly reduce oxygen levels and prevent life from functioning at lower depths, creating dead zones beneath the lake surface.

3.1.8.5 Water Quality

Water quality is important to the health of ecosystems (*e.g.* rivers, streams, and waterbodies), safety (recreational water quality), and drinking water (town, municipal, and private well water). However, there is no single indicator of water quality. Water quality is a combination of physical indicators (*e.g.* sediment, odour, colour, taste), chemical indicators (*e.g.* pH, hardness), and biological indicators (*e.g.* algae, pathogens, diseases, *etc.*).

Natural water bodies vary in water quality as environmental conditions change. Nutrient input, (especially nitrogen and phosphorus), organic carbon, and sediment load affect natural water systems. Beaver dams impede water flow and generally have a negative effect on water quality.

Water Quality Index (WQI) is an index that ranges from 0 to 100, based on 25 variables, including pH, dissolved oxygen, total phosphorus, and nitrate-nitrite. The higher the score, the better the quality of water. WQI can be put into classes (*i.e.* excellent, good, fair, marginal, and poor). The WQI for both the Swan River and Woody River ranged between 'fair' to 'good' from 1992 to 2008 (Figure 3.49).

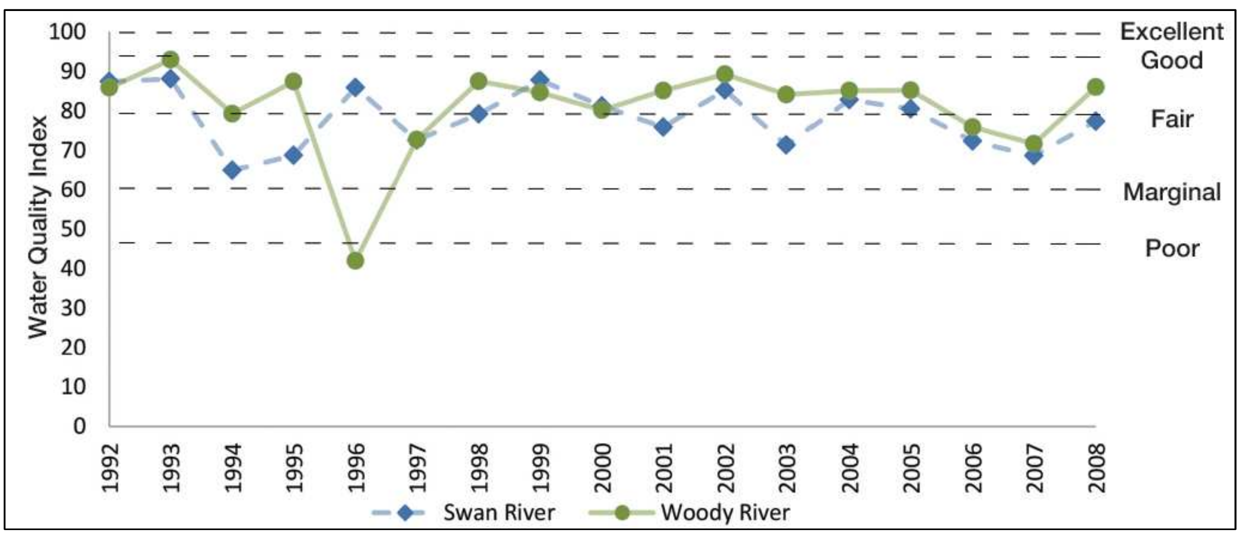


Figure 3.51 Water Quality Index for the Swan and Woody Rivers 1992 to 2008 (Swan Lake Watershed Conservation District).

The WQI was developed by the Canadian Council of the Ministers of the Environment, and is calculated by comparing the water quality data to "Guidelines for Canadian Drinking Water Quality". The WQI measures the scope, frequency, and amplitude of water quality exceedances and then combines the three measures into one score between 0 and 100. The higher the score, the better the quality of water. The scores are then ranked into one of the categories described below:

1. Excellent: (WQI Value 95-100) - Water quality is protected with a virtual absence of impairment; conditions are very close to pristine levels. These index values can only be obtained if all measurements meet recommended guidelines virtually all of the time.
2. Very Good: (WQI Value 89-94) - Water quality is protected with a slight presence of impairment; conditions are close to pristine levels.
3. Good: (WQI Value 80-88) - Water quality is protected with only a minor degree of impairment; conditions rarely depart from desirable levels.
4. Fair: (WQI Value 65-79) - Water quality is usually protected but occasionally impaired; conditions sometimes depart from desirable levels.
5. Marginal: (WQI Value 45-64) - Water quality is frequently impaired; conditions often depart from desirable levels.
6. Poor: (WQI Value 0-44) - Water quality is almost always impaired; conditions usually depart from desirable levels.

3.1.8.6 Groundwater

Sources, Distribution, and Quality
Surface and subsurface geological characteristics affect each other. Therefore, groundwater sources and distribution are described in three subregions: Swan River Valley, Duck Mountain, and Riding Mountain. The quality of the groundwater varies considerably over FML #3.

Swan River Valley Subregion
The Swan River Valley subregion is the lowland area between the Porcupine Hills and Duck Mountain and extends toward Swan Lake. This area lacks Jurassic formations, which means the salty water from the Palaeozoic rocks can filter into the Cretaceous Swan River Formation. Thus, highly mineralized water is common within the regional Swan River sandstone and sand aquifers.

Localized surface sand and gravel aquifers are common throughout the mainly heterogeneous surface glacial deposits. Water quality varies. For example, near Bowsman, potable groundwater is difficult or impossible to find. However, near the Town of Swan River, fresh water is in sandstone aquifers at depths of more than 60 m.

Duck Mountain Subregion
The Duck Mountain subregion includes Duck Mountain and goes east to Lake Winnipegosis , and includes Dauphin Lake. This subregion contains the Manitoba Escarpment, nearly flat lowlands, numerous streams in the northern lowland, and a few streams in many parts of the south. The depth to the Palaeozoic includes a gently eastward sloping transition zone between the carbonate rock, and is greater here than in the other subregions. The southern part of this subregion has Jurassic shale and limestone beds that separate the Swan River Formation from the Palaeozoic carbonate rocks. This slows the movement of salty water from the Palaeozoic rocks into the Cretaceous Swan River Formation.

Overlaying the Swan River Formation are Cretaceous soft shale formations that usually prevent water movement to the overlying till. Sand and gravel lenses interbedded in the thick upland till are fairly common. In the northern lowland complex area, extensive surface sand and gravel deposits are common. Relatively fresh water in deep wells of this area indicates significant local recharge.

Several salt springs exist near Lake Winnipegosis where water from the Palaeozoic carbonates reaches the surface.

Low mineral concentrations in the Swan River Formation aquifer systems indicate good local recharge conditions in the Ethelbert area and along the north-eastern side of Duck Mountain. Extensive surface sand and gravel deposits are also common in the northern part of the lowland. Because fairly deep wells in bedrock in this area have fresh water, significant local recharge likely takes place.

However, several brine springs exist along Lake Winnipegosis where the Palaeozoic carbonate rocks lie under the surface. Along the Valley River, the soft clay shale bedrock acts as a barrier to recharge. This results in salty Swan River Formation water and a lack of fresh groundwater in the Grandview, Gilbert Plains, and Ashville area.

Riding Mountain Subregion

An extensive sand and gravel aquifer exists in the Timberton area south of Duck Mountain at the base of the upland area. Along the Valley River, the bedrock consists of soft clayey shale, with minor sand and gravel lenses. This means limited groundwater recharge. Water from the underlying Swan River Formation is salty. Fresh groundwater is often difficult to find in the areas of Grandview, Ashville, and Gilbert Plains.

Highly mineralized and salty water is common in the lowland area because the Palaeozoic rocks transmit salty water and local recharge is slowed by the shale beds and till.

Alluvial fans at the base of the northeastern slopes of the Escarpment are recharged mainly from precipitation over the alluvial fans and by infiltration from streams that cross them. As a result, the aquifers are a significant source of good quality groundwater.

In a belt up to five km wide east of these alluvial fans, the subsurface is soft clay shale with no aquifers. In deeper water bearing zones, the water is highly mineralized. Drinkable water in this area is rare.

3.1.8.7 Groundwater Wells

Ground water wells are in towns (Figure 3.50 and are surrounded by agricultural land – Swan River, Minitonas, Bowsman, Benito, and Birch River.

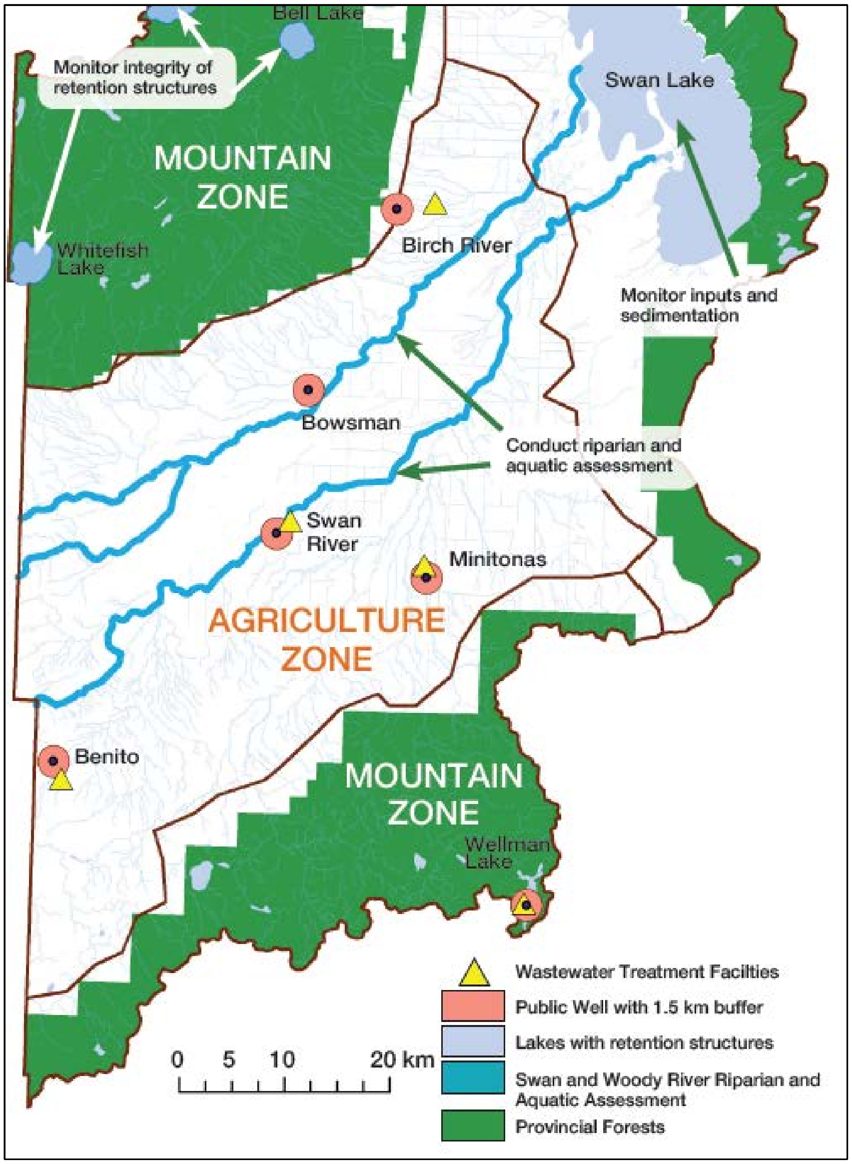


Figure 3.52 Ground water wells in the FML #3 area (Swan Lake Watershed Conservation District)

Public drinking water wells have a protection zone of 1.5 km around each well. Intensive and high pollution risk development activities, such as chemical or fertilizer storage facilities, disposal fields, fuel tanks, waste disposal grounds, or wastewater treatment facilities are restricted in public drinking water source zones.

Rural residents use private wells as their drinking water supply. Nitrates and coliform are the main dangers for contaminating drinking water in private wells.

3.1.8.8 Shallow Aquifers

Aquifers are an underground layer of water-bearing permeable gravel, sand, silt, or fractured rock. Aquifers or layers of water occur at various depths, often in multiple layers, depending on the permeability of the sub-surface layers.

Shallow aquifers are close to the surface, and are likely to be topped up by the local rainfall. The groundwater in these aquifers have a seasonally high water table one to several meters from the ground's surface. These are often used for shallow well water supply.

Water-bearing layers below an impermeable layer are a confined aquifer, and are not directly influenced by precipitation. Confined aquifers are deeper than shallow aquifers and far less sensitive to surface-induced contaminants, such as organic matter.

3.1.8.9 Runoff and infiltration regimes

Precipitation that falls to the ground either runs off the ground surface, or infiltrates the ground and becomes groundwater. Runoff of precipitation depends upon many factors. Clay soils absorb less water than sandy soils, resulting in more overland runoff of water into streams. Likewise, soil already saturated from previous rainfall can't absorb much more water, increasing the amount of surface runoff. Vegetation slows the movement of runoff, allowing more time for precipitation to seep into the ground. Agriculture and the tillage of land also changes the infiltration patterns of a landscape.
Water falling on steeply-sloped land, like the Manitoba Escarpment, runs off more quickly and infiltrates less than water falling on flat land.

Precipitation that falls to the ground surface and infiltrates the ground becomes groundwater. Some water infiltration stays in the rooting zone of the soil and plant roots draw upon this shallow groundwater. The process of evapotranspiration moves water back into the atmosphere. Infiltration replenishes aquifers by filling openings and pore spaces in soil or rock layers. Below the ground surface is an unsaturated zone, which water travels through to reach lower zones. The water table is the point at which the ground is completely saturated. Below this level, the pore spaces between every grain of soil and rock crevice is completely filled with water.

3.1.9. Vegetation

Vegetation is a significant component of ecosystems. Vegetation is highly influenced by the underlying soil texture, nutrient status, and the soil moisture regime. The strong relationship between vegetation and soil is reflected in ecosites, which are used for the planning strata.

Various ecosystems are often described based on their dominant vegetation, including uplands, wetlands, grasslands, shrub lands, and aquatic areas. Examples of these include aspen-hazel forest, black spruce swamp, cattail marsh, alder thicket,

Ecosystems contain many vegetation elements including tree canopies, tall shrub, small shrub, herbs, forbs, mosses, and lichen layers. The average occurrence and percent cover of these vegetation elements are quantified by Arnup *et al.* 2006 (Figure 3.51).

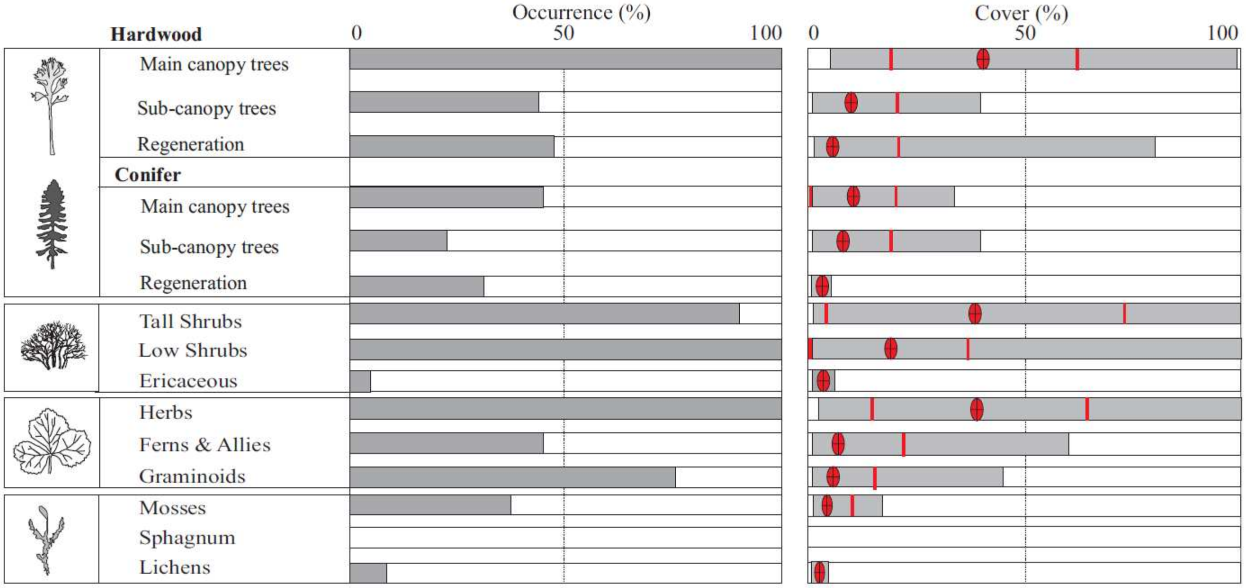


Figure 3.53 Ecosystem elements including trees, shrubs, forbs, mosses, and lichens on aspen–hazel mesic clay ecosite (Arnup *et al.* 2006).

Scale is very relevant and important when managing vegetation. Trees for example can be described at many different scales: a single individual tree; a clump of trees; a stand of trees; aggregates of stands; or a forest at the landscape scale.

3.1.9.1 Vegetation Inventories

To quantify diversity of vegetation, and to implement Ecosystem-Based Management (EBM) as defined in the Manitoba Forest Plan (2002), an ecologically-based vegetation inventory was needed. In 1982, the provincial government created the Forest Resources Inventory (FRI), which was a timber inventory. The FRI timber inventory met its intended needs as a regional-level inventory for broad planning and calculation of Annual Allowable Cut. However, the timber-focused FRI was not suitable for EBM planning, since only the merchantable trees were inventoried, and other ecosystem components such as shrubs, snags, coarse woody debris, soils, wetlands, and understory vegetation were unknown.

Louisiana-Pacific Canada Ltd. initiated or were partners in a series of inventory projects, that eventually culminated in the creation of the Forest Lands Inventory (FLI, 2002), an ecological inventory capable of providing ecological information to implement Ecosystem-Based Management planning. A summary of inventory projects are listed in Table 3.17.

Table 3.17 Summary of Vegetation Inventory Projects.

Year	Project Name and Summary
1982	Forest Resources Inventory – Province of Manitoba inventory
1997	Ecosystem Resource Inventory & Landscape Analysis
1998	Wetland inventory & multiple scale approach (Dave Locky, U of Alberta PhD research, 2005).
1999	LP field test of Wetland Ecological Classification system from Ontario. LP biologists field-tested the Northwestern Ontario wetland ecosite guide (Racey *et al.* 1996) in the Duck Mountain. Wetlands were field surveyed for a 'goodness of fit' with the Ontario Classification.
2001-2006	Ecosite Decision Support System (Baydack 2006). An attempt to create (but not map) ecosites and standardize them across Manitoba.
2002	Forest Lands Inventory. Joint effort between LP and Manitoba Conservation to create an ecological inventory for FMUs 13 and 14 and map at the ecosite level.
2006	Ecosites of the Mid-Boreal Upland Ecoregion of Manitoba (Arnup *et al.* 2006). An ecosite classification system, complete with field guide and ecosite maps for the Duck and Porcupine Mountain Provincial Forests. Built on the 2002 Forest Lands Inventory.
2007	Ducks Unlimited – Land cover classification. Ducks Unlimited completed a satellite image classification of a large portion of FML#3, as part of the Pasquia project.
2013	Provincial inventory for wooded portion of FMUs 11 and 12 - developed from aerial photography flown in 2001 and 1980s but updated to 2013

Vascular Flora of Manitoba has an online list of species, but no pictures, keys, text, or identifying features.

Vascular plants vascular plant flora of Manitoba

https://home.cc.umanitoba.ca/~burchil/plants/

Non-Vascular plants of Manitoba

Bryophytes - mosses and liverworts

https://home.cc.umanitoba.ca/~burchil/plants/mosses/index.html

Lichens – online lists of lichens for Manitoba include:

https://home.cc.umanitoba.ca/~burchil/plants/lichens/index.html

Cryptogamic Herbarium (UofM WIN)

3.1.9.2 Forest Lands Inventory

The inventory used to create the modeling landbase for this Forest Management Plan (2020 to 2040) is the Forest lands Inventory (2002). It was jointly created by LP and Manitoba Conservation. This detailed ecological inventory stratified multiple tree layers to describe vegetation at different heights, which is especially common in aspen-spruce mixedwood forests. In addition, an ecosite classification system (Table 3.18) was developed (Arnup *et al*. 2006) to facilitate a biodiversity conservation strategy. The inventory and its' ecosite classification provide ecosystem information, which is used to help Ecosystem-Based Management.

Table 3.18 Ecosite classification system for the Forest Lands Inventory.

	Ecosite Number	Soil Moisture Class	Soil Texture Class	Vegetation
non-forested wetlands	W1	wet	n/a	Open Bog (low shrub)
	W2	wet	n/a	Open Poor Fen (low shrub)
	W3	wet	n/a	Open Rich Fen
	W4	wet	n/a	Thicket Swamp
	W5	wet	n/a	Shore Fen
	W6	wet	n/a	Meadow Marsh
	W7	wet	n/a	Sheltered Marsh
	W8	wet	n/a	Exposed Marsh
	W9	wet	n/a	Open Water Marsh (floating leaf - peat substrate)
	W10	wet	n/a	Open Water Marsh (submergent - mineral substrate)
forested uplands	11	Dry-Fresh	sandy	TA-BA hardwood
	12	Dry-Fresh	sandy	TA-JP-Spruce mixedwood
	13	Dry-Fresh	sandy	JP-BS feathermoss
	21	Fresh	coarse loamy-silty	WB mixedwood

	Ecosite Number	Soil Moisture Class	Soil Texture Class	Vegetation
	22	Fresh	coarse loamy-silty	TA hardwood
	23	Fresh	coarse loamy-silty	TA-WS mixedwood
	24	Fresh	coarse loamy-silty	JP-BS mixedwood
	31	Fresh	Clayey (lacustrine)	TA-BA hardwood / mixedwood
	32	Fresh	fine loamy (till or stratified)	TA-BA hardwood
	33	Fresh	fine loamy (till or stratified)	TA-BA mixedwood
	34	Fresh	fine loamy (till or stratified)	WS-BF mixedwood
	35	Fresh	fine loamy (till or stratified)	JP-BS mixedwood
	36	Fresh	fine loamy (till or stratified)	BS-JP-(WS-BF) Labrador tea-feathermoss
	41	Moist	sandy to silty	TA-BA hardwood
	42	Moist	sandy to silty	WS (BF) mixedwood
	43	Moist	sandy to silty	BS-JP-feathermoss
	44	Moist	coarse loamy to clayey	Other hardwoods (AG-AE-MM)
	51	Moist	fine loamy to clayey	TA-BA hardwood
	52	Moist	fine loamy to clayey	TA-WS-JP mixedwood
	53	Moist	fine loamy to clayey	BS-feathermoss-Labrador-tea
forested wetlands	61	Wet	fibric-mesic organic	BS-(WS) -Lab tea - Fmoss - Sphagnum
	62	Wet	mesic organic	BS-Alder-Herb Rich
	63	Wet	fibric organic	TL-BS-Sedge (Treed Fen)
	64	Wet	fibric organic	BS-(JP)-Ericaceous-Sphagnum
non-forested uplands	71	Dry - Moist	any mineral soil texture	Open Shrub
	72	Dry - Moist	any mineral soil texture	Closed Shrub
	73	Dry - Moist	any mineral soil texture	Grassland

To implement Ecosystem Based Management at the landscape-level, the ecosystems in the Duck Mountain and Porcupine Mountain Provincial Forests needed to be mapped (and classified. Therefore, LP and Manitoba Conservation-Forestry Branch created a pilot ecological inventory of Forest Management Units 13 and 14, Duck Mountain Provincial Forest and Porcupine Mountain Provincial Forest, respectively. LP and MC managed the project, while the consulting firm The Forestry Corp. was contracted to do the inventory work. The entire project area was approximately 600,000 hectares.

The new Forest Lands Inventory (FLI) is an operational inventory, which has a high level of ground-level accuracy, versus a regional inventory, which has a coarse level of accuracy at the landscape-level. The FLI is also ecologically-based and is designed to accurately map the location and characteristics of ecologically important forest components, such as soil moisture, soil textures, and topography.

100% of the landbase was photo-interpreted, regardless of administration boundaries such as parks, protected area, Treaty Land Entitlement, *etc*. In addition, all land, including forested uplands, forested wetlands, non-forested uplands, and non-forested wetlands were inventoried.

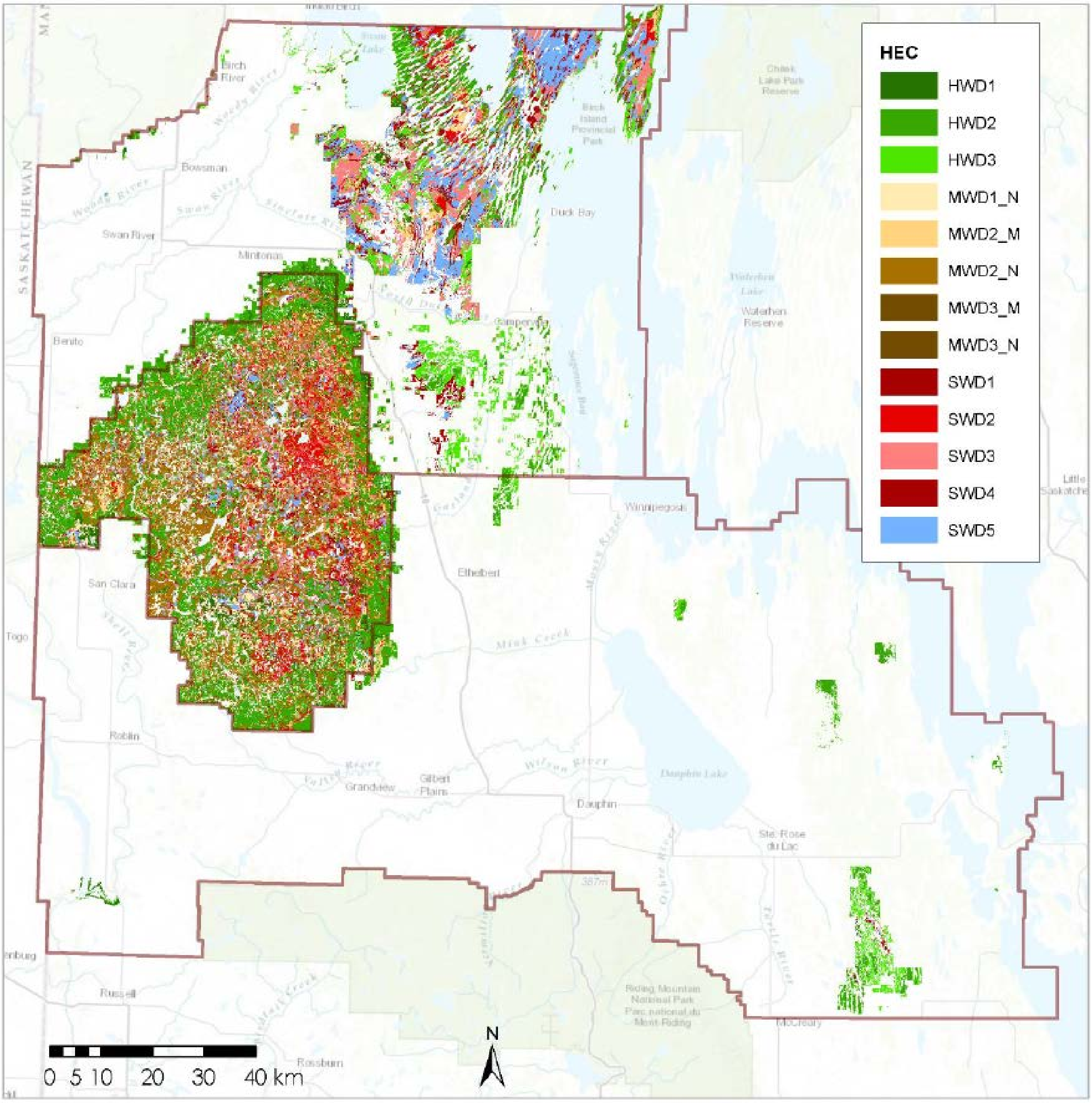


Figure 3.54 Map of Habitat Element Curve strata in FML #3 (ForSite Consulting, 2018) for open crown land.

Landform and soil mapping was completed first. Soils polygons were delineated on 1:60,000 photos, and soils and landform attributes interpreted within each polygon. 282 polygons were field checked for quality control. Primary landform and soils mapping attributes include:

- mode of deposition (e.g. glacio-fluvial, morainal);
- soil texture (e.g. coarse-textured soil (Silty Sand));
- landscape modifiers (e.g. Organic flat, bowl, ribbed, sloping, or level with hummocky mineral soils);
- drainage (e.g. I-imperfectly drained);
- soil order, great group, & subgroup (e.g. D.GL dark gray luvisol); and

soil subgroup modifiers (e.g. calcareous, Bt clay layer, rich Ah horizon).

Two sets of aerial photography, black and white near-infrared photos and colour infrared leaf-off photos, both at a scale of 1:15,000 were utilized. The colour infrared photos show conifer understory, tamarack, and terrain that would normally be masked by the leaves of the hardwoods. Stratification of ecological boundaries into polygons was determined first. Stand attributes were then determined within each polygon.

Forested stands attributes include:

- cover
- cover class
- arrangement
- Canopy (# layers, type, rank)
- % species
- age of origin
- ecological data
- stand conditions (modifiers)
- wetland info

Topographic stand attributes include:

- soil model & number (same as 1:60,000 soils/landform effort)
- parent material / mode of deposition
- parent material texture
- topographic form (e.g. SC side slope concave)
- slope position (1-7)
- slope percent class
- aspect
- soil moisture regime (classes)

Due to the many mixedwood stands in the project area, the FLI was designed to be a multi-layer inventory. Therefore, stands were photo interpreted with several canopy layers (if they have different heights), as well as a conifer understorey, if present.

Quality control (QC) procedures were utilized at each stage of the inventory development. Photo interpretation had QC by having 40 stand-height helicopter observations per 10 km X 10 km map sheet, in addition to 10 ground visits by the photo interpreter. The interpreters did internal QC on their photo interpretation work, and then submitted the line work to provincial photo interpreters, who did additional external quality control.

1,429 ecosystem sampling plots were measured across the project area, in a statistically rigorous sampling design. The ecological plots characterized the forest resource in terms ecological characteristics of the sites, including live trees, snags, coarse woody debris, soils, vegetation, and wildlife observations.

Ecosite primary data (*e.g.* soil moisture, soil texture, vegetation) were mapped by photo interpretation. Ecosite plot data on 536 forested wetland and forested upland plots were collected and used to create 24 distinct and unique forested ecosites. A field key was created, based on the classification results. The forested ecosites were summarized in factsheets.

An ecosite field key was created, based on the ecosite classification results. The forested upland and forested wetland ecosites were summarized in factsheets. Ecosite assignments were made for all forested polygons in the FLI, by using the ecosite primary data and the ecosite key. Through this effort, an ecosite was assigned to every forested upland and forested wetland stand in the landbase. Fact sheets were created for each ecosite, complete with stand structure summaries, vegetation features, and colour photos of average soil conditions, understory vegetation, and tree canopy.

All of the above-mentioned innovations have created an exceptional inventory, with a great depth of 'ecological resolution' and detail. Unfortunately, the ecological depth and detail also make the FLI harder to use. Therefore, a 'User Guide' was created to assist inventory users with correctly using the tabular and spatial data in the FLI (The Forestry Corp. 2004).

3.1.9.3 Previous Forest Resource Inventory

Prior to the creation of the Forest Lands Inventory (2002), the previous forest resource inventory was the 1982 Forest Resource Inventory. Characteristics of this inventory included the following hierarchy of classification:

- Land and water were divided first
- forested and non-forested land (*i.e.* barren-bare rock, fields, meadow, marsh muskeg, and unclassified)
- productive forested (cover groups H, N, M, and S) versus 'non-productive' forested land (*i.e.* treed muskeg, treed rock, willow-alder, and protection forest)

Three digit codes were assigned to each category listed above.

The 1982 FRI had no stand ages. Instead of age, cutting class was assigned, based on size, vigour, state of development and maturity of a stand for harvesting purposes. In general the 1982 FRI had a strong merchantable conifer focus. Significant detail and effort was put into delineating the merchantable conifer stands. Conversely, the hardwoods were all lumped and little effort or detail were put into the non-merchantable hardwoods.

Wetlands were considered 'non-productive' and lumped into muskeg and treed muskeg categories, ignoring the Canadian Wetland Classification system. Ecological information such as landforms and soils were purposefully absent.

3.1.9.4 Forest Stand Age

Forest age is an important consideration, since forest ecosystems are very dynamic. An ecosystem will have different characteristics and habitat values when young, old, or very old. There are different ways and different metrics to measure and estimate stand ages across an entire forest. Two methods utilized in the Duck Mountain include 'Time Since Fire', and inventory age. The metric and methodology of 'Time Since Fire' focuses on the previous stand-replacing event, usually a fire. Results from Tardif 2004 document stands that have not had a fire for 300 years or since the 1720's. Forest inventory ages focus on individual trees by counting their annual growth rings, then estimating stand age. This methodology showed a maximum stand age of 160 years old in the Duck Mountain. Note that rot in aspen prevents counting rings in very old aspen trees.

3.1.9.4.1 Time Since Fire

The importance of understanding natural disturbances has increased as society desires a more natural approach to forest management. The idea behind "natural disturbance pattern emulation" is that forest management strategies that feature retention of natural species composition, stand structures, and landscape patterns similar to those of natural disturbances that will likely promote the conservation of biodiversity.

Little research has been conducted in Manitoba with regards to natural disturbances. One of the principle natural disturbance agents in Manitoba is forest fire. For these reasons and to better understand the dynamics of the Duck Mountain ecosystems, Tardif (2004) developed a 300-year fire history reconstruction for the Duck Mountain Provincial Forest (DMPF).

Standard dendrochronological methods were used to determine the time-since-fire distribution of forest stands within the DMPF (Tardif, 2004). The study results indicated that the fire cycle in the DMPF has dramatically changed since the early 1700s, as mapped in Figure 3.25. In the pre-settlement period (1700-1880), which corresponded to the late portion of the Little Ice Age, the fire cycle may have been around 55 years with an average of 1.8% of the area burning each year. Throughout that period, it is speculated that large, infrequent fires have occurred in conjunction with prolonged droughts. For example, an extreme drought was observed from 1885 to 1895 and coincided with about 83% (283,580 ha) of the DMPF burning.

Time-since-fire dates were obtained for each fire-site by aging dominant trees/species known to regenerate well after fire. The post-fire colonization mechanisms of trembling aspen-balsam poplar-white birch (asexual reproduction within the burn) and, jack pine-black spruce (aerial seed banks within the burn) served to date stand origin. Priority was given to shade-intolerant species like jack pine and trembling aspen, which form even-aged cohorts following forest fires. Other species like white birch, tamarack, black spruce, and white spruce were also used because of their greater longevity. At each site, 8-10 trees were sampled and two cores were extracted from opposite direction and close to the ground level using an increment borer. In young site (less than 80 years) only one core per tree was extracted. Four cores were systematically extracted from white birch, a species characterized by numerous missing rings. No attempt to determine the actual position of the root collar was done.

In addition to time-since-last-fire, indicators of previous fire were looked for. Each site was searched for fire-scarred trees, snags and down woody debris that were charred or not. Many cross-sections were collected. Snags are often the result of past fire and they can be used to extend back in time both the fire history and reference chronologies (Payette et al. 1989). Priority was given to jack pine snags, which may stand for over 100 years. In many sites, it was thus possible to determine both time-since-last-fire and the time to the previous fire. To characterize each fire-site, ten modified Point Centre Quadrat separated by a pacing distance of 10 m were sampled and at each point, the species and diameter of the closest tree in each quadrant was recorded. The data was used to calculate both relative frequency and dominance and to develop an importance value for each species. In addition to the 263 fire-sites, 96 checkpoint-sites were sampled to assess the continuity of the time-since-fire across the landscape and/or to locate fire scarred trees and/or other indicators of past fire activity. These were done when a change in stand structure was observed. In these sites, usually three living trees and/or a few snags were sampled.

Despite these frequent fires, the length of the fire cycle has increased to about 200 years. On average, about 0.5% of the landscape was burning every year. Since the last major fire that occurred in 1961, the length of the fire cycle has been estimated to be 15,000 years. The year 1961 coincided with the most severe drought in the 20th century for that region of Manitoba. Part of this extraordinarily long fire cycle is an artifact of a 40 year data set, which is small for these landscape-level, long time horizon events. Another part of the long fire cycle may also be a reflection of fire detection and control practices that have improved in the last few decades.

At no other time in the 300 year record was there a 40 year period with so little area burned. The impact of fire suppression needs to be further investigated, as it is speculated to play a major role in the lengthening of the fire cycle. The current time-since-fire distribution and age structure observed in the landscape are probably unprecedented. The imprint of the late 19th century fires coupled with settlement and fire suppression have been the dominant forces structuring the ecological processes of today. This study questions the use of the current state of the DMPF, and provides a benchmark on which to evaluate future anthropogenic impacts. It also emphasizes the need to re-introduce larger scale disturbances in the DMPF and questions our ability to cope with potential risks associated with large, infrequent disturbances.

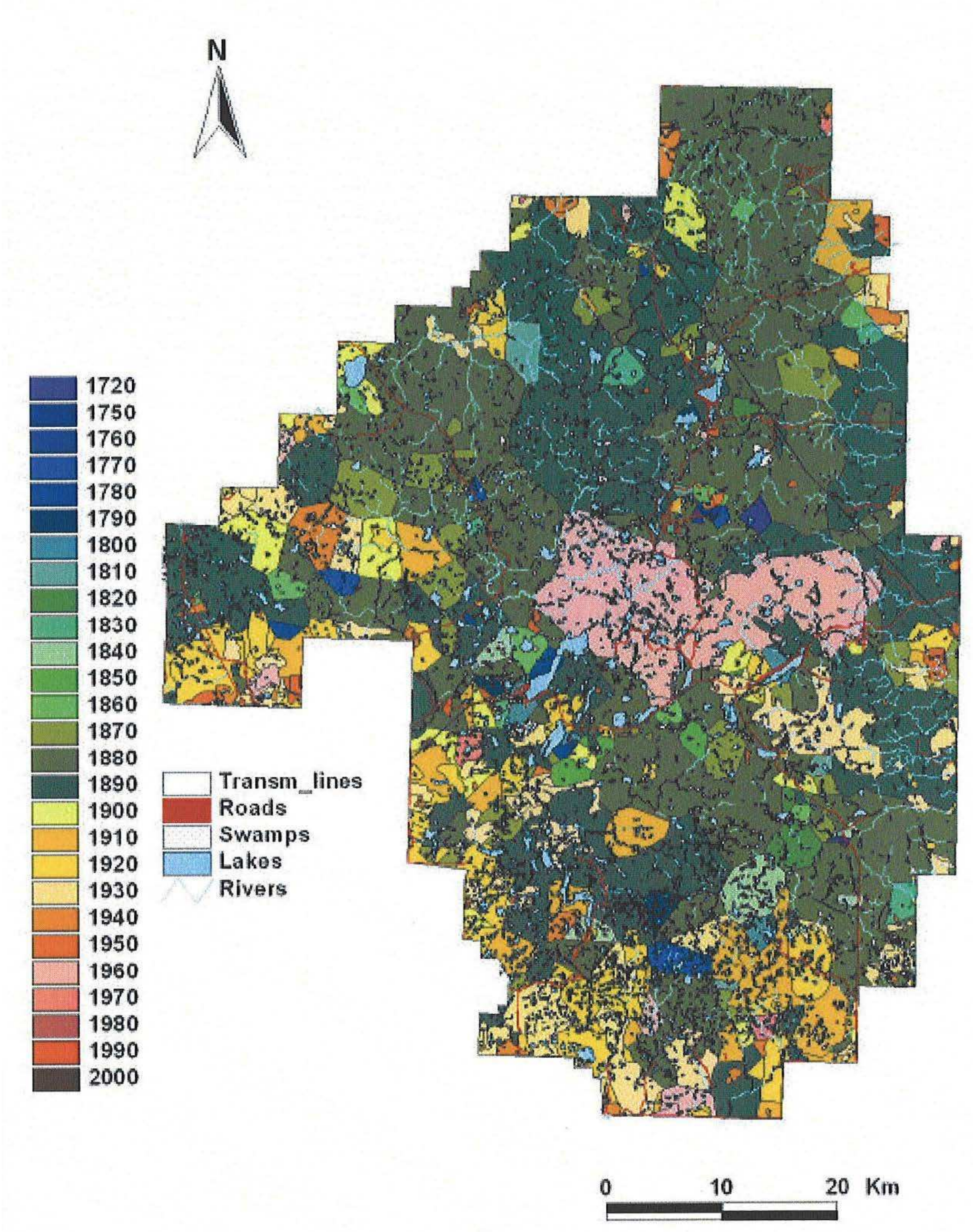


Figure 3.55 Time-since-last-fire map for the Duck Mountain (Tardif, 2004).

The Duck Mountain Provincial Forest (DMPF) is unique with respect to:

- Its' isolated nature along the Manitoba escarpment; and
- The existence of a provincial park within its' boundaries.

Tardif further suggests that with the increased risks or uncertainties associated with global warming and fire suppression, managers should explicitly incorporate the risk of large, infrequent catastrophic fires in their long-term management plan. For the DMPF, this may mean establishing firebreaks or controlling fuel build-up.

There are several additional implications for forest management. Harvesting has replaced fire as the main stand-replacing disturbance agent. The author recommends that the harvest should be dispersed to create a variety of age classes that exist in different areas, similar to a large fire that will leave a forest with diverse age classes intact. This dispersal of disturbances is counterbalanced by a need to develop larger cut blocks or a larger range of cut block sizes than is currently permitted by government guidelines, to create a landscape pattern that maintains some natural characteristics.

3.1.9.4.2 *Inventory Age*

A standard method of populating a forest inventory with an age for every stand is a combination of measuring individual trees within a stand, then estimating the age of nearby stands that appear to be similar. However, age cannot be directed determined from aerial photos or aerial imagery.

The current age class distribution of all forest stands across FML #3 is shown in Figure 3.54. The age class graph is divided into contributing forest, and non-contributing forest (*i.e.* no harvest areas such as parks or buffers). There is a significant age class imbalance, since the majority of the forest is either mature, over mature, or very over mature. The age class 1-20 years are recent stand-replacing disturbances, including softwood harvesting by Quota Holders, hardwood harvesting by LP and Quota Holders, as well as 14,300 ha of blow down that occurred in 2012, and finally a few small fires. The age class structure of the Duck Mountain (FMU 13) has been heavily influenced by the 1890's fire events, where the majority of the Duck Mountain burned all at once 130 years ago.

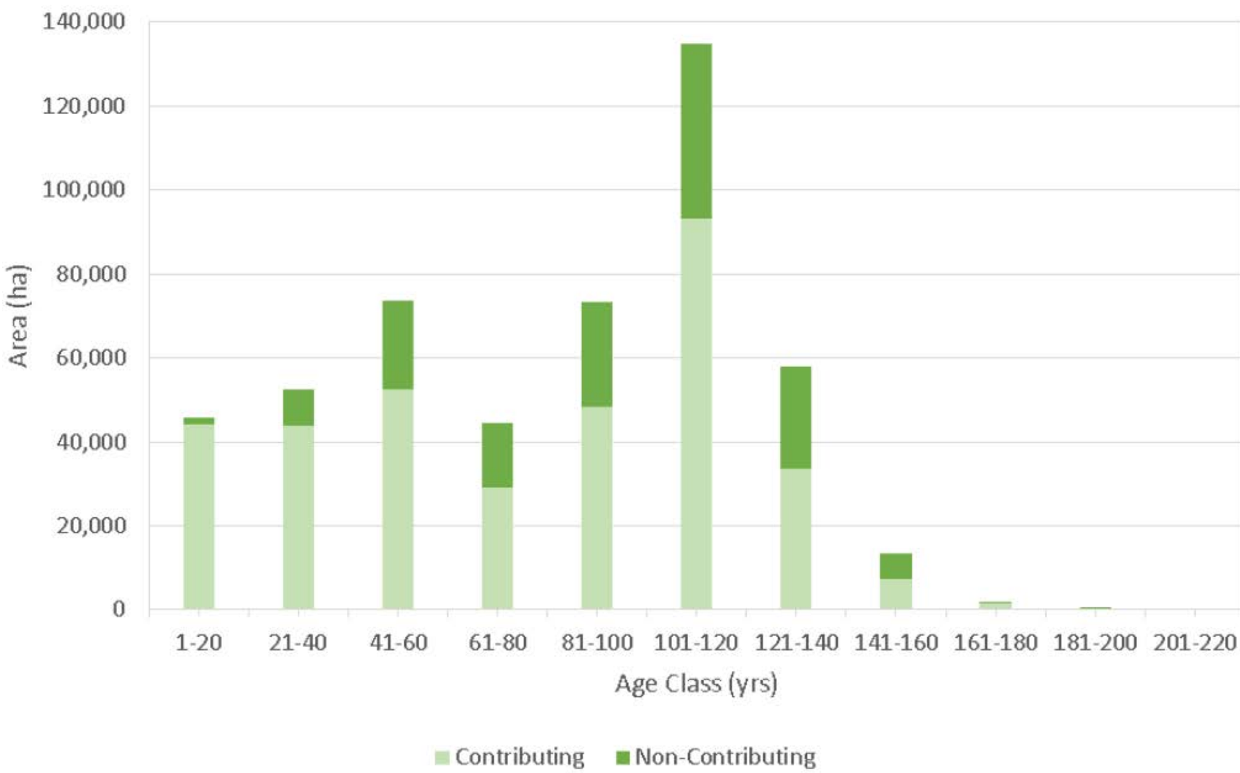


Figure 3.56 Forest age class distribution of FML #3 (ForSite consultants).

3.1.9.5 Vegetation Biodiversity

Vegetation biodiversity is both the number and variety of plants found in an area. Biodiversity is important to having robust and resilient ecosystems. In addition, higher biodiversity provides more habitat opportunities and life requirements for wildlife species.

The baseline diversity of plant species within FML #3 is described by the various vegetation ground sampling efforts have been done in and around FML #3 (Table 3.19).

Table 3.19 Vegetative ground sampling summary in and around FML #3.

Inventory Name	Reference	Location	Findings	Description
Duck Mountain Resource Inventory	MNR 1980	Duck Mountain Provincial Park	300 species of plants	
Riding Mountain National Park Resource Description and Analysis	Briscoe *et al.* 1979	Riding Mountain National Park	nearly 500 species	
Canadian Historical Information Network (CHIN)		Manitoba	over 900 species	a database containing a listing of the herbarium collections of the University of Winnipeg, Manitoba Museum of Man and Nature and other Canadian Institutions.
Ecosites of the Mid-Boreal Upland Ecoregion of Manitoba	Arnup *et al.* 2006	Duck and Porcupine Mountain Provincial Forests	393 species total trees - 12 spp. shrubs - 60 spp. semi-shrubs – 8 spp. herbs – 215 spp. mosses and liverworts – 83 spp. lichens – 15 spp.	Ecosite plot data collected on 536 forested wetland and forested upland plots as part of the Forest Lands Inventory (2002) yielded a vegetation list by life form

The current condition of biodiversity in FML #3 is best quantified by the three biodiversity indices that were measured and calculated for forested ecosites (Figure 3.19) as part of the Arnup *et al.* 2006 ecosite guide. Note that non-forested ecosites were photo-interpreted only, and without field sampling biodiversity indices could not be calculated for non-forested uplands and non-forested wetlands. The three biodiversity metrics are:

i) **Average No. of Species**: The mean number of plant species per sample.

ii) **Total No. of Species**: The total number of plant species encountered in all the samples.

iii) **Shannon-Weiner Index**: A value for the Shannon-Weiner Index calculated from the vegetation samples.

A higher index number means higher biodiversity, while a lower index number means lower biodiversity. Generally, the ecosites with the highest biodiversity are the forested wetlands (ecosites 61 to 64), and the mixedwood ecosites on average to moist conditions (ecosites 31, 33, 34, 35, 42 & 52). The least amount of biodiversity is found in dry sites (ecosites 11 to 24).

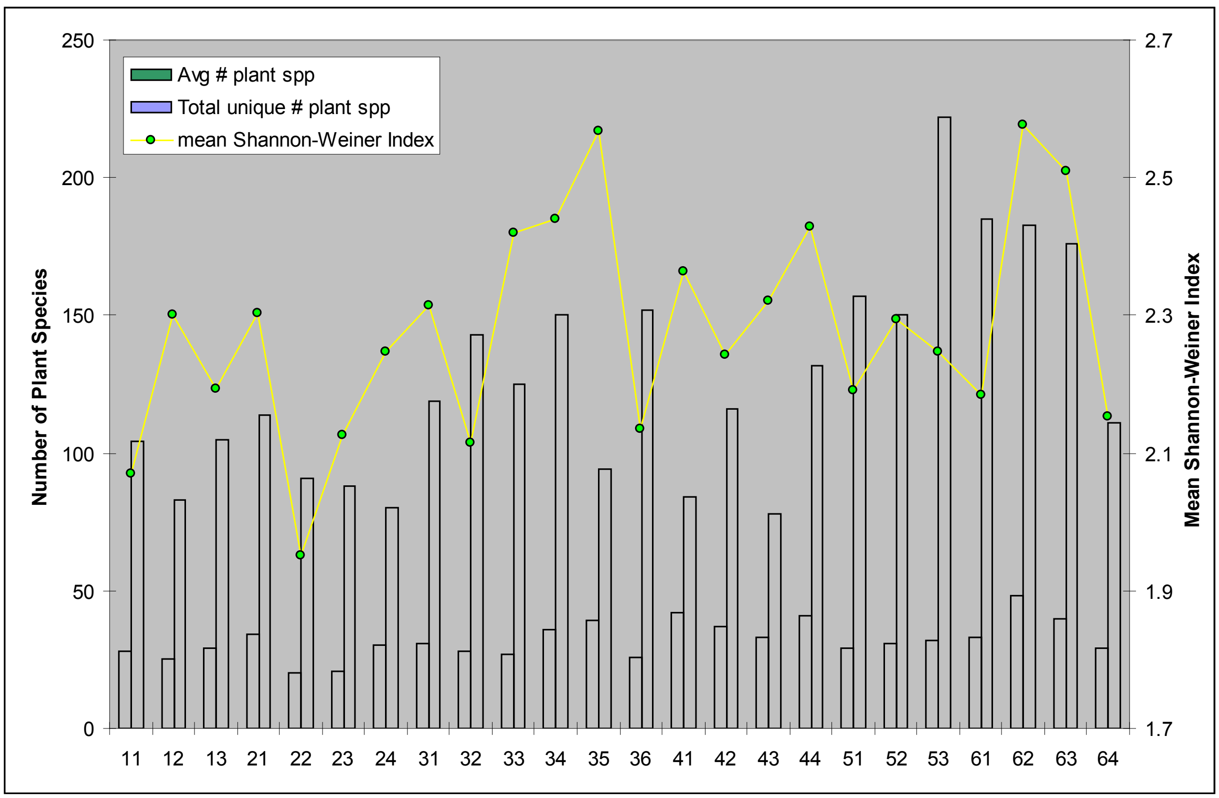


Figure 3.57 Biodiversity indices for forested upland and forested wetland ecosites.

Additionally, soil moisture is an environmental gradient that correlates with vegetative biodiversity. Dry sites have the least biodiversity, and wet sites have the most biodiversity, irrespective of stand cover type (Figure 3.56).

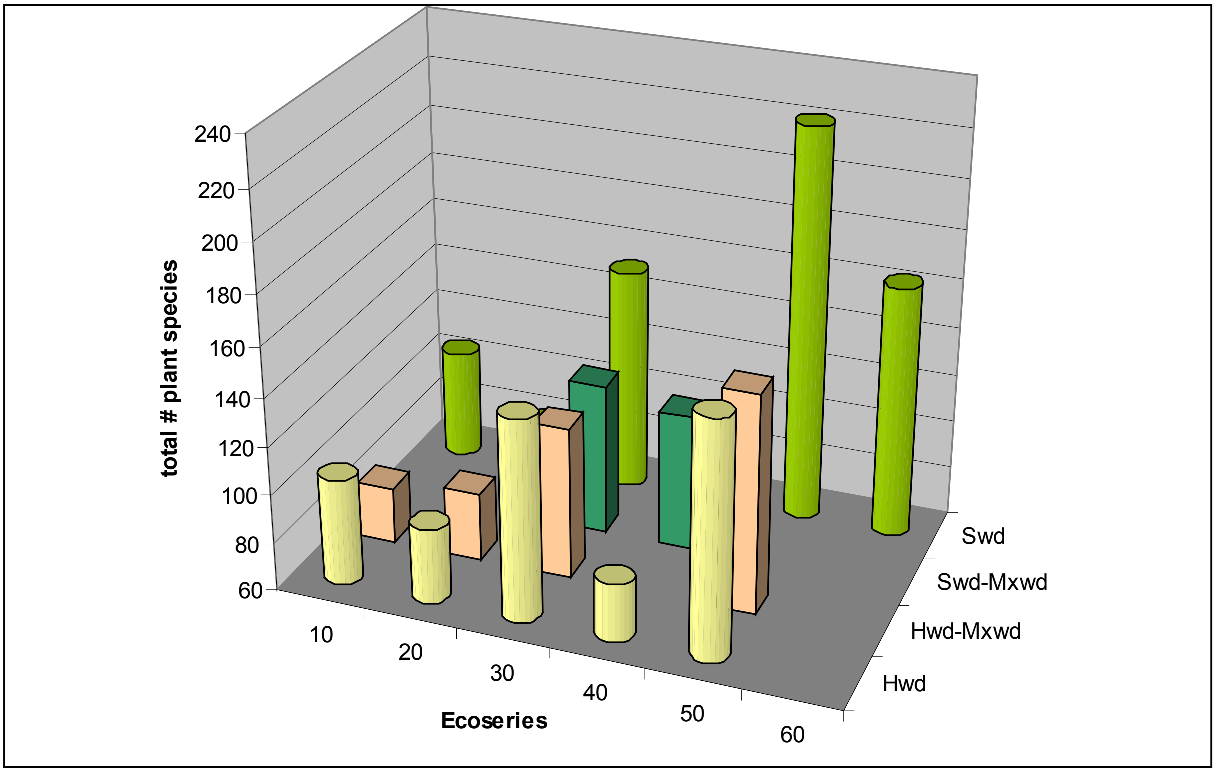


Figure 3.58 Biodiversity index (total number of plant species) increases with soil moisture class (Ecoseries 10=dry; Ecoseries 60=wet).

3.1.9.6 Landscape Diversity

Landscape diversity refers to forest vegetation patterns and structural features of the forest landscape, originally derived from a combination of natural processes and disturbances that are influenced by activities associated with forest management. Landscape diversity, and its ongoing maintenance, is an important element of a desired future forest in order to preserve species diversity in the future.

Three landscape diversity metrics used to define the current landscape diversity are:

1. Hardwood percentage, which is an easily interpreted indictor of diversity;
2. Forest age, which is an easily interpreted indictor of diversity; and
3. Age edge density which measure of the interspersion of habitat that is also commonly used as coarse filter indicator of biodiversity. Forest with the same age over a large area have an age edge density of zero. Forest with many different stand ages over a small area have a high age edge density (measured in metres of edge per hectare). Age edge density is a useful biodiversity metric since some generalist wildlife species prefer abundant edge and diverse cover types within their ranges, whereas other forest interior dependent species require large areas of contiguous forest habitat.

3.1.9.7 Endangered Ecosystems

Manitoba's Endangered Species and Ecosystems Act lists two endangered ecosystems:

1) **Alvar** - thin (usually 10 cm or less) or absent layer of soil over a limestone or dolomite bedrock pavement. Alvars are often very wet in the spring, then very dry in the summer. Manitoba alvars have variable features, including open perennial grassland, shrub land, savannah, and limestone/dolomite flat-rock substrate dominated by lichens.

2) **Tall Grass Prairie** – originally occurred in Manitoba's Red River Valley in south-central Manitoba, but has mostly been converted to farm land.

Neither alvars nor tall grass prairie endangered ecosystems occur in FML #3.

3.1.9.8 Species at Risk - Vegetation

The Manitoba Wildlife and Fisheries Branch is responsible for the administration of Manitoba's Endangered Species and Ecosystems Act. Plant species classified as Endangered and Threatened (as of Oct. 23rd, 2018) are shown in Table 3.20:
https://www.gov.mb.ca/sd/wildlife/sar/sarlist.html
Note that the provincial government does not stratified the location of these species at risk by Forest Management Licence boundaries. To date, none of these species have been found by the Pre-Harvest Survey program.

Table 3.20 Manitoba listed Endangered and Threatened plant species.

Common Name	Scientific Name	* EcoRegion
ENDANGERED PLANTS		
Gastony's Cliffbrake	*Pellaea gastonyi*	
Gattinger's Agalinis	*Agalinis gattingeri*	
Great Plains Ladies'-Tresses	*Spiranthes magnicamporum*	
Rough Agalinis	*Agalinis aspera*	
Smooth Goosefoot	*Chenopodium subglabrum*	
Small White Lady's-slipper	*Cypripedium candidum*	
Western Ironweed	*Vernonia fasciculata*	
Western Prairie Fringed-orchid	*Platanthera praeclara*	
THREATENED PLANTS		
Buffalo grass	*Buchloë dactyloides*	
Culver's-root	*Veronicastrum virginicum*	
Hackberry	*Celtis occidentalis*	
Hairy Prairie-Clover	*Dalea villosa*	
Riddell's Goldenrod	*Solidago riddellii*	
Western Silvery Aster	*Symphyotrichum sericeum*	
Western Spiderwort	*Tradescantia occidentalis*	

* Ecoregion acronyms: MBU-Mid-Boreal Upland; IP-Interlake Plain; AP-Aspen Parklands; LMP-Lake Manitoba Plain; BT-Boreal Transition

Please note that this list of endangered and threatened species is for the entire Province of Manitoba, and likely includes plant species not found in FML #3.

Manitoba's Conservation Data Center ranks approximately 2,000 plant species in the Province. A ranked list (i.e. S1-extremely rare to S5-very common) of aquatic and upland plants and includes many agricultural weeds is provided at:
https://www.gov.mb.ca/sd/cdc/pdf/plant_rank.pdf

The Manitoba ranking (Province-wide) system is:

S1 Very rare throughout its range or in the Province (5 or fewer occurrences, or very few remaining individuals). May be especially vulnerable to extirpation.

S2 Rare throughout its range or in the Province (6 to 20 occurrences). May be vulnerable to extirpation.

S3 Uncommon throughout its range or in the Province (21 to 100 occurrences).

S4 Widespread, abundant, and apparently secure throughout its range or in the Province, with many occurrences, but the element is of long-term concern (> 100 occurrences).

S5 Demonstrably widespread, abundant, and secure throughout its range or in the Province, and essentially impossible to eradicate under present conditions.

The Conservation Data Center also provides lists of species of conservation concern. These species lists are far more than just plants, but also include amphibians, animal assemblages, birds, fish, invertebrates, mammals, and reptiles by ecoregion: https://www.gov.mb.ca/sd/cdc/ecoregions.html

FML #3 spans portions of five different ecoregions:

1) Mid-Boreal Upland
2) Interlake Plain
3) Aspen Parklands
4) Lake Manitoba Plain
5) Boreal Transition

3.1.10. Wildlife

Wildlife in the Forest Management Licence #3 area includes various lifeforms, including mammals, birds, fish, amphibians, reptiles, insects, and invertebrates. Some of the mammals, birds, and fish are commercially or recreationally harvested. Many other species are harvested for domestic consumption by First Nations and others.

Details on common wildlife species (*e.g.* beavers, small mammals, predators *etc.*) were provided in the 2006 Forest Management Plan for FML #3. This FMP will provide detail on moose, marten, and Species at Risk such as the Canada Warbler, Golden-Winged Warbler, and Olive-Sided Flycatcher. Most of the information for these species are from the Federal Species at Risk Act recovery plans, Manitoba Conservation Data Center, and the Boreal Avian Modeling (BAM) project from the University of Alberta. In addition, a general list of mammals, major groups of birds, amphibians, reptiles, insects, and micro-organisms are listed, but not described, in this section.

3.1.10.1 List of mammals

Ungulates

White-tailed Deer – *Odocoileus virginianus*
Moose – *Alces alces*
Elk - *Cervus elaphus manitobensis*
Mule deer - *Odocoileus hemionus*

Large Predators

Black Bear – *Ursus americanus*
Gray Wolf – *Canis lupus*
Coyote – *Canis latrans*
Red Fox – *Vulpes vulpes*
Lynx – *Lynx canadensis*
Cougar – *Felis concolor*

Furbearers

Wolverine – *Gulo gulo*
Long-tailed Weasel – *Mustela frenata*
Short-tailed Weasel – *Mustela erminea*
Striped Skunk – *Mephitis mephitis*
Mink - *Mustela vison*
Racoon – *Procyon lotor*
Beaver – *Castor canadensis*
Muskrats – *Ondatra zibethicus*
River Otter – *Lutra canadensis*
Marten – *Martes americana*
Fisher – *Martes pennanti*

Small Mammals

FML #3 contains approximately 29 species of small mammals distributed over a broad range of habitats. Three of these, the dusky shrew, water shrew (*Sorex palustris*) and arctic shrew (*Sorex obscurus*), are found close to lakes, streams, ponds, marshes, bogs, and surrounding riverbanks (Whitaker 1980, Banfield 1974).

Six others, the northern bog lemming (*Synaptomys borealis*), meadow jumping mouse (*Zapus hudsonius*), meadow vole (*Microtus pennsylvanicus*), heather vole (*Phenacomys intermedius*), Franklin's ground squirrel (*Spermophylus franklinii*) and woodchuck (*Marmota momax*) are typically found in woodland glades, meadows and grassy or sedge fields (Whitaker 1980, Banfield 1974).

The remaining small mammal species are:

- Northern long-eared bat (*Myotis septentrionalis*)
- Silver-haired bat (*Lasionycteris noctivagans*)
- Big Brown bat (*Eptesicus fuscus*)
- Red bat (*Lasiurus borealis*)
- Hoary bat (*Lasiurus cinerius*)
- Little brown myotis (*Myotis lucifugus*)
- Least chipmunk (*Eutamias minimus*)
- Gray squirrel (*Sciurus carolinensus*)
- Red squirrel (*Tamiasciurus hudsonicus*)
- Northern flying squirrel (*Glaucomys sabrinus*)
- Star-nosed mole (*Condylera cristata*)
- Masked shrew (*Sorex cinereus*)
- Pygmy shrew (*Microsorex hoyi*)
- Short-tailed shrew (*Blarina brevicauda*)
- Vagrant shrew (*Sorex monticollis*)
- Deer mouse (*Peromyscus maniculatus*)
- Southern red-backed vole (*Clethrionomys gapperi*)
- Eastern chipmunk (*Tamius striatus*)
- Snowshoe hare (*Lepus americanus*)
- Porcupine (*Erithizon dorsatum*)

Arboreal mammals

Arboreal mammals spend much of their life history in trees. Arboreal species in FML #3 are bats, myotis, squirrels, and least chipmunk.

Bats and myotis are insectivorous.

- The little brown myotis and big brown bat form summer nursery colonies and roost in buildings and hollow trees.
- The Northern long-eared bat and silver-haired bat roost under loose bark, in dead trees and tree cavities or nests.
- The red bat roosts in trees near a forest edge or hedgerow. The hoary bat roosts in evergreen trees (Whitaker 1980, Banfield 1974).
- The little brown myotis, Northern long-eared bat, and big brown bat hibernate in colonies in buildings, caves, or mines (Whitaker 1980).

- The silver-haired bat, red bat and hoary bat all migrate south during the winter (Barclay 1984).

The gray squirrel tends to inhabit hardwood and mixedwood forest (Whitaker 1980) while the northern flying squirrel and red squirrel are usually found in softwood and mixedwood forests (Whitaker 1980 and Novak et al 1987). The least chipmunk is found in open softwood forests (Whitaker 1980).

Small Ground mammals

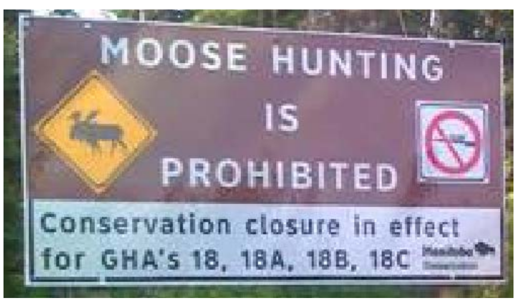
Moles, shrews, mice, voles, eastern chipmunk, snowshoe hare, and porcupine spend most of their life history on the ground. Small ground mammals other than the vagrant shrew use a variety of habitats from wet areas near waterbodies to moist or dry softwood, mixedwood, or hardwood. The vagrant shrew uses primarily mixedwood habitats (Whitaker 1980). The eastern chipmunk and porcupine are primarily ground species, but readily climb trees (Whitaker 1980).

3.1.10.2 Moose

Moose (*Alces alces*) are consistently important to everyone in Forest Management Licence #3 area. Different groups of people have different reasons for moose being important. Moose hold cultural significance for many Indigenous peoples who harvest moose an important traditional food source, social and ceremonial purposes (Nepinak 2018). Moose are a spectacular animal for wildlife viewing and photography. Currently there is no regulated sport hunting for moose. Some people walk in the forest and collect shed moose antlers, which can used for crafts or sold to a dealer.

In the recent past, moose have had locally declining populations. The rapid population decline has led to a Conservation Closure (*i.e.* no moose hunting) in this area. However, moose is not on the Manitoba, Canadian, or international endangered species list. This Forest Management Plan considers moose a species of social concern. Moose have an intrinsic value within the natural ecosystem, and for the people of Manitoba (Nepinak 2018).

3.1.10.2.1 Moose Populations



Local moose populations have declined but are rebounding (Figure 3.57). The current condition of moose populations in the Duck Mountain is that the population is increasing, most likely due to the success of the 2011 to present conservation closure, which prohibits hunting of moose.

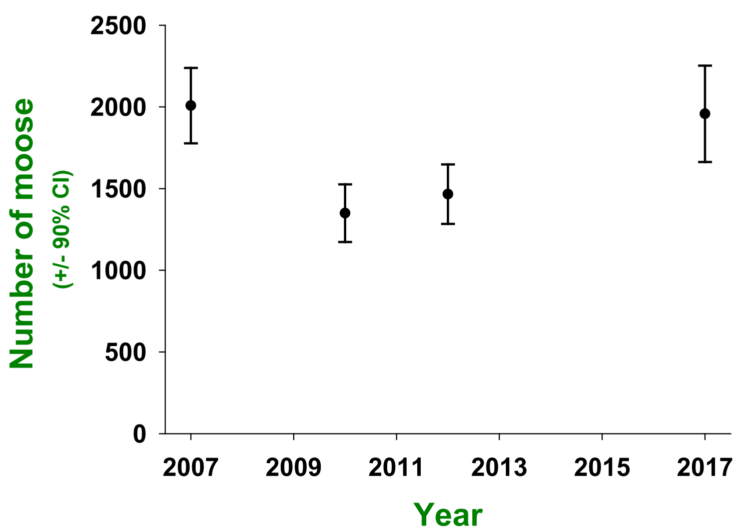


Figure 3.59 Moose population estimates for the Duck Mountain population (Wildlife and Fisheries Branch).

The Province of Manitoba has suggested a number of factors that may potentially be contributing to the decline in moose population, including:

- Moose tick infestations
- Increased forest access and subsequent licenced and subsistence hunting
- Increased wolf predation
- Diseases such as brain worm and liver fluke
- Increased black bear predation

Some moose populations make regular seasonal movements between areas of favourable food supplies and several distinct home ranges, separated by a considerable distance (Nowak 1991). In western Manitoba, home ranges for moose are largely unknown.

*3.1.10.2.2 **Moose Habitat***

The current forest condition of moose habitat in the Forest Management Licence #3 area is not yet available, since quantifying moose habitat is in progress. The best available information on moose habitat in the local area is based on both aerial survey data and recent literature reviews.

Resource Selection Function

Moose habitat in FML #3 is an important consideration in the development of the Forest Management Plan. To assist with the modeling of moose habitat, the Government of Manitoba contracted a Resource Selection Function (RSF) study (Zabihi-Seissan 2018a) to identify moose habitat selection using the most recent moose aerial winter survey data in the Duck Mountain. Later, a Resource Selection Function validation study was completed using multiple years of aerial winter survey data (Zabihi-Seissan 2018b).

General results from the Resource Selection Function showed that in the Duck Mountain during early winter, moose have a high preference for mixedwood stands, slight preference for hardwood stands, and avoid conifer stands. Other general trends included wetlands. Moose showed a preference for marshes, a slight avoidance of fens and swamps, and a strong avoidance of bogs.

Specific results from the Resource Selection Function showed three variables were statistically significant:

1. distance to water (positive selection – moose were found closer to water more often)
2. distance to roads (avoidance – moose were more often away from roads)
3. forest age (positive selection – moose showed a selection and preference for young forest)

The validation work, based on multiple winter aerial surveys showed that the same three variables were statistically significant on each of the three aerial surveys. The curves for each variable varied slightly between surveys years, but were so similar that they were combined into a single curve by averaging the three individual curves.

Moose Literature Reviews

Literature reviews on moose habitat were completed by the Government of Manitoba (Zabihi-Seissan 2018c), and also by the National Council for Air and Stream Improvement (Vice and Loehle 2018). Both literature reviews showed a strong and consistent finding about moose habitat that also matches the findings of the Resource Selection Function reports – moose have a very strong preference for young regenerating hardwood and mixed wood stands, which provide high quality forage and browse for moose.

Both literature reviews state scientific evidence shows that active forest management and forest harvesting are beneficial for moose populations. Active forest management results in young forest stands that are an essential part of moose habitat.

General Moose Habitat

The most important moose habitat is mixed stands of conifer and hardwood where early stages of plant succession are present (Krefting 1974). Favoured habitats are moist areas with willow (*Salix* spp.) and poplar (*Populus* spp.) (Nowak 1991) as are shrub lands, riparian zones, muskeg, burns and cutovers for much of the year (Dorn 1970; Cairns and Telfer 1980; Rolley and Keith 1980; Mytton and Keith 1981; Nietfeld *et al*. 1984; Risehoover 1989). Telfer (1978, 1984) described optimal habitat as areas dominated by early successional vegetation offering a wide diversity of stand types mixed with a variety of age classes that provide both mature conifer cover and open disturbed areas for forage.

Important moose habitats throughout the year are willow, trembling aspen, marsh, and beaver floods in the transition zone between forests and prairies, from north-western Minnesota to northern Alberta (Berg and Phillips 1974).

Timber harvest in some regions is presently the most important factor improving moose habitat because it creates vegetation in the early seral stage. Moose seem quite able to deal with habitat disturbances such as fire or logging (Prescott 1974). Telfer (1978) states that moose distribution can be changed and populations possibly increased by manipulating browse supply.

Large cutovers have little potential for a high quality habitat and moose strongly prefer mixed stands (Girard and Joyal 1984). Maintaining a mosaic of 15 to 30 year-old logged areas intermixed with mature, closed canopy, timbered stands provides productive moose habitat (Matchett 1985).

Food

Moose are a boreal forest species whose distribution is more closely related to the range of northern trees and shrubs than to any other factor (Kelsall and Telfer 1974, Coady 1982). In the boreal forest, food resources have high nutritive value during brief summers and low quality and availability during long winters. To accommodate this, moose store large quantities of fat during summer and fall that offset their winter energy deficit (Schwartz 1992).

Moose are generalist herbivores feeding on a variety of green plants, leaves, and new growth of shrubs and trees during summer, switching to the twigs of woody vegetation in winter (Kubota 1974; Stevens 1974; Miquelle and Gordon 1979; Jackson *et al*. 1991).

In winter, moose eat largely what is available, that depends on snow accumulation (Bonar 1985) and the condition of the winter range (Peek 1974). During the late fall and winter season, moose use deciduous browse almost exclusively as food, although they may eat different species in different regions (Bonar 1985; Telfer 1988).

Moose browse willow, red-osier dogwood, saskatoon, trembling aspen, balsam poplar, paper birch, pincherry, chokecherry, high-bush cranberry, mountain ash, beaked hazelnut, balsam fir, mountain maple, rose, green alder, and nannyberry (Dorn 1970; Barrett 1972; Brassard *et al*. 1974; Stelfox 1974; Crichton and Wielgus 1981; Zach *et al*. 1982; Nietfeld *et al*. 1984; Bergstrom and Danell 1986; Goulet 1992; Pruss and Pekins 1992).

Peek (1974) reports that, for Manitoba, red osier dogwood and willows are the main species taken while balsam fir, trembling aspen, *Virburnum* spp., Manitoba maple, balsam poplar, and raspberry were also commonly taken. Mountain maple, trembling aspen, and beaked hazelnut appear to be important in the more southerly portions of moose range in Manitoba (Peek 1974). Studies by Crichton and Wielgus (1981), Zach *et al*. (1982) and Goulet (1992) support Peek's conclusions.

In summer, moose eat leaves from deciduous trees and shrubs (Timmerman and McNichol 1988). Seventy-five percent of a moose's summer diet is terrestrial plant material (LeResche and Davis 1973: Belovsky and Jordan 1978) and the other 25 percent is aquatic. The amount of herbaceous food eaten is considered small compared with leaves and aquatics (Timmerman and McNichol 1988).

Aquatic feeding is common from June to mid-September (McMillan 1953; Peterson 1955: De Vos 1958; Dodds 1960; Cobus 1972; Peek 1974) as aquatic plants provide an important source of essential nutrients such as sodium, iron, potassium, calcium, magnesium and manganese (Botkin *et al*. 1973); Jordan *et al*. 1973; Aho and Jordan 1976; Fraser *et al*. 1980, 1984).

Mineral licks
Mineral licks are important to summer habitat. Aquatic vegetation provides significant amounts of sodium (Jordan *et al*. 1973). This may explain the importance of licks in areas lacking aquatic vegetation (Best *et al*. 1977). Where aquatic vegetation is available, Fraser (1980) found that moose use licks mainly in spring and early summer, usually beginning with green-up and ending when aquatic vegetation becomes common. In Manitoba, mineral licks (Figure 3.58) are used frequently in all regions during spring and summer. The Duck Mountain has an abundance of mineral licks, due to the topography and the mineral-rich soil that the water flows through.

Figure 3.60 Mineral licks in the Duck Mountain.

Calving areas
Cows seclude themselves before giving birth, often in dense cover (Leptich and Gilbert 1986; and Jackson *et al*. 1991). Calving sites are often undisturbed and poorly drained areas close to water. They may have small diameter browse species present (Altman 1958, 1963; Leptich and Gilbert 1986). Islands and peninsulas offer convenient access to water for escape from predators and are frequently selected for bearing young (Jackson *et al*. 1991). Calving sites on mainland areas include islands in open bogs (Cederlund *et al*. 1987) and lowland climax communities (LeResche *et al*. 1974). Most sites are in areas that give protection from predators (Stephens and Peterson 1984; Addison *et al*. 1990).

Cover
Moose can withstand extremely cold temperatures (Renecker *et al*. 1978). However, they are subject to heat stress in all seasons (Kelsall and Telfer 1974). Renecker and Hudson (1986) observe that upper critical temperatures in controlled experiments were 14º to 20º C or more in summer and -5º and 0º in winter. In summer, moose seek cool cover such as dense and moist lowland conifer and deciduous stands near water. In winter, they reduce their activity levels (Timmerman and McNichl 1988). Coniferous cover reduces energy expenditure and increases the efficient use of the shrub understory (Moen 1968 and Ozoga 1968).

In winter, the depth and quality of snow affect movements and habitat (Krefting 1974). Generally, as winter progresses, moose shift into habitats dominated by conifers and select the shallowest snow for travel (Timmerman and McNichol 1988). Movement is restricted when snow depths are over 65 cm (Des Mueles 1964; Kelsall and Prescott 1971; Phillips *et al*. 1973; Krefting 1974). Depths greater than 90 cm are critical. In late winter, movement is more difficult because of deeper snow, crusted snow and reduced fat or energy reserves to meet the demands of movement (Timmerman and McNichol 1988).

Jack pine, black spruce, balsam fir, and white spruce provide winter cover in the boreal forest (Timmerman and McNichol 1988). In western Manitoba, mature coniferous cover with adjacent immature cover is used heavily. The best cover with adjacent immature cover is used heavily.

Winter habitat typically consists of mature or overmature mixedwood stands of relatively low stocking (less than 60 percent) as these relatively open canopies contribute to shrub productivity and browse availability (Jackson *et al*. 1991). Burned or cutover areas in early successional stages often have good browse production and can be important to winter habitat (Jackson *et al*. 1991).

In summer, moose prefer habitat that provides high quality forage on land, aquatic-feeding areas, a source of water, and cool, dense lowland conifer stands. These components should be close to each other, minimizing energy expenditure for travel (Jackson *et al*. 1991).

3.1.10.3 Elk

Of the wildlife in the area, the elk (*Cervus elaphus*) have received the greatest attention, primarily because of the problems created by the elk's seasonal movements into the agricultural areas near Swan River. Economic losses caused by elk feeding on farmers' haystacks and bales has resulted in a number of studies on how to reduce the damage caused by the elk.

3.1.10.3.1 ***Elk Population Trends***

Unlike elk populations in the Riding Mountain National Park and Spruce Woods Forest to the south of FML #3, the populations of the Duck Mountain Provincial Forest have not been extensively studied. Aerial surveys for elk were flown in 1988, 1995, and 2005. The 2005 survey results showed approximately 1670 elk were found to be living in the Duck Mountain Provincial Forest and surrounding area.

More recently aerial surveys were conducted in 2014 and 2018 (Table 3.21). The aerial survey in 2018 was conducted in Game Hunting Areas 18, 18A, 18B, and 18C from 2-13 February, to obtain current information on the Duck Mountain elk population. A combined survey method was used by which the entire survey area was stratified and a minimum count (total area coverage) was conducted in areas where elk were likely to occur (totalled 23% of the survey area). Sample units in the two strata less likely to contain elk were randomly sampled until suitable precision and confidence in the accuracy of density estimates were obtained. The survey produced a point estimate of 1,162 (90% CI: 1093 – 1231) elk and an average density of 0.16 elk/km^2. Survey methods were the same for surveys conducted in 2014 and 2018 and the results are comparable. The 2018 point estimate suggests no change in this population since 2014. A 2005 survey of the Duck Mountain area was conducted using a different method (wedge method) and produced an estimate of 1,670 elk.

Table 3.21 Elk population estimates (Wildlife and Fisheries Branch).

Year	Number of Elk (Point Estimate1)	90% Confidence Interval	Mean Density (Elk/km2)	Total Survey Area (km2)
2014	1,170	977 – 1,363	0.169	6,922.5
2018	1,162	1,093 – 1,231	0.164	7,059.0

Home Range

The elk in and near FML #3, primarily reside in the forested areas of the Porcupine Hills, Duck Mountain and Riding Mountain National Park, but regularly move on to the surrounding agricultural lands. These movements that are more pronounced during the winter than the summer, may expose the elk to increased hunting pressures and have resulted in considerable conflicts with many farmers because of the damage caused by elk feeding on haystacks and alfalfa fields. A recent study conducted by Chranowski (2006), indicated that the mean (minimum convex polygon) home range size of Duck Mountain Provincial Forest elk ranged from 45.3 to 444.8 km^2. Riding Mountain National Park cow elk had similar mean MCP home ranges of approximately 17.3 to 448.1 km^2. Chranowski (2006) also noted that seasonal home ranges for elk increase in spring which is thought to be due to a cow's need to find suitable calving habitat. Elk home ranges increase again as the animal comes into the rut in autumn and early winter. Cow elk in the Duck Mountain Provincial Forest also show fidelity to specific home ranges that can be relatively small in size. Fidelity to small home ranges can be associated with micro-habitat characteristics that may be rare across the landscape but provide high nutritional forage value.

3.1.10.3.2 ***Elk Habitat***

Elk habitat is highly variable. They prefer to graze in relatively open pastures, meadows, riparian areas, river flats, and aspen Parklands (Banfield 1974). Relatively open pastures are preferred in summer while denser wooded areas are favoured during the winter (Whitaker 1980). Chranowski (2006) noted that deciduous forests and forage cropland areas tend to be the favoured habitat types of elk within the Duck Mountain region. For elk in the DMPF, use of agricultural crop areas increased in the spring, tapered off in the summer and then increased again in November and December. He also noted that use of native prairie grassland habitats was also significant especially during the month of May. Elk use of wetland habitat types indicated a peak during late summer months.

Elk use of mixedwood forest types was also very significant during spring to late summer months (Chranowski 2006). These forest types often provide cooler, shaded habitats due to the tall mixed canopy, dense shrub, and herb undergrowth that offer relief to cows and calves during hot summer temperatures. Conifer forest types were least preferred by elk in the DMPF area (Chranowski 2006).

Calving Areas

Elk calving areas have been described as areas within the forest or at the ecotone where there is access to open forage areas. Calving habitat is also generally close to escape cover and near open water. Calving areas are found to be on gentle south facing slopes, that contain dense ground cover (shrubs, large downed woody material, other debris) to help conceal young calves (Skovlin 1982).

3.1.10.4 Marten

The marten (*Martes americana*) inhabits late successional forest communities throughout northern North America (Marshall, 1951). Marten are mainly terrestrial in their activities, mostly carnivorous, generally nocturnal, and active throughout the year (Allen, 1982). The species is most abundant in mature coniferous forests, but they also inhabit mixedwood coniferous and deciduous forests (Mech and Rogers, 1977). Winter is the critical season for marten because of reduced foraging opportunities and restricted mobility (Raine, 1983). Coarse woody debris on the ground is important for denning, cover, and feeding habitat.

Marten have a diversified diet. Some food items are consumed regularly, some seasonally and some erratically. Song birds, bird eggs, insects, fruits, and berries are used seasonally. Mammals are the most important food and make up the bulk of the winter diet. Voles are the principal food (More 1978, Koehler and Hornocker 1977, Thompson and Colgan 1987, Weckwerth and Hawley 1962). However marten are opportunistic and will feed on red squirrel, snowshoe hare, mice, shrews, and ruffed grouse.

Marten habitat requirements are best met in mature coniferous or conifer-dominated mixedwoods with a canopy closure greater than 30 percent (Hessey and Racey, 1989). Many of these stands contain numerous snags and windfall logs that offer denning opportunities and access below snow cover for hunting. According to Allen (1982) they prefer forest stands with 40 to 60 percent canopy closure and avoid stands with less than 30 percent cover. Spruce or fir in the canopy improve the suitability of forest stands for marten. Stands of at least 40 percent spruce or fir provide optimal winter habitat (Allen 1982, Lofroth and Steventon 1990).

Patches of dense, conifer-dominated mixedwoods tend to form core areas (Mech and Rogers 1977, Thompson and Colgan 1987) where most of the marten's daily activity takes place.

The size, shape, and juxtaposition of these core areas influence the quality of habitat, size of home range and population (Allen, 1982).

Vegetative cover may influence travel. Marten tend to avoid openings, especially in winter. Travel across openings is linear and swift (Robinson 1953, Hawley and Newby 1957, Herman and Fuller 1974, Koehler and Hornocker 1977, Lofroth and Steventon, 1990). Female marten in winter have been observed to follow tree cover around an opening that males would readily cross (Steventon and Major 1982). Generally marten avoid openings. However, marten display concentrated foraging activities along the edges of overmature forest stands and meadows where herbaceous vegetation is abundant (Allen, 1982). Other literature suggests marten seldom venture more than 100 meters into openings (Hargis and McCullough 1984, Ingram 1973, Simon 1980, Spencer *et al*. 1983).

Marten need coarse woody debris for cover (Allen 1982; Lofroth and Steventon 1990). They require well-insulated resting dens in the winter because of their lack of fat reserves, poor insulation, and long thin bodies. Resting sites are often associated with coarse woody debris, which in the winter provides breaks in the snow for subnivean access. In winter, marten seem to select access sites with an abundance and complexity of coarse woody debris (Lofroth and Steventon, 1990).

If cover requirements are met, adequate reproduction habitat should also be available (Allen, 1982). Females may have more restrictive requirements for cover from March to August for whelping (Lofroth and Steventon, 1990). Insufficient dens could result in fewer births. Whelping dens may be found in ground burrows, red squirrel cone middens, old stumps, root masses of large trees, ground debris, or tree cavities (Thomas 1979, Hargis and McCullough 1984, Lofroth and Steventon 1990).

Marten populations are structured around male home ranges (Allen, 1982). Home range boundaries often coincide with edges of topographic or vegetative features such as large open meadows, burns, and streams (Hawley and Newby, 1957). Within each home range core areas can be identified where marten concentrate hunting activities (Marshall 1952, Hawley and Newby 1957, Mech and Rogers 1977, Thompson and Colgan 1987).

Although male marten home ranges can contain a number of forest cover types, including undisturbed and harvested stands, females predominate in mature forests (Steventon and Major, 1982). Winter home ranges are often larger than summer ones and home ranges for males are larger than those are for females are.

3.1.10.5 Birds

FML #3 contains a variety of bird species and habitats. Based on current knowledge and expected distributions, there are 263 bird species that either breed in, or migrate through FML #3. That makes up 73 percent of the 361 confirmed bird species in Manitoba:

- 139 of the total species are not found in forested land and for the most part are not affected by logging operations. The proximity of Lake Winnipegosis and the Swan and Pelican lakes is particularly important to water birds in the region.
- The remaining 124 species are found in forested land and occupy a great variety of habitats. These species include hawks, owls, upland gamebirds, woodpeckers, and passerines.
- 33 of the 265 species are strictly migratory and do not breed in the study area.
- Additional species, both land and water birds, rely on snags, cavities, stumps, or boxes for nesting. These include primary excavators and secondary users.

Major groups of birds found in FML #3 include:

- Waterfowl
- Bald eagles and osprey
- Owls
- Colonial nesting birds
- Accipiter hawks
- Woodpeckers
- Grouse
- Song bird

There are 17 song bird species that represent range of biodiversity (age, cover type, interspersion) in FML #3. Sufficient data exists from the LP Bird Project to link these bird's probability of occupancy to habitat.

AOU Code	Common Name
AMRE	American redstart
BCCH	Black-capped chickadee
BHCO	Brown-headed cowbird
BHVI	Blue-headed vireo
BOCH	Boreal chickadee
BRCR	Brown creeper
COYE	Common yellowthroat
CSWA	Chestnut-sided warbler
GCKI	Golden-crowned kinglet
HETH	Hermit thrush
OVEN	Oven bird
REVI	Red-eyed vireo
SWTH	Swainson's thrush
VEER	Veery
WIWR	Winter wren
YBSA	Yellow-bellied sapsucker
YWAR	Yellow warbler

3.1.10.6 Waterfowl

Waterfowl include all species of birds living in wetlands or lakes, except the colonial nesting birds. Many birds in wetland communities nest some distance away on dry land, often in a plant community not associated with wetlands (Erskine 1977). Five species of ducks are secondary cavity users, the bufflehead (*Bucephala albeola*), common goldeneye (*Bucephala clangula*), wood duck (*Aix sponsa*), hooded (*Lophodytes cucullatus*) and common merganser (*Mergus merganser*). They nest in hollowed tree trunks. The proximity of old forest adjacent to streams and ponds is critical to breeding habitat for these species.

Louisiana-Pacific was a funding partner for the Ducks Unlimited Canada (DUC) Pasquia Project under the DUC Western Boreal Program. There are several key program areas related to the Pasquia Project, with one program focused on conducting an inventory of waterbird use. Aerial surveys have been flown by DUC and have been successful in locating two Trumpeter Swan families in the Duck Mountain, a species thought to be extirpated from the area. We look forward to the completion of the analysis of the survey data to address knowledge gaps related to waterbirds and their habitat in the Duck Mountain, that will enable LP to assess the effectiveness of current forest management strategies related to wetlands and waterbird habitat, and ensure continued availability of wetland habitat into the future.

Duck Mountain Provincial Forest and Park supports a great variety of wetland bird communities, as do the watersheds associated with the Swan-Pelican Lakes and Lakes Manitoba-Winnipegosis. Various wetland communities include:

- Open water
- Marshes
- Fens
- Bogs

Open water

The common loon (*Gavia immer*), lesser scaup (*Aythya affinis*), common goldeneye, bufflehead, and white-winged scoters (*Melanitta fusca*) do not usually nest over water, but they spend most of their time, including foraging, nesting and preening, near open water (Erskine 1977).

Buffleheads frequent much smaller ponds than the others do. Goldeneyes also frequent backwaters and slow stretches of rivers, and lakes and ponds. Suitable trees for nesting are often more common in these habitats (Erskine 1977).

Marshes

Deep marsh is usually characterized by permanent open water (1–3 m deep) surrounded by, or interspersed with, stands of reed, bulrush or cattail. Waterbirds found primarily in such habitats include eared (*Podiceps nigricollis*) and western grebes (*Aechmophorus occidentalis*), redhead (*Aythya americana*), canvasback (*Aythya valisinerina*) and ruddy duck (*Oxyura jamaicensis*) (Erskine 1977).

A number of other species occur in high numbers, but are not restricted to the deep marsh. These are: red-necked (*Podiceps grisegena*) and horned grebes (*Podiceps auritus*), American coot (*Fulica americana*), Franklin's gull (*Larux pipixcan*) and black tern (*Childonias niger*) (Erskine 1977).

Few species in shallow marsh habitat are confined to a single nesting situation. They may be found nesting in the marsh, at the water's edge in wetland vegetation or farther inland among land plants. Waterbirds of the shallow marshes include pied-billed grebe (*Podilymbus podiceps*), American bittern (*Botaurus lentiginosus*), mallard (*Anas platyrhyncos*), black duck (*Anas rubripes*), gadwall (*Anas strepera*), pintail (*Anas acuta*), American widgeon (*Anas americana*), green (*Anas crecca*) and blue-winged teals (*Anas discors*), northern shoveler (*Anas clypeata*), ring-necked duck (*Aythya collaris*), Virginia rail (*Rallus limicola*), sora (*Porzana carolina*) and Wilson's phalarope (*Phaloropus tricolor*) (Erskine 1977).

Fens

Fens and bogs are characterized by organic soils. Fens are more nutrient rich than bogs due to surface and groundwater inputs and have greater plant diversity. They have complex hydrology and can transport large volumes of water and nutrients.

Waterbirds associated with fens are yellow rail (*Coturnicops noveboracensis*), common snipe (*Gallinago gallinago*), solitary sandpiper (*Tringa solitaria*), greater (*Tringa melanoleuca*) and lesser yellowlegs (*Tringa flavipes*), and Bonaparte's gull (*Larus philadelphus*) (Erskine 1977).

Bogs

Bogs are peatlands that receive water only through precipitation. They are nutrient poor and are isolated from groundwater and surface runoff.

The most numerous birds in a bog habitat are songbirds. In slightly wetter areas, and depending on the availability of open water, Ring-necked duck, common snipe, solitary sandpiper, and greater and lesser yellowlegs may appear (Erskine 1977).

3.1.10.7 Endangered or Threatened Wildlife species

Animals listed as endangered or threatened are listed by Manitoba's Endangered Species and Ecosystems Act (ESEA) website: https://web2.gov.mb.ca/laws/statutes/ccsm/e111e.php (accessed March 18, 2019)

The species listed by ESEA (as of August 2018) in or around FML #3 are in Table 3.21.

Table 3.22 Manitoba listed endangered or threatened animals by local ecoregions.

MB Endangered Species and Ecosystems Act ranking	Lifeform	Common Name	Scientific Name	MB Conservation Data Center Ranking	* Ecoregions
endangered	bird	Baird's sparrow	*Ammodrainus bairdii*	S1B	MBU
endangered	bird	Burrowing owl	*Athene cunicularia*	S1B	AP, LMP
endangered	bird	Piping plover	*Chardrius meldus*	S1B	IP, AP, LMP
endangered	bird	Trumpeter Swan	*Cygnus buccinator*	S1B	MBU, IP, AP, BT
endangered	bird	Peregrine falcon	*Falco peregrinus anatum*	S1B	AP, LMP
endangered	bird	Loggerhead shrike	*Lanius ludvicianius*	S1B	MBU, IP, AP, LMP
endangered	bird	Chestnut-collared Longspur	*Calcarius ornatus*	S2B	AP, LMP
endangered	mammal	Little Brown Bat	*Myotis lucifugus*	S2N,S5B	IP
threatened	bird	Canada Warbler	*Cardellina canadensis*	S3B	MBU, IP, AP, LMP, BT
threatened	bird	Golden-winged Warbler	*Vermivora chrysoptera*	S3B	MBU, IP, AP, LMP, BT
threatened	bird	Olive-sided Flycatcher	*Contopus cooperi*	S3B	MBU, IP, AP, LMP, BT
threatened	bird	Sprague's Pipit	*Anthus spragueii*	S2B	MBU, AP, LMP, BT
threatened	bird	Red-headed Woodpecker	*Melanerpes erythrocephalus*	S3B	MBU, IP, AP, LMP, BT
threatened	bird	Whip-poor-will	*Caprimulgus (Antrostomus) vociferus*	S3B	IP, LMP, MBU
threatened	bird	Short-eared Owl	*Asio flammeus*	S2S3B	MBU, IP, AP, LMP, BT
threatened	mammal	Mule Deer	*Odocoileus hemonius*	S3	AP, MBU

* Ecoregion acronyms: MBU-Mid-Boreal Upland; IP-Interlake Plain; AP-Aspen Parklands; LMP-Lake Manitoba Plain; BT-Boreal Transition

Manitoba Conservation Data Center

MBCDC has developed lists of plant and animal species and plant communities, also known as elements of biodiversity, found in Manitoba. MBCDC assigns each of these elements a conservation status rank, based on how rare the species or community is in Manitoba then collects detailed information on where the provincially rare elements have been found. These locations, known as element occurrences, are mapped in a geographic information system (GIS) and entered into a species and plant community database.

Conservation Data Centre Ranks (Global and Provincial)

Species are evaluated and ranked by the Conservation Data Centre on the basis of their range-wide (global - G) status, and their Province-wide (subnational - S) status according to a standardized procedure used by all Conservation Data Centres and Natural Heritage Programs. These ranks are used to determine protection and data collection priorities, and are revised as new information becomes available.

For each level of distribution—global and provincial—species are assigned a numeric rank (Table 3.22) ranging from 1 (very rare) to 5 (demonstrably secure). This reflects the species' relative endangerment and is based primarily on the number of occurrences of that species globally or within the Province. However, other information, such as date of collection, degree of habitat threat, geographic distribution patterns and population size and trends, is considered when assigning a rank. The number of occurrences listed below are suggestions, not absolute criteria.

For example, the Green Frog (*Rana clamitans*) is ranked G5, S2. That is, globally the species is abundant and secure, while in Manitoba it is rare and may be vulnerable to extirpation.

Table 3.23 Conservation Status Ranking (Province of Manitoba).

Rank	Definition
1	Very rare throughout its range or in the Province (5 or fewer occurrences, or very few remaining individuals). May be especially vulnerable to extirpation.
2	Rare throughout its range or in the Province (6 to 20 occurrences). May be vulnerable to extirpation.
3	Uncommon throughout its range or in the Province (21 to 100 occurrences).
4	Widespread, abundant, and apparently secure throughout its range or in the Province, with many occurrences, but the element is of long-term concern (> 100 occurrences).
5	Demonstrably widespread, abundant, and secure throughout its range or in the Province, and essentially impossible to eradicate under present conditions.
U	Possibly in peril, but status uncertain; more information needed.
H	Historically known; may be rediscovered.
X	Believed to be extinct; historical records only, continue search.
SNR	A species not ranked. A rank has not yet assigned or the species has not been evaluated.
SNA	A conservation status rank is not applicable to the element.

Other Heritage Codes

Code	Definition
G# G# S# S#	Numeric range rank: A range between two of the numeric ranks. Denotes range of uncertainty about the exact rarity of the species.

Subrank

Code	Definition
T	Rank for subspecific taxon (subspecies, variety, or population); appended to the global rank for the full species, e.g. G4T3.

Qualifiers

Code	Definition
B	Breeding status of a migratory species. Example: S1B,SZN - breeding occurrences for the species are ranked S1 (critically imperilled) in the Province, nonbreeding occurrences are not ranked in the Province.
N	Non-breeding status of a migratory species. Example: S1B,SZN - breeding occurrences for the species are ranked S1 (critically imperilled) in the Province, nonbreeding occurrences are not ranked in the Province.
Q	Taxonomic questions or problems involved, more information needed; appended to the global rank.
T	Rank for subspecific taxon (subspecies, variety, or population); appended to the global rank for the full species.
#	A modifier to SX or SH; the species has been reintroduced but the population is not yet established.
?	Inexact or uncertain; for numeric ranks, denotes inexactness.

Note there are separate endangered and threatened species lists for each ecoregion. Forest Management Licence #3 includes portions of five different Ecoregions (in order of greatest to least amount in FML #3):

- Mid-Boreal Upland
- Interlake Plain
- Aspen Parklands
- Lake Manitoba Plain
- Boreal Transition

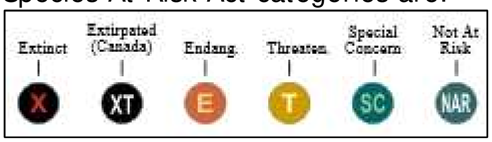
COSEWIC and the Species at Risk Act

COSEWIC (Committee on the Status of Endangered Wildlife in Canada) was established in 1977 to provide Canadians with a single, scientifically sound classification of wildlife species at risk of extinction. COSEWIC began its assessments in 1978 and has met each year since then to assess wildlife species. COSEWIC uses a process based on science, Aboriginal Traditional Knowledge and community knowledge to assess the risk of extinction for wildlife species. Its' process is thorough, independent, and transparent.

The federal Species at Risk Act (SARA) is a piece of Canadian federal legislation that became law in Canada on December 12, 2002. It was designed to meet a Canadian commitment under the International Convention on Biological Diversity. The goal of the Species at Risk Act is to protect endangered or threatened organisms and their habitats.

The purpose of SARA is to protect wildlife species at risk in Canada. Within the Act, COSEWIC was established as an independent body of experts responsible for identifying and assessing wildlife species considered to be at risk. This is the first step towards protecting wildlife species at risk. Subsequent steps include COSEWIC reporting its results to the Canadian government and the public, and the Minister of the Environment's official response to the assessment results. Wildlife species that have been designated by COSEWIC may then qualify for legal protection and recovery under SARA.

Species At Risk Act categories are:



LIST OF WILDLIFE SPECIES AT RISK
In addition to the species which have a protected status under the Province of Manitoba, COSEWIC lists under Schedule 1 of the Species At Risk Act (as of Dec. 2018) a number of federally protected species known to inhabit areas within FML #3 presently or previously on the website: http://www.registrelep-sararegistry.gc.ca/species/schedules_e.cfm?id=1

Endangered

Eskimo Curlew (*Numenius borealis*)
Burrowing Owl (*Athene cunicularia*)
Piping Plover (*Charadrius melodus circumcinctus*)
Loggerhead Shrike (*Lanius ludovancianus excubitorides*)

Threatened

Golden-winged Warbler (*Vermivora chrysoptera*)
Sprague's Pipit (*Anthus spragueii*)
Red-headed Woodpecker (*Melanerpes erythrocephalus*)

Special Concern

Rusty Blackbird (*Euphagus carolinus*)
Yellow Rail (*Coturnicops noveboracensis*)

3.1.10.8 Canada Warbler

Description

Long-tailed woodland bird with rounded head. Blue-gray above, yellow below, bold yellow eye ring, white undertail coverts. Male has black streaky necklace, female is duller, necklace indistinct. Length 5 ¼ inches.

Habitat Requirements

Canada Warbler's primary habitat is cool, moist, typically deciduous-leading forest with dense shrub understory, complex ground cover, and steep slopes and/or open water. Forests older than rotation age (e.g., >125 years) are consistently identified as the most valuable habitat for this species, as well as high shrub cover within stands.

3.1.10.9 Golden-Winged Warbler

Description

Small short tailed woodland bird with slender bill. Male blue-gray above, bright yellow crown, black throat, whitish-gray underparts, black ear patch edged white, blue-gray wings, yellow wing patch. Female duller. Length 4 ¾ inches

Habitat Requirements

The golden-winged Warbler requires early to mid-successional deciduous forest within larger landscapes of mature forest (Confer et al. 2011), limiting its distribution within Manitoba to the boreal-parkland transition. It prefers a specific habitat structure that includes herbaceous, shrub, and tree components. Some habitat sites are characterized by mature forest, where canopy gaps create a patchy shrub layer that is comparable to the understory of early successional sites, or the shrubby edge of wetlands.

3.1.10.10 Olive Sided Fly Catcher

Description

Large, sturdy flycatcher with pointed wings and short tail. Dark brown-gray above, olive-gray flanks almost meeting across breast, throat, and belly dusky white, white downy tufts on lower back. Length 7 ½ inches.

Habitat Requirements

In western Canada, the Olive-sided Flycatcher is found in 0-30-year-old harvested stands and 0-10-year-old burned stands, provided they contain residual trees, and >125-year-old fire-origin mixed wood forests. This species preferred habitat is old, open (>40% cover) coniferous forest or young burned stands, forest openings, and edges containing snags and live trees. Important habitat features for this species include:

- Tall, prominent perches (snags preferred to live trees).
- Riparian areas, water bodies, swamps, bogs, and muskegs containing snags.
- High-contrast edges between mature forest (used for nesting) and openings (used for hunting).

*3.1.10.11 **Amphibians***

The Duck Mountain Resource Inventory (MNR 1980) and the Riding Mountain National Park Resource Description and Analysis (Brisco et al. 1979) list six amphibians and four reptiles as known to be occurring in the area.

- The wood frog (*Rana sylvatica*) is common in the area. It is found in moist wooded areas.
- The boreal chorus frog (*Pseudacris maculata*) is also common in the area and is found near lakes, ponds, bogs, and streams.
- The northern leopard frog (*Rana pipiens*) is common throughout Riding Mountain and most commonly found in the Shell River Valley in Duck Mountain.
- The Canadian Toad (*Bufo hemiophrys*) is common along the shorelines of small waterbodies.
- Tiger salamanders (*Ambystoma tigrinum*) are reported in low numbers in rotten logs, amid burrows and moist places in Riding Mountain. They are absent from the Duck Mountain inventory. The inventory did describe them as being found in the low lands between Duck and Riding Mountains.
- The western gray tree frog (*Hyla versicular*) is described as being at the extreme northern limit of its' range in Riding Mountain although Duck Mountain inventory did list one observation near Camperville on Lake Winnipegosis. This frog is found in small trees and shrubs near waterbodies.

*3.1.10.12 **Reptiles***

The reptiles of FML #3 include the relatively common western plains garter snake (*Thamnophis radix haydeni*) and red-sided garter snake (*Thamnophis sirtalis parietalis*) found near waterbodies. The western plains garter snake occurs in Riding Mountain and near Gilbert Plains (between Riding and Duck Mountain) but has not been reported in Duck Mountain. The red-sided garter snake is abundant in the Shell Valley.

The red-bellied snake (*Storeria occipitomaculata*) is reported as being at the northern edge of its range in Riding Mountain and is not reported in Duck Mountain. The red-bellied snake can be found near waterbodies, bogs and in aspen and open forests.

The western-painted turtle (*Chrysemys picta*) was reported to occur in low numbers near waterbodies in Riding Mountain and near Gilbert Plains. However, this turtle was not reported in the Duck Mountain.

3.1.10.13 Invertebrates

Insects provide many benefits to the ecosystems in FML #3. Birds, fish, and frogs all depend on insects as a source of food. Pollination by bees, moths, and butterflies is an invaluable ecological service that insects provide. Insects are also important predators of pests and also play a critical role in the decomposing or recycling materials, eliminating waste, and keep soils healthy.

There are many groups and kinds of insects in the Boreal forest. Their main groups (class, subclass, and order) of insect species are shown in Table 3.23.

Table 3.24 Main groups of inverebrates in the boreal forest.

Class	Subclass	Order
Hexapoda – 6 legged	**Apterygota** - wingless insects	Collembolans or springtails (snow fleas) Thysanura (silverfish, bristletails, firebrats)
	Pterygota - insects with wings	Ephemeroptera - Mayflies Odonata - Dragonflies and damselflies Orthoptera - Grasshoppers, crickets, and praying Mantids Dermaptera - Earwigs Anoplura - Sucking lice Hemiptera - True bugs Homoptera – bugs, Aphids, or plant lice Coleoptera - Beetles Neuroptera - Alderflies, dobsonflies, snakeflies, lacewings, antlions, and owlflies Lepidoptera - Butterflies, moths Diptera - True flies, black flies, mosquitoes Siphonaptera - Fleas Hymenoptera - Wasps, ants, bees Mecoptera - scorpionflies
Arachnida	Spiders, Ticks, Mites	

There is an entire section within this Forest Management dedicated to forest insects and disease. That section of insects details insects that can cause significant tree damage, including stand-replacing mortality of 100% of the trees in an area.

3.1.10.14 Micro-organisms

Microorganisms are the main drivers of carbon flow in forests and play critical roles in the carbon balance through the decomposition of dead biomass of different origins. Both fungi and bacteria play significant roles as decomposers in the forest.

Fungi
Mushrooms, moulds, and yeasts are examples of fungi. Fungi get their energy by digesting living or dead organic matter, and are important decomposers of organic matter. The ecological service of fungi is to break down dead matter and return the nutrients to the soil. The fungi that feed on dead organic matter are called saprophytes.

The role of fungi in breaking down dead wood is especially crucial. Lignin is the substance that glues wood cellulose fibres together, and it is so tough that animals cannot digest it. Certain fungi are able to biodegrade lignin with specific enzymes, allowing the vast amounts of dead wood in a forest to be broken down. Without fungi the forest would pile up with layer upon layer of stems, needles, leaves and other dead matter.

Fungi naturally benefit tree, shrub, and other plant growth by growing in and around the roots of the host plant. A mutually beneficial symbiotic relationship if formed and is referred to as mycorrhiza. The plant supplies chlorophyll to the fungus, and the fungus supplies water and mineral nutrients taken from the soil to the plant. Most plant species form mycorrhizal associations

Bacteria
In forest soils, bacteria inhabit multiple habitats with specific properties, including bulk soil, rhizosphere, litter, and deadwood habitats, where their communities are shaped by nutrient availability and biotic interactions. Bacteria contribute to a range of essential soil processes including the cycling of carbon, nitrogen, and phosphorus. Bacteria take part in the decomposition of dead plant biomass and interact with plant roots and mycorrhizal fungi as commensalists or mycorrhiza helpers.

3.1.11. Forest Insects and Diseases

Forest insect and disease management is a provincial responsibility in Manitoba's forests. Forestry and Peatlands branch performs forest health monitoring exercises within the boundaries of FML #3. Using a cooperative approach, government also relies on LP to provide additional forest health information and, most importantly, operational support for pest management activities.

There is a forest health survey component to all of pre-harvest and post-harvest surveys. Manitoba Sustainable Development typically follows-up on forest health problems detected in these surveys with more intensive surveys by forest health specialists. Government and LP personnel then work together to develop response strategies for specific forest health problems, as they arise within the FML #3 area.

The most common and effective approaches to pest management that LP is engaged in are salvage operations to mitigate losses due to insects and disease. Generally, the company's greatest concern surrounds regenerating forests, and LP invests significant resources to ensure that insect and disease threats are minimized as young forests develop.

A multitude of forest insects and diseases influence forest health within the boundaries of FML #3. Some of the more frequently encountered forest pests and pathogens are described in detail in this chapter. The chapter is divided into three main sections:

1) Forest insect pests;
2) Hardwood and Conifer Decay; and,
3) Parasitic plants, rust fungi, and blight diseases.

Symptoms, impacts, life history traits, and specific control options are discussed for each species in the dedicated sub-sections under those main sections headings. Common names, scientific names, and specific areas of concern as they relate to individual pests and diseases reviewed in this chapter are listed in Table 3.24.

Table 3.25 Relatively common forest insect pests and diseases of FML #3.

Common name	Scientific name(s)	Specific areas of concern
Forest Tent Caterpillar	*Malacosoma disstria* [Hübner]	Aspen dieback and mortality
Spruce Budworm	*Choristoneura fumiferana* [Clemens]	Mortality of fir and spruce
Jack Pine Budworm	*Choristoneura pinus pinus* [Freeman]	Jack Pine mortality
Poplar borer	*Saperda calcarata* [Say]	Young and old Aspen stands
Root collar weevils: Warren's root collar weevil; Two Hylobius spp. without common names	*Hylobius warreni* [Wood]; *Hylobius pinicola* [Couper]; *Hylobius radicis* [Buchanan]	Softwood plantations. Weevils feed around roots and root collars causing mortality
Shoot weevils: White pine weevil; Lodgepole terminal weevil; Northern pine weevil; Pales weevil;	*Pissodes strobi* [Peck]; *Pissodes terminalis* [Hopping]; *Pissodes approximatus* [Hopk.]; *Hylobius pales* [Herbst]; *Pachylobius picivorus* [Germar]	Softwood plantations. Weevils feed in and around developing shoots causing growth reductions and stem deformities

Common name	Scientific name(s)	Specific areas of concern
Pitch-eating weevil		
Brown cubicle rots of conifers: *Refer to Table 3.23 for a listing of common names associated with brown cubicle rots – not all species have common names*	*Anisomyces odoratus* [(Wulf.: Fr.) Pat.]; *Coniofora puteana* [(Schum.: Fr.) Karst.]; *Fomitopsis officianalis* [(Vill.:Fr.) Bond and Singer]; *Fomitopsis pinicola* [(Sw.:Fr.) Fr.]; *Phaeolus schweinitzii* [(Fr.) Pat.]; *Serpula himantioides* [Fr.]	Relatively old conifer and mixed conifer-hardwood stands
Red ring rot a.k.a. white pocket rot	*Phellinus pini* [(Brot.: Fr.) Ames]	Relatively old conifer and mixed conifer-hardwood stands
Stringy Butt Rott a.k.a. Yellow Stringy Rot	*Perenniporea subacida* [(Peck) Donk.])	Older conifer and hardwood trees
Aspen Trunk Rot	Phellinus tremulae [(Bondarzev) Bondartsev and Borisov]	Relatively old aspen stands
Poplar peniophora	*Peniophora polygonia* [(Pers.:Fr.) Bourdot & Galzin]	Relatively old aspen stands
Hypoxylon Canker	*Hypoxylon mammatum* [(Wahlenb.) P. Karst]	Young and old aspen stands
Armillaria Root Rot *All Armillaria spp. share this common name*	*Armillaria ostoyae* [(Romagn.) Herink]; *Armillaria calvescens* [Bérubé and Dessureault]; *Armillaria sinapina* [Bérubé and Dessureault]	Relatively old hardwood, conifer, and mixed stands; young naturally regenerated and planted stands
Dwarf mistletoes Eastern dwarf mistletoe Jack pine dwarf mistletoe	*Arceuthobium pusillum* [Peck]; *Arceuthobium americanum* [Nutt.]	Conifer stands less than 50 years old
Western Gall Rust	*Endocronartium harknessii* [(J. P. Moore) Y. Hiratsuka]	Jack Pine stands
Shepherd's Crook	*Venturia macularis* [(Fr.) E. Müller & Arx]	Growth reductions and mortality of poplar

3.1.11.1 **Forest Insect Pests**

3.1.11.1.1 Forest Tent Caterpillar (Malacosoma disstria)

The forest tent caterpillar (FTC) is a defoliating insect with a transcontinental distribution that prefers trembling aspen as its host (Hiratsuka *et al*. 1995). Forest tent caterpillars are also known to affect other deciduous tree species associated with aspen (*e.g*. white birch), and may even progress to spruce and tamarack during severe outbreaks (Hildahl and Campbell 1975, Ives and Wong 1988). In Manitoba, FTC outbreaks are widespread and tend to persist for three to six years in intervals of 10 years (MNRF, 1987). Effects range from light crown thinning to complete defoliation and mortality, depending upon the severity and duration of the outbreak (MNRF, 1987; Oldford, 2005).

Despite the generally indirect role FTCs play in aspen mortality, they remain the most severe aspen pest in Canada and the only aspen defoliator to cause large-scale growth losses (Rose and Lindquist, 1997; Oldford, 2005). The last forest tent caterpillar outbreak in Manitoba began in 2012 and peaked with an estimated 1,411,322 ha defoliated. The population is on the decline with province wide defoliation estimated as 33,946 ha in 2018. For these reasons, strategies to mitigate FTC impacts are among the highest priorities in LP's Integrated Forest Pest Management (IFPM) approach in FML #3.

The most obvious symptom of infestation and forthcoming defoliation are numerous grayish brown egg bands found on twigs and small branches. Silken mats woven between leaves signal infestations in progress, and forest tent caterpillars can often be found grouped together when molting or resting (Hiratsuka *et al*., 1995; Ives and Wong, 1998). Young larvae are black, hairy and 2-3 mm long. Mature larvae reach 45-55 mm in length, and are hairy with broad, bluish lateral bands; and have narrow, broken orange and brown lines on the body. Mature caterpillars also have distinctive white keyhole shaped dorsal markings (Hiratsuka *et al*., 1995).

The forest tent caterpillar has one generation per year (Ives and Wong, 1988). Eggs are laid from late July to early August. The eggs that survive the winter hatch the following spring around the time of bud flush (MNRF, 1987). There are five larval growth stages (instars) before FTCs mature, typically in mid-June. Mature larvae then spin cocoons and pupate in about 10 days into adult moths that emerge, disperse, mate, and lay eggs for the next generation (Hiratsuka *et al*. 1995).

The most destructive stage of defoliation typically occurs in June where a single (5th instar) forest tent caterpillar can consume up to seven leaves per day (MNRF, 1987). After two or more years of infestation, loss of leaves reduces tree vigour and results in dieback of twigs and branches; and reduced radial growth. The weakening of trees during FTC outbreaks also makes them more susceptible to other diseases, insects, or abiotic events (Hildahl and Campbell, 1975). For example, the presence of secondary pests such as Hypoxylon canker and wood boring insects has been reported to increase in aspen stands following FTC infestations in Manitoba (MNRF, 1987). While mortality from defoliation can occur, it is most likely to occur when there is a second factor causing defoliated trees to be stressed like drought, poor soils, or additional forest pest issues.

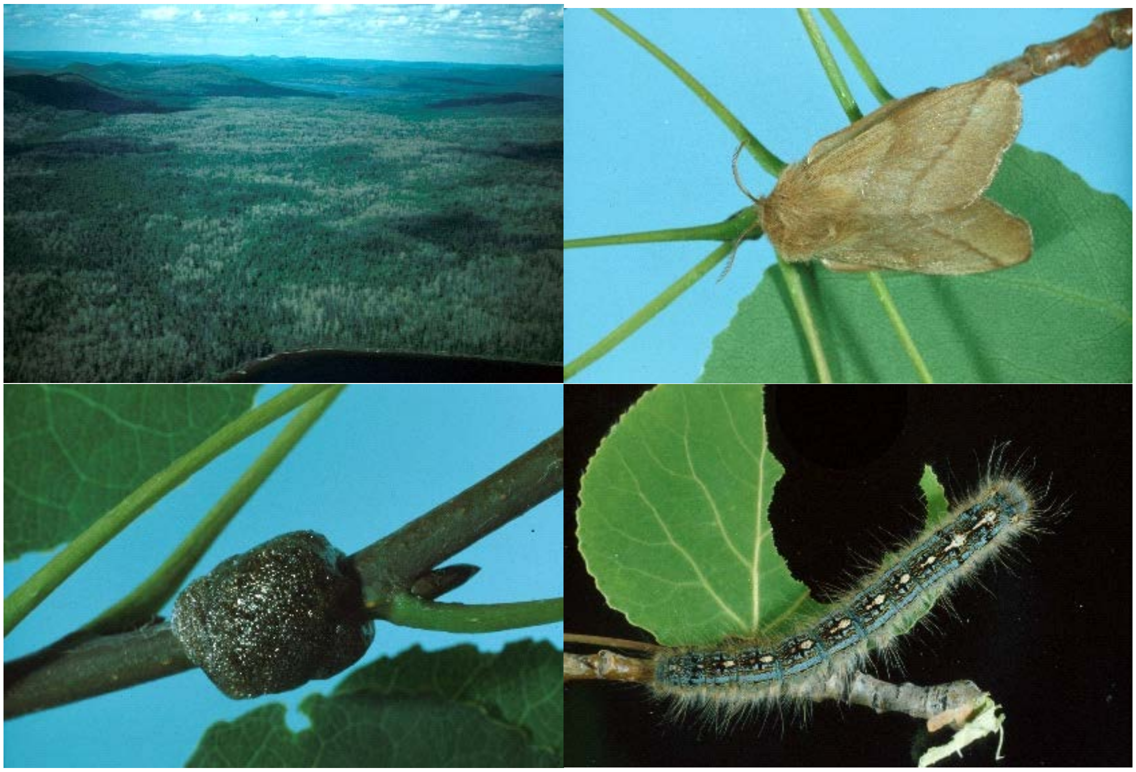


Figure 3.61 Forest tent caterpillar image series: aerial view of defoliation of trembling aspen, top left; adult female moth, top right; egg band, bottom left; and larva and feeding damage on trembling aspen, bottom right (all photos NRCAN 2003b; credits Luc Côté and Thérèse Arcand).

Manitoba Sustainable Development's aerial survey programs provide the detection of new outbreaks. Infestations detected through LP monitoring activities are recorded and reported to Manitoba Sustainable Development. Provincial forest health specialists synthesize this information to map outbreaks and if needed, coordinate management unit level approaches to FTC control. Operationally, LP assists by harvesting and regenerating severely infested stands to mitigate losses due to forest tent caterpillars.

Louisiana-Pacific managers are also investigating the utility of an Aspen Decision Support System (DSS) that may provide a more dynamic and proactive approach to predicting and responding to FTC outbreaks in the future. Basically, an Aspen DSS incorporates risk management into the scheduling of aspen stand harvesting, so as to mitigate FTC impacts in both the short and long-term (Oldford, 2005). Specifics of this IFPM activity are further discussed in main body of the IFPM chapter (Section 4.4).

3.1.11.1.2 Spruce Budworm (Choristoneura fumiferana)

The spruce budworm is considered the most serious defoliating pest of spruce and fir forests in North America and is among the most common budworms in the Prairie Provinces (Ives and Wong, 1988; NRCAN, 2003a; NRCAN, 2003b). Across Canada, populations show some regional spatial synchrony and oscillate in 30-35 year cycles, typically including 5-10 years at high outbreak levels (Williams and Liebhold, 2000). High populations of spruce budworm may cover and destroy hundreds of thousands of hectares of valuable spruce and fir forest (Hiratsuka *et al.*, 2005; Anon., 2005). In Manitoba, the spruce budworm feeds primarily on white spruce and balsam fir, and, less frequently, black spruce (Anon., 2005). The last outbreak in Manitoba ended in 2010, at its' peak affected 178,303 hectares of spruce/fir forests.

The first signs of spruce budworm damage are frass and silken webbing around buds or last year's foliage (Hiratsuka *et al.*, 1995). Larvae and caterpillars feed on needles and buds, causing top and branch dieback that often gives infested trees a scorched appearance. While there is only one generation per year, it is the cumulative effect of budworm feeding over several years that can lead to considerable growth losses and mortality. Repeated attack of new foliage reduces tree vigour and increases vulnerability to other insects and diseases (Anon., 2005; Hiratsuka *et al.*, 1995; Manitoba Conservation, 2003).

Mortality from spruce budworm infestations varies in relation to outbreak severity, duration, and host species. Balsam fir may be killed in as little as 3 years when spruce budworm populations are at outbreak levels. White spruce, with its comparatively denser foliage, can usually endure outbreaks that last up to 5-6 years, after that they too may be killed (Anon., 2005; Manitoba Conservation, 2003).

The life cycle of the spruce budworm takes one year to complete. In July, adult females lay eggs in clusters on the underside of needles. Larvae hatch after 10 days and seek out bark crevices or sheltered branches where they spin a protective mat called a hibernacula. They molt and overwinter in these silken shelters without feeding. Second instar larvae emerge prior to bud flush and begin feeding on old needles and unopened buds from late April to mid-May (Hiratsuka *et al.*, 1995; Ives and Wong, 1988).

They continue to grow and feed on new foliage as it emerges, molting four more times between May-June. Mature (6th instar) larvae consume the most foliage in early June, roughly 90% of their lifetime consumption. During outbreak years, spruce budworm will even feed on older foliage after new growth is fully consumed. Mature larvae range in length from 18 mm to 24 mm and have dark brown heads over dark greenish brown bodies; and their bodies are lined with rows of paired, pale spots (Hiratsuka *et al.*, 1995; Ives and Wong, 1988).

Later in June, mature larvae spin silken tunnels between two or three shoots wherein they pupate (Hiratsuka *et al.*, 1995). Adult moths emerge in July and August, disperse, mate, and lay eggs (Anon., 2005). Adult moths are grey-brown in colour with silvery white patches on their forewings, and have wingspans that range from 21-30 mm (Ives and Wong, 1988).

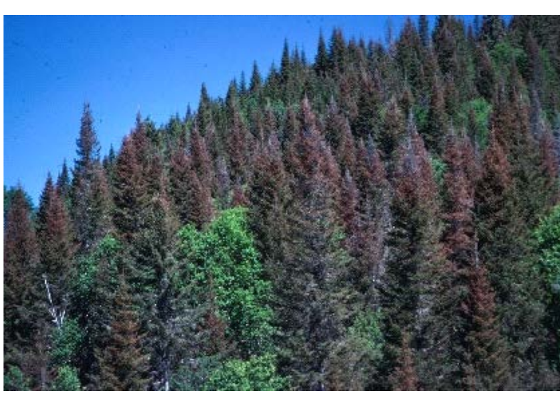


Figure 3.62 Spruce budworm image series: severely defoliated balsam fir stand, top left; adult female moth, top right; larva with silken webbing, bottom left; egg mass, bottom right (all photos NRCAN 2003b; credit Thérèse Arcand).

Management tactics to control spruce budworm include: (1) spraying insecticides; (2) salvage harvesting of dead trees in the 3- to 5-year period when still usable; (3) planting non-susceptible tree species such as jack pine and hardwoods, or low susceptibility species such as black spruce; (4) pre-commercial thinning at the stand level or harvest planning at the landscape level to reduce the most susceptible fir and spruce species and/or age-classes; or (5) doing nothing and accepting the resulting growth reduction and mortality (MacLean, 1996; MacLean *et al.*, 2001).

In Canada, two insecticides options are commonly used against spruce budworm: the biological insecticide *Bacillus thuringiensis* (B.t.); and, the insect growth regulator hormone *Tebutinozide* (Mimic®). Both have been used in Manitoba to help manage spruce budworm populations.

Historically, LP and Manitoba Sustainable Development have employed all five of the management tactics listed above to varying degrees to manage local spruce budworm outbreaks. There has, for example, been some salvage logging of white spruce killed by spruce budworm within the Wine and Laurie Lake Operating Areas located in the Duck Mountain Provincial Park (although these operations took place before LP managed FML #3).

Fortunately, spruce budworm populations have not recently reached outbreak levels in FML #3, so the focus has been on monitoring rather than response tactics. LP continues to contribute to provincial monitoring of spruce budworm outbreaks by reporting infestation extents and severities through pre harvest surveys. LP managers also intend to work with Manitoba Sustainable Development to coordinate salvage and spray programs for specific areas within FML #3 when deemed necessary for spruce budworm management.

3.1.11.1.3 Jack pine budworm (Choristoneura pinus)

The jack pine budworm periodically defoliates jack pine stands and is widely distributed across north central and northeastern North America. Its range encompasses parts of Saskatchewan, Manitoba, Ontario, the northern Lake States, Eastern Canada, and the northeastern United States. Similar to the spruce budworm, the jack pine budworm feeds on buds and developing foliage. Unlike the spruce budworm, however, populations exclusively reach outbreak levels in jack pine dominated stands. The jack pine budworm also feeds on other native pines and black spruce, but seems unable to develop outbreaks in natural stands of these hosts (Volney, 1994; Hiratsuka *et al*., 1995).

In Manitoba and Saskatchewan, outbreaks of jack pine budworm are periodic and typically last 2-4 consecutive years, recurring about every 10 years and covering up to two million hectares (Hiratsuka *et al*., 1995). Populations develop best in natural stands of jack pine stands beyond 25 years of age that flower profusely. Dispersal from older stands to younger stands and nursery plantings during outbreaks, however, has also resulted in damage to Scots, red, jack, and lodgepole pine plantations (Volney, 1994; Hiratsuka *et al*., 1995).

Early symptoms of jack pine budworm include frass and silken webbing among mined cone buds. As infestation progresses, larvae extend their individual silken feeding tunnels along developing shoots. Partially digested needles and frass embedded in webbing give afflicted tree crowns a reddish-brown, scorched appearance. Feeding causes reduced annual tree growth and, depending on outbreak severity and duration, may lead to top kill and even tree mortality. The susceptibility of individual trees also varies according to root condition. Root disease, root deformities (often resulting from poor planting techniques), and root disturbance are all associated with an increase in the incidence of more severe damage (Volney, 1994; Hiratsuka *et al*., 1995).

The life cycle of jack pine budworm closely resembles that of the spruce budworm and also takes one year to complete. Eggs are laid in late July and early August. Larvae hatch in about 10 days, and seek overwintering sites under bark scales where individuals spin small, silken hibernacula. No feeding takes place until second instar larvae emerge in the spring, disperse on silken threads, and begin feeding on pollen cone buds. Most larvae continue to feed, grow, and develop to a seventh instar by early July. It is in this mature stage (7^{th} instar) that they consume the most foliage (Volney, 1994; Hiratsuka *et al*. 1995).

Mature larvae average 22 mm in length and have brown to black heads subtended by dark brown thoracic shields with a distinctive white band directly behind the head. Their bodies are reddish-brown with yellowish sides and are lined by two rows of paired, white spots. Mature larvae eventually pupate in the feeding tunnels they have constructed along shoots during spring and early summer. Adult moths emerge in late July and early August, disperse, mate, and lay eggs. Adult moths have rusty-brown coloured forewings mottled with silvery bands and flecks of darker scales, with wingspans between 15 mm and 28 mm (Hiratsuka *et al*., 1995).


Figure 3.63 Jack pine budworm image series: damage in a moderately defoliated jack pine stand, top left; adult jack pine budworm moth near pupal case and silken webbing, top right; larva on jack pine needle and twig with silken webbing, bottom left; egg mass, bottom right (all photos NRCAN 2003b; credit René Martineau and Thérèse Arcand).

Outbreaks may be anticipated by aerially monitoring jack pine stands for defoliation, pheremone traps, and foliage inspections. Stands may be protected, if warranted, with treatments from either the insect growth regulator hormone Tebutinozide (Mimic®) or the bacterial insecticide *Bacillus thuringiensis* var. *kurstaki* (*Btk*).

Alternatively, stands that have sustained top kill and mortality may be salvaged to arrest local outbreaks and prevent further losses from secondary pests and pathogens (Volney, 1994). Louisiana-Pacific works with Manitoba Sustainable Development to monitor the condition of jack pine stands and incidence of jack pine budworm within FML #3. Stands that show signs of infestation are prioritized for harvesting to mitigate the impacts of jack pine budworm in FML #3.

3.1.11.1.4 Poplar borer (Saperda calcarata)

The poplar borer is a native pest that occurs throughout the range of trembling aspen in Canada. Its' principal host is trembling aspen but it may also attack balsam poplar and willow species. Poplar borers rarely kill trees outright. However, because they are relatively long lived and may persist for several years in infected trees, the cumulative effects can be severe. Prolonged infection results in extensive tunnelling and gallery building that weakens stems, impacting wood quality and making them more prone to breakage. Poplar borer damage also increases infested trees' susceptibility to other pests and pathogens such as Hypoxylon canker (Hiratsuka *et al.*, 1995; NRCAN, 2003a;, Frey *et al.*, 2004).

Symptoms of infestation include swollen bark areas, sap run, and piles of fibrous, coarse frass in bark crevices and near the base of the trunk and the roots. Closer examination will reveal exit holes and gallery entrances characterized by boring dust, frass buildup, and varnish like resins exuding from these holes. If the bark of infested trees is removed, larvae and their galleries can most often be seen (NRCAN, 2003a; Solomon, 1995; Hiratsuka *et al.*, 1995).

Poplar borers require 3 to 5 years to complete their life cycle. Adults emerge early in the summer and begin to feed on the foliage and bark of tender shoots of host trees. They mate and lay eggs about one week after emergence. Adult females deposit eggs in crescent-shaped notches they cut into the bark, usually on parts of the tree exposed to the sun. Adult poplar borers are long-horned beetles between 20-30 mm in length with antennae about as long as their bodies. Adults can be recognized by their grayish blue body colour that is heavily stippled with fine brown dots that overlay a faint yellow pattern (Solomon, 1995; Hiratsuka *et al.*, 1995).

Young larvae develop and mine into the bark shortly after eggs are deposited, where they remain over the winter. The following spring, larvae enter the sapwood, where they continue to feed and grow for 2-3 years, eventually mining into the heartwood as well. Mature larvae are legless, creamy white grubs with brown heads that can reach up to 40 mm in length. In their third or fourth year, mature larvae construct hibernation cells at the distal end of their burrows. They overwinter in these chambers and pupate into adults the following spring, completing a life cycle that can span 3-5 years (Hiratsuka *et al.*, 1995; Solomon, 1995).

Poplar borers affect both young and old aspen stands, but are most prevalent in relatively open stands and stands growing on poor sites. At the tree level, poplar borers tend to favour young, smaller diameter stems (7 to 10 cm diameter), but may still attack any size aspen when populations are high and egg-laying microhabitats are suitable (Hiratsuka *et al.*, 1995; Henigman *et al.*, 2001; NRCAN, 2003a). According to Solomon (1995) historical surveys have indicated that up to 64% of the aspen trees in southern Michigan and 53% of the aspen trees at five locations in British Columbia had been attacked at some time by these insects.

Figure 3.64 Poplar borer image series: pupa in a pupation cell on a trembling aspen stem; adult male (photos NRCAN 2003b; credit Thérèse Arcand).

Fortunately, natural mortality of poplar borers is relatively high. Natural biological controls including predators (*e.g.* woodpeckers), parasites, excessive sap flow, and diseases, have been reported to destroy between 65-80% of borer populations annually (Solomon, 1995). This explains in part why direct mortality due to poplar borers is relatively low despite the relatively high incidence of attacks.

Silvicultural control by removing individual infected stems has historically proven to be ineffective, likely because of the inverse relationship between stand density and level of infestation (Solomon, 1995). Nevertheless, because of their impacts on wood quality and role in increasing aspen trees' susceptibility to other forest pests and diseases, poplar borers remain a pest of concern for LP managers.

When monitoring activities reveal high levels of infestation in FML #3, stands are prioritized for harvesting. Silviculturally, LP's approach to managing poplar borers includes sanitation following harvest (removal of infested materials) and regenerating aspen at densities less prone to infestation. The risk of poplar borer infestation is also taken into account when planning the location (relative to infested stands) and species regenerated following harvests to mitigate future poplar borer problems.

3.1.11.1.5 Root collar weevils (Hylobius spp.)

In Manitoba, there are three species of weevils belonging to the genus *Hylobius* that as larvae feed in and around the root collars of trees: (1) Warren's root collar weevil (*Hylobius warreni*), (2) *H. radicis,* and (3) *H. pinicola*. They differ morphologically in that *H radicus* is slightly smaller than *H. warreni* (10-12 mm vs. 12-15 mm), and both are wingless as adults whereas adult *H. pinicola* have wings. *Hylobius pinicola* are similar in appearance to *H. Warreni*, with irregular white scales over black bodies that give them a grayish colour. The smaller *H. radicis* have yellow scales that form spots on their elytra, giving them a reddish-brown appearance (Hiratsuka *et al*., 1995).

Warren's root-collar weevil and *H. pinicola* both have transcontinental distributions and are pests of several conifer species in Canada. In Manitoba, *H. warreni* prefers white spruce and jack pine but may also affect red pine, Scots pine, and Norway spruce (Hiratsuka *et al*., 1995; NRCAN, 2003b). *Hylobius pinicola* also infests spruce, as well as larch and possibly fir (Hiratsuka *et al*., 1995). *Hylobius radicis* occurs from Nova Scotia to southeastern Manitoba where it affects red pine, jack pine, Austrian pine, and Scots pine.

Hylobius Warreni and *H. pinacola* affect natural and managed stands of all ages but prefer moist, well-drained, highly productive sites. In contrast, *H. radicis* is particularly abundant in sandy, well-drained sites and is mainly a pest of young plantations (Hiratsuka *et al*.; 1995). Although root collar weevil infestation rarely results in mortality of older trees, entire roots may be girdled resulting in growth losses and increased susceptibility to other forest pests and pathogens (Thompson *et al*., 2002; NRCAN, 2003b).

All three species are particularly problematic in young conifer plantations. Mortality in young trees is common where feeding galleries completely encircle and girdle trees at the root collar. Numerous plantations throughout B.C.'s central interior have experienced mortality levels from root collar weevils in excess of 10% (Thompson *et al*., 2002). Root collar weevil infested trees in plantations are also more susceptible to breakage from wind and ice damage (Hiratsuka *et al*., 1995).

Figure 3.65 Left, adult Warren's root collar weevil (Hylobius warreni). Adult Hylobius radicis and H. pinicola are similar in morphology and appearance. Right, base of Scots pine tree infested by Warren's root collar weevils with litter removed to reveal damage (both photos NRCAN 2003b; credit Thérèse Arcand and René Martineau).

Root collar weevil damage is most easily identified in the field by resin flows at the base of infested trees. Resins mixed with debris often form dirty whitish masses on the ground that can be lifted to reveal galleries and pupal chambers constructed by the larvae (NRCAN, 2003b; Hiratsuka *et al.*, 1995). Infested trees tend to exhibit straw-coloured to deep red foliage starting with the older needles, and stunted terminal growth (Henigman *et al.*, 2001; Cerezke, 1994).

All three *Hylobius* spp. have quite similar life history traits, and the internal damage they cause is often difficult to distinguish. Larvae construct tunnels beneath the bark of the roots and root collar to feed in the cambium, causing growth reductions and potentially mortality (Thompson *et al.*, 2002; Cerezke, 1994; NRCAN, 2003b). Larvae generally complete their development in two years, but adults may live up to five years and therefore multiple generations overlap. Adults overwinter in the duff layer at the base of the trees, and crawl up the trunks to feed at night on the bark of the upper surface of small branches. They may also feed on the bark of the roots (Henigman *et al.*, 2001).

Louisiana-Pacific managers are particularly concerned with the impacts of these root collar weevils in conifer plantations across FML #3. Infested older stands are of lesser concern except when located adjacent to young stands because flightless adult *H. warreni* are able to move up to 13 m per year; and winged *H. pinacola* even further (Thompson *et al.*, 2002; NRCAN, 2003b; Henigman *et al.*, 2001). Like many other forest pests, there are no known direct control measures for root collar weevils. However, certain silvicultural practices can provide protection from weevil infestations (NRCAN, 2003b).

First, planting susceptible tree species in moist sites with heavy litter and duff loads or nearby already infested areas should be avoided. Other recommended practices protect trees from root collar weevil outbreaks include removing and burning all affected trees on infested sites, reducing the duff near the root collar and large roots, removing all plant debris from the vicinity of planted trees, and pruning the lower branches on stems > 2 cm in diameter in problem areas. Most of these approaches serve to limit the availability of suitable overwintering habitats for adult weevils (NRCAN, 2003b).

Louisiana-Pacific monitors young plantations for root collar weevil damage during post-harvest surveys. Louisiana-Pacific's approach to root collar weevil control in FML #3 is focused on removal of infected trees to control immediate root collar weevil problems; and sanitation activities to mitigate the risk of recurring problems in regenerating areas.

3.1.11.2 Shoot weevils

There are several species of shoot boring/mining weevils that share both morphological and biological traits, the most obvious being a tendency to infest young vigourously growing shoots. At least five species of shoot weevils occur in Manitoba: (1) the white pine weevil (*Pissodes strobi*); (2) the lodgepole terminal weevil (*Pissodes terminalis*); (3) the northern pine weevil (*Pissodes approximatus*); (4) the Pales weevil (*Hylobius pales*); and (5) the pitch-eating weevil (*Pachylobius picivorus*), that often occurs in association with the Pales weevil (NRCAN, 2003b; Hiratsuka *et al.*, 1995; Nord *et al.*, 1984).

Of these, the white pine weevil is of the highest concern in Manitoba because of its low host specificity, wide distribution, and affinity for trees growing in young conifer plantations. Also of relatively high concern is the lodgepole terminal weevil, that attacks young jack pine plantations across Manitoba. Moreover, both the white pine weevil and the lodgepole terminal weevil specifically target terminal shoots ("leaders") resulting in stem deformities and growth reductions with potentially significant economic impacts (Hiratsuka *et al.*, 1995).

Other shoot weevils rarely warrant special control measures in Manitoba's forests. Although the northern pine weevil may affect red pine and jack pine, it occurs primarily in Scots pine Christmas tree plantations; and very high populations are needed in order to cause significant damage (NRCAN, 2003b; Shetlar, 2002). Pales weevils and associated pitch-eating weevils are at the northern extent of their range in southeastern Manitoba; and both these species are also of greater concern in Christmas tree plantations than in managed forests in part because of their dependency on fresh stumps to complete their lifecycles (Nord *et al.* 1984).

In fact, of the five species of shoot boring/mining weevils mentioned above, only the white pine weevil and the lodgepole terminal weevil are listed Hiratsuka *et al.*'s (1995) field guide to forest insects and diseases of the prairie Provinces. Since these two species of shoot weevils are of the highest relative importance in Manitoba forests, they are further described below.

3.1.11.2.1 White Pine Weevil (Pissodes strobi)

In the Prairie Provinces and Northwest Territories the white pine weevil attacks white, Engelmann, blue, and Norway spruces. It can also seriously infest jack, red, and Scots pines, and even occasionally black spruce (Drouin and Langor, 2001; Hiratsuka *et al.* 1995). White pine weevils show a strong preference for open-grown trees in plantations that are between 1.5 m - 8.0 m in height with leader shoots greater than 12 mm in diameter (Drouin and Langor, 2001; NRCAN, 2003a; NRCAN, 2003b).

Figure 3.66 White pine weevil damage to spruce, left. Leader dieback and flagging is common to all infested tree species. Feeding and egg laying holes, right (both photos NRCAN 2003b, credit Marc Bolduc and Thérèse Arcand).

Although white pine weevil attacks rarely result in host mortality, white pine weevils target main stems just below the current year's growth (*i.e.* the leader) causing significant immediate growth losses and stem deformities in the long-term. White pine weevil attack always kills current and last year's leaders, and sometimes three or more years of leader growth are lost to these pests. Many affected trees develop forked main stems in response to leader death that greatly reduces their potential to provide high quality mill products in the future (Drouin and Langor, 2001; Hiratsuka *et al.*, 1995).

The first symptom of white pine weevil infestation is the presence of resin beads on last year's leader in the spring. Closer inspection will reveal punctures caused by feeding that also serve as egg deposition sites. By mid-July the leaders of infested trees wilt and turn brown. Multiple forked stems and wilted leaders in conifer plantations indicate persistent shoot weevil infestations (Drouin and Langor, 2001; Hiratsuka *et al.*, 1995).

White pine weevils have one generation per year. Eggs are laid in feeding holes they create on the previous year's leader in early spring. Larvae soon hatch and tunnel downward, spiralling while feeding on phloem tissues below the bark. This larval feeding consequently girdles the shoot and kills the current leader (Drouin and Langor 2001; Hiratsuka *et al.*, 1995). Larvae are small, legless grubs with reddish-brown heads that continue to feed under the bark and molt four times over 5-6 weeks before they mature. Mature larvae then excavate cavities in the woody tissues of infested shoots that they line with wood chips in that to pupate.

Adults emerge from these "chip cocoons" between late July and early September, feed for a period of time on the branches nearby, and retreat to the duff layer to overwinter and repeat the cycle the following spring. Adults are dark brown beetles about 8 mm long with white and yellow patches on their backs; and two elbowed antennae near the top of a long snout (Drouin and Langor, 2001; Hiratsuka *et al.*, 1995; NRCAN, 2003b).

The impact of white pine weevil in alternate hosts can be severe enough that the Canadian Forest Service recommends control measures be instituted as soon as damage becomes apparent (Drouin and Langor, 2001). In Alberta, up to 20% of white spruce in plantations may be infested each year in some plantations (Hiratsuka *et al.*, 1995). Drouin and Langor (2001) recommend that if it is present in a plantation, preventive spraying of its spruce and pine should be undertaken as a matter of course.

The use of chemical insecticides at 3 to 4 year intervals may be required until the trees are over 10 m tall (Drouin and Langor, 2001). Alternatively, pruning and destroying infested shoots before adults emerge can be an effective control tactic in small plantings. However, this will not prevent future infestations so problem areas should be checked and pruned annually (Drouin and Langor, 2001).

In FML #3, young conifer plantations are monitored for white pine weevil infestations during regeneration surveys and supplemental forest health surveys led by Manitoba Sustainable Development. When significant problems are identified, LP managers decide on a case-by-case basis what tactic (*i.e.* removals, thinning, pruning, chemical insecticides, etc.) or combination of tactics is warranted to control white pine weevil infestations.

3.1.11.2.2 Lodgepole terminal weevil (Pissodes terminalis)

In Canada, the lodgepole terminal weevil attacks lodgepole pine and jack pine from Manitoba west to British Columbia and the Yukon. It occurs in natural stands but prefers low-density, open grown conditions in young plantations while trees are between 2 m and 9 m in height. In Manitoba, yearly incidence of attacks is typically low (*i.e.* 2%-5%) but may be as high as 30% some years (Hiratsuka *et al.*, 1995).

Like the white pine weevil, lodgepole terminal weevils exclusively attack terminal shoots of their host species (Hiratsuka *et al.*, 1995; Duncan, 1986). Most lasting damage only occurs following repeated attacks of the same tree that result in crooked and forked stems and bushy crowns, that adversely affects the tree’s merchantability. Leader loss can be recovered in 2-3 years if trees are not attacked in succeeding years (Hiratsuka *et al.*, 1995).

Figure 3.67 Lodgepole terminal weevil damage, left (credit L. Machauchlan); Right frame shows pupa in mined terminal shoot (credit Henigman *et al*. 2001).

In jack pine stands in Manitoba, *P. terminalis* has a 1-year life cycle. Adults overwinter in the duff, emerge between May and June, and begin feeding on the phloem of the current year's leader. They mate in early spring and females deposit eggs in feeding punctures from late June to early July. Larvae hatch in about two weeks and begin feeding in the phloem, spiralling upward towards the terminal bud, that eventually girdles and kills the terminal shoot. Infested jack pine terminals curl at the top and start to fade to yellowish-brown in July. Larvae are cream coloured legless grubs with reddish brown heads that reach 10-12 mm in length (Duncan, 1986; Hiratsuka *et al*., 1995).

There are four growth stages (instars) from hatching to maturity. Mature larvae mine pupal chambers in the pith, pupate, and emerge as adult moths from mid-August until September. Adults then return to the duff to overwinter. Adult weevils are 5-7 mm long, mottled brown in colour with variable white and yellow patches and, like other weevils, have a prominent snout (Duncan, 1986; Hiratsuka *et al*., 1995).

Biological or chemical control of the lodgepole terminal weevil is not often warranted since infestation rates are typically low (Duncan, 1986; Hiratsuka, 1995). Fortunately, natural mortality of the weevil, either by parasites (*e.g.* Hymenopterans) or resin flow within attacked leaders, is often quite high. Silvicultural strategies LP employs to reduce the impact of the lodgepole pine weevil include clearcutting of infested stands followed by site preparation activities (*i.e.* scarification) and removal of diseased materials to sanitize the site. This last tactic reduces the duff habitat that adult weevils depend on to survive the overwintering period (Duncan, 1986).

3.1.11.3 Hardwood and Conifer Decay

There are many pathogens that lead to decay in both hardwood and conifer trees. Although essential as decomposers in functional ecosystems, decay fungi can destroy heart and sapwood, decreasing trees' value and potentially making them unmerchantable. Trees with extensive stem, butt and root rots are easily toppled or broken by weather events (*i.e.* wind, ice, and rain) and some decay fungi are capable themselves of killing standing trees. Decay fungi are not surprisingly more prevalent in older stands as they often act in concert with other pests and diseases to decompose senescent trees and dead wood on the ground (Hiratsuka *et al.*, 1995; Zeglen 1997).

The presence of fruiting bodies such as conks, mushrooms, etc. on the outside of infected trees constitutes the most obvious external symptoms of wood decay. When available these often provide a good means to identify the particular pathogen involved. Most decay fungi are spread from spores released by fruiting bodies, but some also spread underground through the soil or by contact with other trees' root systems. Spores often enter trees via exposed branch stubs and other natural injuries caused by mechanical abrasions, hail, and frost. Stem wounding during harvesting has also been implicated in the spread of wood decay fungi (Zeglen 1997). In addition, other animals (*e.g*. woodpeckers), insects (*e.g*. poplar borers) and diseases often provide entry courts for wood decay fungi to become established (Zeglen 1997, Davis and Meyer, 1997, Hiratsuka *et al.*, 1995).

Internally, rot colours in the early stages of decay are highly variable, but in the final stages all rots are either white or brown. This distinction is related to digestive abilities of the different decay fungi. White rot fungi digest both carbohydrates (cellulose) and lignin, whereas brown rots cannot digest lignin and decaying wood therefore retains some residual colour (Davis and Meyer, 1997, Hiratsuka *et al.* 1995; Zeglen, 1997).

Decayed wood textures are also highly variable among different decay fungi and change over time as infections progress. Generally though, most are classified as stringy rots, pocket rots, or cubicle rots since these patterns are readily distinguishable (Davis and Meyer, 1997; Hiratsuka *et al.*, 1995). The location of the rot (root, stem, butt, or combinations of these) also provides a means to group and classify the many decay fungi that affect forest trees.

Decay fungi nomenclature, however, remains somewhat confusing because of the historical reliance on the location, textures, and colours of rots to derive common names. Many of the common names in use today might actually refer to numerous decay pathogens that share similar appearances in decaying wood, especially when fruiting bodies are absent or more than one decay fungus attacks the same tree.

Few direct control measures for wood decay fungi exist, and none to date have been demonstrated to be practical at the scale of managed forests. However, indirect control for most wood decaying fungi can be achieved silviculturally. Since the incidence and severity of decay increases with stand age, the simplest and most common form of control of decay fungi is to harvest stands before decay reduces the value of trees below an acceptable economic threshold. Tree disease in plantations is most often controlled by removal of infected trees and sanitization of the site (Davis and Meyer, 1997; Manion, 1981).

The term "pathological rotation age" refers to the age where annual growth increment no longer exceeds annual loss of wood volume due to decay, and often dictates when stands should be harvested depending upon the specific site, decay pathogens, and host tree species concerned (Manion, 1981). Both the company and Manitoba Sustainable Development monitor the incidence of decay fungi in the forests of FML 13. The concept of pathological rotation age is frequently applied by LP managers to prioritize harvesting in response to wood decay problems identified at the stand level.

Louisiana-Pacific's approach to controlling wood decay pathogens in FML #3 includes additional silvicultural strategies such as site sanitation by removal of infected materials (*e.g.* mechanically during operations and by controlled burning); and planting or buffering plantations with non-susceptible species following harvesting. The following sub-sections describe in greater detail some common decay fungi of specific concern to LP managers in FML #3. Unless otherwise noted, the general control measures mentioned here apply to the decay fungi described in the sub-sections that follow.

3.1.11.3.1 Brown cubicle rot

Brown rots in general are much more common in conifers than in hardwoods, and LP managers are most concerned with their impacts in the older conifer-dominated stands in FML #3 (Hiratsuka *et al.*, 1995; Zeglen 1997). Brown cubicle rot provides a good example of a common name, developed from a historical reliance on the physical attributes of decayed wood that actually refers to many decay fungi with similar characteristics. Without fruiting bodies to help in identification, wood decay caused by the brown cubicle rot *Laetiporus sulphureus* can easily be confused with other brown cubical rot fungi such as *Phaeolus schweinitzii* or *Fomitopsis pinicola* where their ranges overlap and they share common hosts (NRCAN, 2003a).

Figure 3.68 Fruiting bodys of *Laetiporus sulphurous*, left (credit Pamela Kaminski at http:// pkaminski.homestead.com); Fruiting body of Fomitopsis pinicola, right (credit http:// home.att.net/~b.kuznik/).

Some geographic confusion also surrounds the use of this common name. For example, in eastern Canada brown cubicle rot refers specifically to the fungus *Fomitopsis pinicola*, better known in the west as brown crumbly cubicle rot, whereas in British Columbia brown cubical rot most often refers to *Laetiporus sulphureus,* a brown cubical type rot that primarily affects western larch (NRCAN, 2003b; Allen *et al.*, 2003). Hiratsuka *et al.* (1995) prepared a list of the 15 most common decay fungi of coniferous trees in the prairie Provinces that includes the six brown cubicle rots (listed in Table 3.25). Not all species listed here have established common names, but all are brown cubicle type rots and are often collectively referred to as such.

Table 3.26 Common brown cubicle rots of conifers (adapted from Hiratsuka *et al.* 1995).

Common name	Scientific name	Type of decay	Fruiting body
N/A	*Anisomyces odoratus* [(Wulf.: Fr.) Pat.]	Brown cubical pocket rot	Small annual shelving conks; upper surface velvety, reddish brown to gray; lower surface with tubes
N/A	*Coniofora puteana* [(Schum.: Fr.) Karst.]	Brown cubicle rot	Resupinate, thick, fleshy; surface olive brown, margin cream coloured
Quinine conk	*Fomitopsis officianalis* [(Vill.:Fr.) Bond and Singer]	Dark brown cubicle rot	Large conks up to 60 cm wide, hoof-shaped, whitish
Red belt fungus	*Fomitopsis pinicola* [(Sw.:Fr.) Fr.]	Crumbly brown cubicle rot	Large, perennial, flat, hoof-shaped conks; margin often reddish-brown; upper surface crusty, gray-black
Velvet top fungus	*Phaeolus schweinitzii* [(Fr.) Pat.]	Brown cubicle rot, red-brown butt rot	With or without central stalk, upper surface velvety, dark reddish brown; large angular pores
N/A	*Serpula himantioides* [Fr.]	Brown cubicle rot	Resupinate patches; hymenial surface irregularly folded, brown to raw umber; margin cream coloured

Operationally, distinctions are rarely made among the various species of brown cubicle rot fungi. However, by tracking the incidence of brown cubicle rots in relation to stand type, age, and harvest volumes, LP managers are continually refining the pathological rotation ages associated with brown cubicle rots in FML #3. This operational information is re-integrated in strategic wood supply forecasting, so that fibre losses due to decay fungi might be mitigated in harvests planned for different forests types and age classes in the future. In addition, where pre-harvest surveys detect high incidences of brown cubicle rot decay, these stands are prioritized for harvesting.

3.1.11.3.2 Red ring rot (Phellinus pini) a.k.a. white pocket rot

Red ring rot (*Phellinus pini*) is a white pocket rot fungus that in its early stages produces characteristic white spindle-shaped fibrous zones ("pockets") in the heartwood of infected trees. For this reason it is also commonly referred to "white pitted rot", "honeycomb rot", and "white pocket rot" of conifers (NRCAN, 2003b; Allen *et al.*, 2003). Red ring rot fungus is believed to be the most economically important decay fungus of conifers in the Prairie Provinces (Hiratsuka *et al.*, 1995). According to Zeglen (1997), it is one of the most widely distributed and destructive decay fungi in all of North America. It affects almost all conifer species, and in some regions it has even been found on maple, alder, and birch (Allen *et al.*, 2003; Blanchette, 1980).

Fruiting bodies vary considerably among host tree species, but are generally shelf-like, hoof-shaped conks up to 20 cm wide with dark upper surfaces and furrowed yellow-brown undersides lined with round, irregularly-shaped pores (Hiratsuka *et al.*, 1995; Allan *et al.*, 2003) (Figure 22). Fruiting bodies and “punk knots” (bulging masses of tightly packed hyphae) commonly form at branch stubs (Zeglen, 1997). Internally, early decay appears as a red or purple stain in the heartwood that in cross section often reveals a well-defined ring, hence the common name "red ring rot" (Allan *et al.*, 2003). As decay develops, spindle-shaped zones of white fibers are produced running parallel to the grain. Over time these coalesce, and decay columns develop that are entirely composed of soft, light-coloured, and fibrous decayed woody material (Zeglen, 1997).

Figure 3.69 A fruiting body of red belt fungus from cutblock TEL-833.

Louisiana-Pacific’s approach to controlling of red ring rot fungus in FML #3 is focused on detecting infected stands and prioritizing harvests to mitigate losses. Relative amounts of white pocket rot are also recorded during harvesting operations in relation to stand type and age. Volume estimates used in wood supply forecasting are then adjusted accordingly. These activities help LP managers refine the most appropriate pathological rotation ages to mitigate losses attributable to white pocket rot for different stand types, site types, and stand ages across FML #3.

3.1.11.3.3 Stringy butt rot, a.k.a. yellow stringy rot (Perenniporea subacida)

Stringy butt rot affects spruces, firs, pines, and also some hardwood species across North America (Allan *et al.*, 2003). The yellow colour of its mycelial mats is relatively unique among stringy rot fungi, and explains why it is sometimes also referred to as yellow stringy rot. It belongs to a widespread fungal genus that affects many different tree species in temperate and tropical forests worldwide; upwards of 55 species names appear in the literature associated with this genus (Gerber *et al.*, 1999).

Since the morphology of the species varies somewhat by host tree, and taxonomy for this genus is continually evolving through the use of advanced microscopic and genetic techniques, there possibility exist that more than one species of *Perenniporea* that affects trees within FML #3, (Gerber *et al*., 1999). *Perenniporea subacida* may also sometimes be confused with *Radulodon americanus* (Ryv.), another stringy white rot decay fungus with similar characteristics that affects broadleaf trees in the prairie Provinces (Hiratsuka *et al*., 1995).

Symptoms of yellow stringy rot infection include characteristic fruiting bodies and the appearance of infected wood as decay progresses. Fruiting bodies of *Perenniporea subacida* most commonly form on undersides of decaying logs on the ground and the lower portions of dead standing trees. They are resupinate, perennial leathery masses with creamy-white to yellow coloured exposed surfaces containing small (5-6 per mm) circular pores (Allen *et al*., 2003).

Figure 3.70 An example of a tree infected by *Perenniporea subacida* (credit British Columbia Ministry of Forests and Range from http://www.for.gov.bc.ca/).

Internally, a light brown stain in the heartwood signals early stages of decay. As decay progresses, small white pits develop that over time coalesce to form a mass of white spongy fibres containing small, black flecks. Annual rings often separate and characteristic stringy yellow-white mycelial mats frequently form between the sheets. Eventually, the wood is completely destroyed, leaving a hollow butt (Allen *et al*., 2003), as shown in Figure 23 above.

Louisiana-Pacific's approach to managing yellow stringy rot in FML #3 is consistent with that used to mitigate the impacts of other wood decay fungi. Stands with high levels of infection are prioritized for harvesting, and infected materials are removed to sanitize these sites before they are regenerated. The incidence of stringy yellow rot in relation to stand type, site type, and age is also recorded and this information is integrated into future harvest planning.

3.1.11.3.4 Aspen Trunk Rot (Phellinus tremulae)

Aspen trunk rot is one of the most serious problems limiting the utilization of mature aspen in western Canada. It is a white rot fungus that occurs exclusively in trembling aspen, and is the most damaging and economically important pathogen associated with this tree species. Like most wood decaying fungi, volume losses attributable to aspen trunk rot increase significantly with tree age (Hunt and Etheridge, 1995; Peterson and Peterson, 1992; NRCAN, 2003a).

When present, a single fruiting body generally indicates considerable decay. Fruiting bodies are hoof-shaped, perennial, hard, woody conks up to 20 cm wide and 15 cm thick (Figure 3.69). Fruiting bodies can be distinguished from similar shelf-like fungi by their angled upper and lower surfaces that give them a wedge-like shape. The upper surface of reproductive *P. tremulae* fruiting bodies is deeply zoned, grey-black to black, and roughened when old. The lower surface is brown and porous, lined with basidia that produce basidiospores (Allan *et al.*, 2003; Volk, 2004).

Figure 3.71 Fruiting bodies of *Phellinus tremulae* (credit Pacific Forestry Centre, www.pfc.forestry.ca/)

Aspen trunk rot has been estimated to cause 90–95% of aspen volume loss in northeastern British Columbia (Henigman *et al.*, 1999). In Ontario, Basham (1958) attributed 74.6% of heartrot in all merchantable aspen to *P. tremulae*; and Thomas *et al.* (1960) estimated that *P. tremulae* caused 38.6% of volume loss in the trunk portion of aspen in Alberta (Parsons *et al.*, 2003). Unfortunately, there are often no external indicators of aspen trunk rot, making it difficult to accurately estimate decay volumes and the true economic impact of this aspen disease (NRCAN, 2003a).

Aspen trunk rot conks form in association with branch scars on living and dead standing trees, and on dead wood on the ground. Black, sterile mycelial masses commonly called sterile conks, blind conks, or punk knots also form at branch scars and signal aspen trunk rot infection. Another symptom of aspen trunk rot infection is that decayed wood in fresh cut trees has a distinct wintergreen odour (NRCAN, 2003a; Allan *et al.*, 2003).

3.1.11.4 Invasive Insect Species

Invasive insect species are not native to Manitoba, have a tendency to spread, and often become a nuisance or cause harm to native organisms. Invasive insect species may be intentionally or unintentionally introduced. Potentially, invasive insect species can negatively impact the forest environment, economy, and recreation.

Two significant invasive insect species include the Emerald Ash Borer and the Cottony Ash Psyllid. These two invasive insects are described on the provincial website: https://www.gov.mb.ca/stopthespread/fis/index.html

3.1.11.5 Parasitic plants

Dwarf mistletoes, *Arceuthobium spp*. are parasitic plants that infect coniferous trees. Two species of dwarf mistletoe occur in Manitoba. *Arceuthobium americanum* is a parasitic plant of jack pine. Eastern dwarf mistletoe (*Arceuthobium pusillum)* is less common, and is a parasite plant on black spruce, white spruce, and less commonly tamarack-larch.

3.1.11.5.1 **Jack Pine Mistletoe**

Arceuthobium americanum is a parasitic flowering plant of jack pine. The parasitic plant obtains nourishment from its host through a well-developed root system that grows inside the host tree’s bark. The plant appears as aerial shoots on infected branches. Berries are formed on the ends of mistletoe stalks on the female plant. Each berry contains a single green coloured seed. The berries mature between mid-August and mid-September. Internal pressure builds and causes the seed to be forcibly discharged up to 18 metres. The seed is covered in a sticky substance called viscin, which allows the seed to adhere to host trees.

A root-like structure grows out of the seed and penetrates the surface of the host tree. A parasitic root system develops underneath the host tree’s bark. Two to three years later, aerial shoots appear, and four or five years to produce mature seed. The tree branch swells at the point of infection and the formation of a broom begins (Figure 3.70). The dwarf mistletoe plant is perennial on the host tree, and dies when the host tree dies.

Figure 3.72 Dwarf mistletoe brooms on jack pine.

3.1.11.5.2 Spruce Mistletoe

Eastern dwarf mistletoe (*Arceuthobium pusillum)* is less common, and is a parasite plant on black spruce, white spruce, and less commonly tamarack-larch.

Figure 3.73 Eastern dwarf mistletoe on black spruce.

3.1.11.6 Rust Fungi

Western gall rust (*Endocronartium harknessii* [(J. P. Moore) Y. Hiratsuka]) affects the growth and survival of jack pine trees. In large concentrations, gall rust can kill entire stands of jack pine. The galls grow on branches and stems of jack pine trees, girdling and eventually killing the branch or entire tree.

The Onion Lake (ONL) operating area in the Duck Mountain had gall rust initially discovered in 2004 by Pre Harvest Surveyors and operations staff. Later the province of Manitoba confirmed the presence and extent of the disease Western gall rust. To combat the inevitable losses of the diseased stands, LP, Quota Holders, and the IRMT mutually agreed to harvest the dying stands.

Within the western gall rust sanitation cutovers, tree species that are not affected by western gall rust, such as spruces and aspen, are left behind to form wildlife tree patches, buffers, and meet the line-of-sight guideline wherever possible.

3.1.11.7 Blight Diseases

Venturia shoot blight (Shepherd's crook) can be found in most aspen forests, but it is rarely a significant cause of damage. *Venturia* is a fungus that invades the leaves of the emerging shoots, causing a brown or black leaf spot. Typically, the fungus grows through the leaf petiole and into the shoot the new shoot. The new shoot blackens, causing the characteristic shepherd's crook. Leaves and succulent shoots of aspen are killed not long after bud break. Aspen mortality is rare, but loss of height growth within a single growth season is common.

Figure 3.74 Examples of *Venturia* shoot blight.

3.2. ECONOMIC AND SOCIAL ENVIRONMENT

This section of the plan provides a socio-economic profile of the Stats Canada Parklands Economic Region (Figure 3.73), that approximates the location of Forest Management Licence #3. The Parklands Region is an amalgamation of Census Divisions 16, 17, and 20. All data were summarized by Statistics Canada (2017) from the 2006, 2011, and 2016 censuses. The first part of the profile looks at the demographic characteristics of the area, such as population and age trends. Languages spoken in the area are summarized. Income and wealth statistics are part of the socio-economic profile, as is employment.

Figure 3.75 The Parklands Economic Region (Manitoba Bureau of Statistics 2012)

3.2.1. Economic Geography of the Parklands Region

The Forest Management License #3 area is located in west-central Manitoba, and is also known as the Parklands Region. The licence area is adjacent to the Saskatchewan border, and the edge of Riding Mountain National Park to the south, Dauphin in the southeast, and is bounded on the east by Lake Manitoba and Lake Winnipegosis (Figure 3.74).

The topography of Riding Mountain and the Duck Mountain form obstacles to travel, therefore the main lines of travel and communication go around the mountains. Highway #5 runs east-west between Riding Mountain Park and Duck Mountain Provincial Park. Highway #10 is a provincial trunk highway that connects Dauphin to Swan River and communities to the north. Lakes Manitoba and Winnipegosis impede travel east into the centre of the Province (the Interlake region). The Trans-Canada highway is a major east-west artery, but is hundreds of kilometers to the south of FML #3. Thus, the Parklands region is geographically isolated and has a greater natural affinity with eastern Saskatchewan than with the rest of Manitoba.

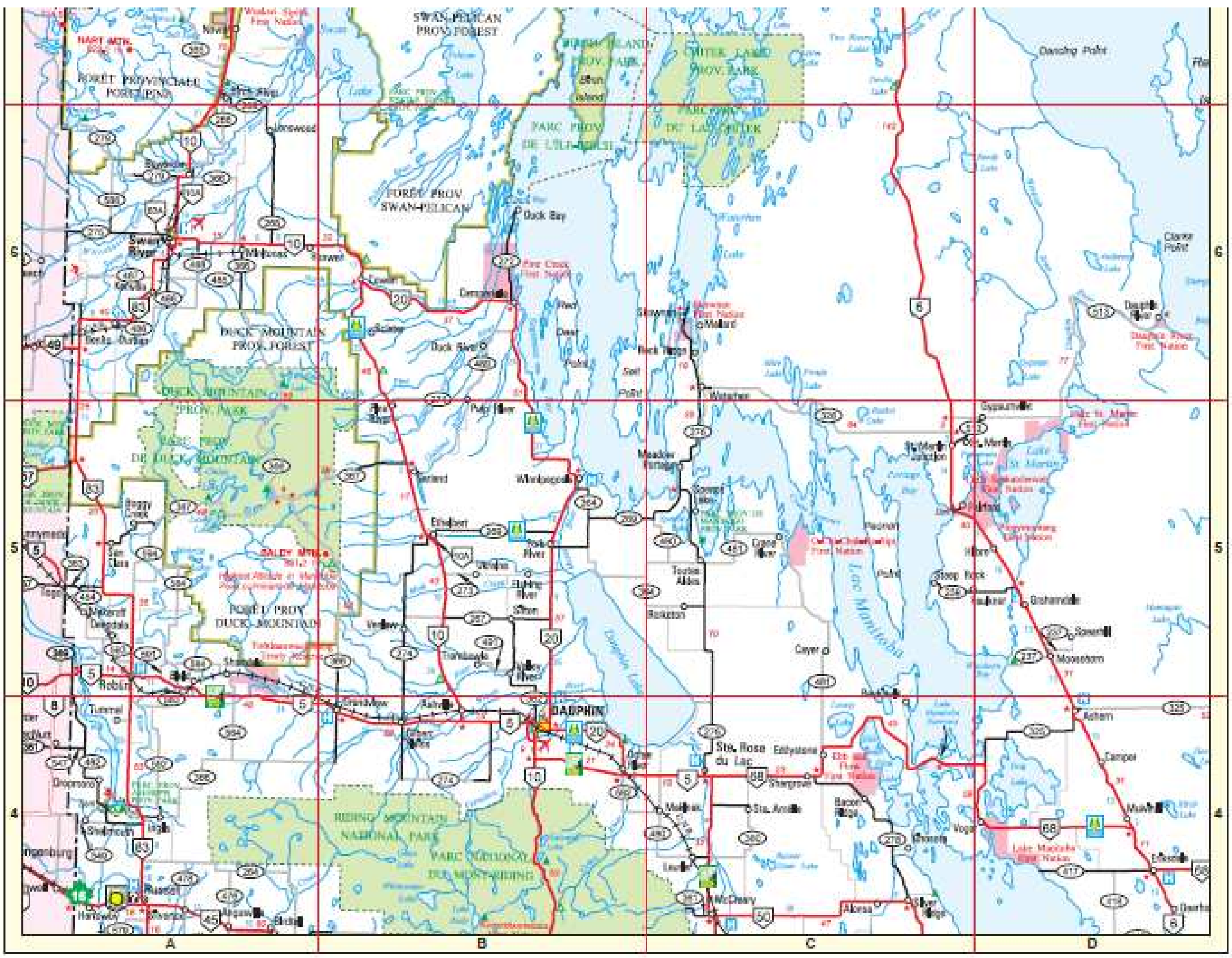


Figure 3.76 The Parklands Region general area.

Dauphin is the only city in the Parklands Region, and is a regional hub. Towns are the next smallest community type. There are five towns in the area, including Grandview, Minitonas, Roblin, Ste. Rose du Lac, and Swan River. Villages, such as Bowsman and Ethelbert, are even smaller. Some residents of the Parklands live on a farm or an acreage within a Rural Municipality (RM) instead of a town or village.

There are five First Nations reserve areas within Forest Management Licence #3. They are: O Chi Chak ko Sipi (Crane River); Ebb and Flow; Pine Creek; Tootinaowaziibeeng (Valley River); and Wuskwi Sipihk. Numerous Metis settlements are also in the licence area. There are also First Nations Reserves outside the licence area, including Sapotaweyak, Rolling River, Waywayseecappo First Nation, and others.

3.2.2. Population Trends

The population of the Province of Manitoba expanded by 5.8% in the last census period (2011 and 2016). However, most of Manitoba's population increase (69%) occurred within the City of Winnipeg. The Parklands Region was the only region in Manitoba to decline in population (1.0%) between 2011 and 2016. The Parklands Region population also declined in the previous census period (2006 to 2011) by 1.5%.

Larger communities within the Parklands region (*i.e.* Dauphin and Swan River) experienced modest population growth. Smaller population centers in the Parklands Region experienced declines in population, with the exception of the town of Grandview and the villages of Ethelbert and McCreary.

Table 3.27 Population trends in the Parklands Region.

Location	2016	2011	2006	% change 2011 2016	% change 2006 2011
Province of Manitoba	1,278,365	1,208,268	1,148,401	5.8%	5.2%
Parklands Economic Region	41,674	42,088	42,708	-1.0%	-1.5%
CITIES					
Dauphin	8,457	8,251	7,906	2.5%	4.4%
TOWNS					
Gilbert Plains	785	811	760	-3.2%	6.7%
Grandview	864	859	839	0.6%	2.4%
Minitonas	465	522	497	-10.9%	5.0%
Roblin	1,697	1,774	1,672	-4.3%	6.1%
* Rossburn	512	552	546	-7.2%	1.1%
* Russell	1,599	1,669	1,590	-4.2%	5.0%
Ste. Rose du Lac	1,021	1,023	995	-0.2%	2.8%
Swan River	4,014	3,907	3,869	2.7%	1.0%
VILLAGES					
Benito	370	377	370	-1.9%	1.9%
* Binscarth	407	425	395	-4.2%	7.6%
Bowsman	262	298	315	-12.1%	-5.4%
Ethelbert	277	275	312	0.7%	-11.9%

Location	2016	2011	2006	% change 2011 2016	% change 2006 2011
McCreary	507	472	487	7.4%	-3.1%
Winnipegosis	617	647	628	-4.6%	3.0%

**town or village is in the Parklands Economic Region, but not within Forest Management Licence #3*

All of the Rural Municipalities in the Parklands Region experienced substantial declines in population between 2011 and 2016 (Table 3.27) with the exception of the RM of Dauphin.

Table 3.28 Population trends in rural municipalities in the Parklands region.

Rural Municipality	2016	2011	% change 2011 2016
Dauphin	2,388	2,200	8.6%
Swan Valley West	2,829	2,923	-3.2%
Grandview	1,482	1,508	-1.7%
Ste. Rose	1,712	1,794	-4.6%
Gilbert Plains	1,470	1,623	-9.4%
Minitonas/Bowsman	1,653	1,816	-9.0%
Hillsburg/Roblin/Shell River	3,214	3,284	-2.1%
Lakeshore	1,363	1,401	-2.7%
Mossey River	1,145	1,186	-3.5%
Ethelbert	607	629	-3.5%
Mountain North	559	637	-12.2%
Mountain South	419	467	-10.3%
Alonsa	1,247	1,270	-1.8%
Riding Mountain West	1,420	1,390	-2.2%
TOTAL	**21,508**	**22,128**	**-2.8%**

Demographic data were available for some, but not all Indigenous communities in the region. Population data and trends are summarized in Table 3.28.

Table 3.29 Population trends in Indigenous communities in the Parklands region.

Community	2016	2011	% Change 2011 2016
Camperville	820	547	49.9
Ebb and Flow	1,341	1,297	3.4
Pine Creek	631	685	-7.9
Shoal River	810	802	1.0
Swan Lake	23	49	-53.1
Valley River	353	364	-3.0
Waywayseecappo	1,365	1,219	12.0
TOTAL	**7,359**	**6,974**	**5.5**

3.2.3. Age Trends

Community resident ages for the year 2016 are summarized in this section. Median age of all persons in the Parklands Region is almost a decade higher than the Province of Manitoba's median age (Table 3.29). The median age of residents by community varies slightly, but not significantly. The distribution of age groupings across communities is quite similar across the Parklands Region. There are slightly less young (0 to 14 year olds) people in the Parklands Region than the Provincial average, but significantly more seniors than the Provincial average, especially the 85 year old and over category.

Table 3.30 Age summary comparison by location.

Location	Median age (years) 2016	0 to 14 years old (%)	15 to 64 years old (%)	65 years old and over (%)	85 years old and over (%)
Province of Manitoba	38.3	19.1	65.4	15.6	2.3
Parklands Economic Region	45.8	18.2	58.5	23.3	3.9
CITIES					
Dauphin	44.5	17.4	56.5	26.1	5.3
TOWNS					
Gilbert Plains	48.6	16.6	53.5	30.6	7.0
Grandview	56.8	14.5	45.7	39.3	9.8
Minitonas	49.0	16.0	58.5	24.5	4.3
Roblin	49.1	17.9	51.5	30.9	8.5
*Rossburn	54.3	15.7	48.0	35.3	9.8
*Russell	45.3	16.6	56.6	26.9	7.2
Ste. Rose du Lac	52.7	15.2	51.0	33.3	8.3
Swan River	45.4	17.1	56.2	26.8	6.4
VILLAGES					
Benito	47.8	13.5	55.4	31.1	6.8
*Binscarth	51.0	13.4	59.8	26.8	2.4
Bowsman	46.5	17.3	59.6	23.1	1.9
Ethelbert	49.2	17.9	53.6	30.4	3.6
McCreary	55.0	15.8	48.5	37.6	6.9
Winnipegosis	48.8	18.7	54.5	26.8	5.7

**town or village is in the Parklands Economic Region, but not within Forest Management Licence #3*

The City of Winnipeg has a younger population than the Town of Roblin (Figure 3.75). 64% of Winnipeg's population is less than 50 years of age, and only 7% of the population older than 75 years. Roblin has 19% of the population is 75 years or older, and only half of the population is younger than 50 years of age.

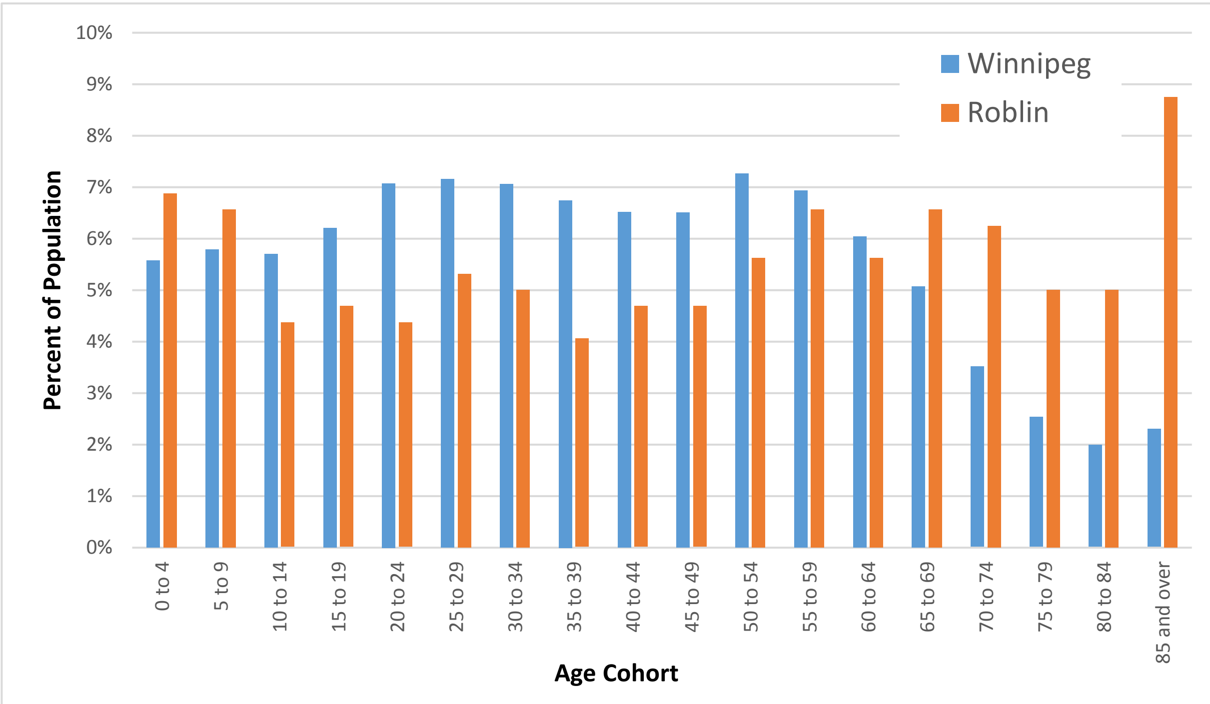


Figure 3.77 Population cohorts in Winnipeg and Roblin, Manitoba (Statistics Canada, 2016).

3.2.4. Languages Spoken

Canada is a bilingual country. Both English and French are Canada's two official languages. In the Parklands Region, English is spoken by most residents (Table 3.30), with 4.8% of residents being bilingual, and a very small percentage speak French only. Only 0.1% of Parklands residents speak neither English nor French.

Table 3.31 Official languages spoken in the Parklands Region.

Language	2016 number of respondents	percentages
Total - Knowledge of official languages for the total population excluding institutional residents - 100% data	40980	100%
English only	38935	95.0%
French only	15	0.04%
English and French	1970	4.8%
Neither English nor French	60	0.1%

The mother tongue concept refers to the first language learned at home in childhood and the language is still understood. An amazing number of different languages (Table 3.31) are spoken and considered 'mother tongue' in the Parklands Region. The majority of these languages are Ukrainian, Aboriginal, and German languages, with a fractional percentage of languages from all over the world.

Table 3.32 Mother tongue languages in the Parklands Region.

Language	Number of respondents 2016
Official languages	36055
English	35215
French	835
Non-official languages	4330
Aboriginal languages	**715**
Cree-Montagnais languages	90
Plains Cree	5
Swampy Cree	10
Cree; n.o.s.	80
Ojibway	605
Michif	20
Dakota	5
Aboriginal languages; n.o.s.	5

Language	Number of respondents 2016
Non-Aboriginal languages	**3615**
Afro-Asiatic languages	30
Semitic languages	30
Amharic	5
Arabic	25
Tigrigna	5
Austro-Asiatic languages	5
Vietnamese	5
Austronesian languages	255
Bikol	5
Cebuano	25
Ilocano	5
Tagalog (Pilipino; Filipino)	215
Creole languages	10
Creole; n.o.s.	5
Dravidian languages	45
Malayalam	50
Indo-European languages	
Balto-Slavic languages	
Latvian	5
Slavic languages	
Belarusan	5
Czech	40
Polish	75
Russian	60
Serbian	5
Slovak	5
Ukrainian	1980
Germanic languages	
Afrikaans	25
Danish	20
Dutch	65
German	680
Icelandic	5
Norwegian	10
Vlaams (Flemish)	10
Greek	5
Indo-Iranian languages	

Language	Number of respondents 2016
Gujarati	15
Hindi	10
Konkani	5
Punjabi (Panjabi)	15
Urdu	10
Iranian languages	5
Indo-Iranian languages; n.i.e.	5
Italic (Romance) languages	
Portuguese	10
Romanian	25
Spanish	55
Korean	15
Niger-Congo languages	10
Niger-Congo languages; n.i.e.	5
Sign languages	5
Sino-Tibetan languages	
Chinese languages	75
Cantonese	20
Mandarin	15
Chinese; n.o.s.	35
Uralic languages	
Finnish	5
Hungarian	15

3.2.5. Income and Wealth Statistics

Statistics Canada collects census data regarding family income, which is a strong indicator of overall socio-economic well-being. Median family income data are shown for regional communities in Table 3.32. The Parklands region reports lower median incomes than the average for Manitoba. Swan River, Dauphin, Ste. Rose du Lac, and Minitonas report higher than average 2016 family income within the Parklands Region.

Table 3.33 Median family income data by community.

Cities and Towns	2016 income ($)
Swan River	$74,112
Dauphin	$73,326
Ste. Rose du Lac	$72,875
Minitonas	$71,424
Gilbert Plains	$68,352
Winnipegosis	$67,840
Roblin	$66,304
Grandview	$61,440
Bowsman	$58,368
Benito	$58,112
Ethelbert	$52,672
AVERAGE (All)	**$65,893**
AVG (pop'n < 1000)	$62,601
AVG (pop'n > 1000)	$71,654
Parklands Region	**$69,642**
Manitoba	**$84,441**

Table 3.33 shows the median income data by Rural Municipality (RM). The RMs of Dauphin and Swan River have higher median income than other RMs, while the RMs of Alonsa, Ethelbert, and Mountain South have lower than average median incomes within the Parklands Economic Region.

Table 3.34 Family income statistics for communities by Rural Municipality.

Rural Municipality	2016 income ($)
Dauphin	$83,328
Riding Mountain West	$83,712
Minitonas/Bowsman	$76,442
Swan Valley West	$75,392
Gilbert Plains	$73,856
Hillsburg/Roblin/Shell River	$70,528
Lakeshore	$69,274
Ste. Rose	$69,120
Mossey River	$68,864
Grandview	$66,048

Rural Municipality	2016 income ($)
Mountain North	$60,459
Ethelbert	$54,656
Alonsa	$51,456
Mountain South	$47,232
Average	**$67,883**

Statistics Canada also provides dwelling price estimates, but this metric is a less reliable indicators of overall socio-economic well-being. Nevertheless, dwelling values are shown since they make attractive indicators of a community's current and future prospects. Communities that are healthy and socio-economically sound will be desirable places to live and one would expect that housing prices would reflect this. Furthermore, if prospects were bright, this would encourage strong house prices, whereas an uncertain future would lead to low prices as some people would opt to relocate and relatively few people would be willing to move into a declining community.

Table 3.34 shows dwelling price data for communities in the Parklands Region. Data for individual Rural Municipalities are not shown.

Table 3.35 Single family detached dwelling 2016 values by community.

City and Towns	2016
Swan River	$180,156
Dauphin	$159,847
Roblin	$149,528
Ste. Rose du Lac	$125,293
Minitonas	$129,778
Gilbert Plains	$100,160
Winnipegosis	$99,882
Grandview	$79,984
Ethelbert	$80,001
Bowsman	$75,160
Benito	$70,141
AVG (All)	**$113,360**
AVG (pop'n < 1000)	$90,729
AVG (pop'n > 1000)	$153,706
Parklands Region	$150,070

3.2.6. Employment

Table 3.35 shows general statistics related to the workforce and employment in the region. In general, there is a high participation rate (*i.e.* a high proportion of the eligible population is willing to work) and the rate of employment in the region is relatively high. It is notably higher in the rural municipalities and very small villages, however given the population declines experienced in those settings, these data indicate that people who live in a rural area but are out of work either get work quickly or move elsewhere.

Table 3.36 General work force and employment statistics for the Parklands region.

Population Segment	Region # persons in 2016
Total population 15 years and over	32,760
In the labour force	19,710
Employed	18,465
Unemployed	1,250
Participation rate	60.2%
Employment - population ratio	56.4%
Unemployment rate	6.3%

In the Swan River area, a large percent of the economy depends upon agriculture. Cereal farming for seeded grains and oilseeds is prevalent in the region, while there is also some mixed farming for producing cattle, dairy, pigs, and other animals. Other major sectors are services, including health, education, accommodation, and food services. Tourism is also important, since the provincial parks and nearby national park attract an increasing number of tourists to the area.

Agriculture, forestry, fishing and hunting (Table 3.36 and Figure 3.76) reports the highest percentage of employment in the Parklands Region, and is well above the Manitoba percentage, mainly due the amount of agricultural activity in the region. Commercial large game and game bird outfitting provide a seasonal income source in the region. Outfitting is very popular for non-resident black bear, white-tailed deer, and game birds.

Healthcare and social assistance is the next highest percentage of employment in the region. The percent of Parklands Region residents employed by healthcare and social assistance is higher than the Manitoba provincial average.

Trapping provides a significant seasonal income to the area. Records are available for only the Duck Mountain and Porcupine Registered Trapping Sections, where 65 trappers were permitted and generated an estimated $72,386 in raw fur sales in 2016-2017. The surrounding lands are in the Open Trapping Area and have significant trapping activity, although specific harvest locations for each trapper are not known and values cannot be determined.

Table 3.37 Employment by sector, summarized for Manitoba and the Parklands region.

Sector	Manitoba 2016	Parklands Region 2016
Management of companies and enterprises	0.10%	0.00%
Mining; quarrying; and oil and gas extraction	0.84%	2.19%
Utilities	1.14%	0.54%
Real estate and rental and leasing	1.27%	0.62%
Information and cultural industries	1.67%	0.72%
Arts; entertainment and recreation	2.00%	1.44%
Administrative and support; waste management and remediation services	3.43%	1.88%
Finance and insurance	3.99%	3.27%
Other services (except public administration)	4.32%	3.76%
Professional; scientific and technical services	4.38%	2.75%
Agriculture; forestry; fishing and hunting	4.42%	17.89%
Transportation and warehousing	5.46%	3.68%
Accommodation and food services	6.72%	5.64%
Public administration	7.18%	6.44%
Construction	7.63%	6.59%
Manufacturing	8.41%	3.48%
Educational services	8.47%	7.98%
Wholesale and retail trade	14.10%	14.47%
Health care and social assistance	14.47%	16.66%
Total	100.00%	100.00%

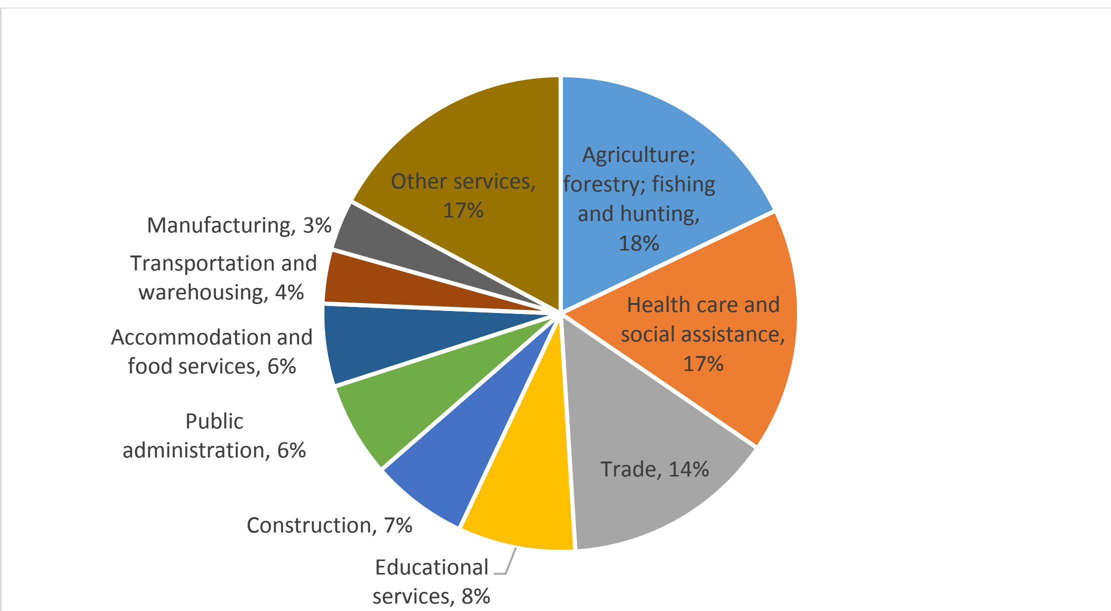


Figure 3.78 Distribution of Employment by sector in the Parklands Economic Region.

3.2.7. Economic Profile of the Town of Swan River

The Town of Swan River is a major trading center for the region, since very few other communities are located in the region that can provide the range of services available in Swan River. The economic base is diversified with several industries contributing to the local economy, including agriculture, forestry, manufacturing, and tourism. Salient features of the community and its' workforce are shown in Table 3.37. Swan River shows an unemployment rate of 5%, which is lower than the Parklands Region.

Table 3.38 Selected economic features of the Town of Swan River.

Particulars	2016
Population	4,032
Participation Rate (%)	58.7
Employment Rate (%)	55.8
Unemployment Rate (%)	5.0
Total Experienced Labour Force	1,790
Engaged in Primary Industries	110
Engaged in Manufacturing and Construction	200
Engaged in Service Industries	1,475

3.2.8. Economic Profile of the Town of Minitonas

Minitonas is a smaller community whose salient features are shown in Table 3.38. The population of Minitonas has decreased in recent years. Minitonas shows an unemployment rate of 4.8%, lower than the Parklands Region average.

Table 3.39 Selected features of the village of Minitonas.

Particulars	2016
Population	465
Participation Rate (%)	53.8
Employment Rate (%)	51.3
Unemployment Rate (%)	4.8
Total Experienced Labour Force	210
Engaged in Primary Industries	0
Engaged in Manufacturing and Construction	60
Engaged in Service Industries	155

3.2.9. Economic Contribution by the Forest Industry

Statistics Canada lumps agriculture, forestry, hunting and fishing together in the same category, so it is not possible to separate forestry's contribution to the Parklands Region economy based on Statistics Canada data only. However, there is a significant economic contribution by the forest industry in FML #3 by Louisiana-Pacific Canada Ltd., Spruce Products Ltd., and 21 Quota Holders. This is evidenced by the towns of Swan River and Minitonas having lower unemployment rates than the Parkland Region average. In addition, median family income and house prices are also higher than the Parkland Region average.

LP employs nearly 5,000 workers in North America, 1,400 direct employees in Canada, and 230 hourly and salary employees in Manitoba. The current annual Manitoba payroll is approximately $16,000,000. It has been noted by local residents that the LP jobs are very steady, and that LP provides a significant benefit to the local economy. In addition to a significant amount of employment, LP has paid $2,260,000 in Crown dues to the Province of Manitoba in the 2017-2018 harvest season. The LP mill converted from Oriented Strand Board to LP Smart Siding ($117 million upgrade) in 2015.

In addition to the mill, there are harvest and haul jobs for 500,000 m^3 of wood each year. Current annual log purchase contracts total $21,000,000 annually, which employs approximately 250 people. There are also spin-off benefits for all the support to the mill, harvest, and haul.

Spruce Products Ltd. (SPL) is a privately held sawmill that employs a staff of approximately 60 people at their mill and woodlands division. SPL harvests softwoods from within FML #3 as well as the Porcupine Mountains and surrounding area. SPL has being supplying products for Canadian and International markets since 1942. In addition to being a major employer in the area, Spruce Products is also a strong member of the community and provides support to numerous organizations and local events each year.

3.2.10. Recreational, Cultural, or Historic Values that Contribute to Socio-Economic Conditions

There are some recreational, cultural, and historic values that contribute to the socio-economic conditions in the Parklands Region. Some of these values provide direct income, other values provide indirect income or spinoff benefits. Cultural and historic values provide improvements to quality of life in the Parklands Region, even if there is little monetary gain.

3.2.10.1 Recreation and Tourism

Recreation and tourism are detailed in the Land Use section of this chapter. However, this socio-economic section provides a linkage between socio-economic conditions and recreation in the Parklands area. For example, the Thunder hill area with ski hills and mountain bike trails is a significant recreational area. In the Town of Swan River there is a snowboard, ski, and mountain bike shop named ‘Rumors’. This speciality store and its’ employees would not exist without the Thunder hill ski area providing valuable winter recreation opportunities.

Trails

Snowmobile trails in the forests provide an experience for local Parklands residents. People outside the Parklands also bring their snowmobiles into the local area to utilize and experience the forested trails. In winters where there is little or no snow in southern Manitoba, but snow in the Parklands Region, there is a significant increase in snowmobile tourism. Community hosted snowmobile poker derbies are common across the Parklands region. There are economic benefits to the local hotels, restaurants, and gas stations. The popularity of snowmobiles and ATVs is evidenced by the high number of snowmobile and ATV dealers and repair shops in Swan River, Dauphin, and other Parklands towns.

Trails are also used for non-motorized recreation, such as hiking, biking, and cross-country skiing.

Parks and Campgrounds

Duck Mountain Provincial Park provides some socio-economic benefits to the local area. It has four campgrounds offering a mix of basic and electrical sites, in addition to rental cabins and full-service lodges. Many of the park activities (e.g. hiking trails, fishing) are listed in other sections.

Asessippi Provincial Park provides some socio-economic benefits to the Parklands Region. It is located at the southern end of the Lake of the Prairies, in the south western portion of FML #3.

Ski Hills

Asessippi Ski Area & Resort near Inglis, MB offers skiing and snowboarding on 26 runs, two terrain parks, and a beginner area. In addition, there is a tubing park features five downhill runs, snow biking, snow shoeing, sled dogs, snow skates, and kiteboarding. In the summer, mountain biking occurs on the hills.

Thunder hill Ski area is on the western edge of the Swan Valley, and features 22 groomed downhill ski runs, two runs of almost 3/4 mile with 450 feet of elevation. There are also 2.2 km of unmarked cross-country ski trails & snowshoe trails.

Recreation not associated with a landscape feature (e.g. Thunder hill) but with a significant seasonal socio-economic effect in the Parklands includes:

Northwest Regional Roundup and Exhibition (rodeo) is hosted on the last weekend of July in Swan River each year. Attendance is in the thousands, and people come from across Canada to attend. The four day event features a parade, western rodeo, exhibits, demonstrations, concerts with live entertainment, and a Midway with amusement rides. http://www.northwestroundup.ca/details.html

Dauphin Countryfest is an annual music festival hosted at the Countryfest site south of Dauphin. The site has a 12,000 seat amphitheater, 450-800 capacity hall, 3 outdoor stages, and vendor booths. https://countryfest.ca/

Recreational sports in the Parklands have a seasonal, but significant socio-economic effect. Sports tournaments bring people from across the Province, which benefit local area hotels, restaurants, and shopping. Facility-based recreation includes:

Hockey arenas exist in most communities.

Curling rinks in almost every community host bonspiels and tournaments during the winter months.

The **Kinsmen Aquatic Centre** (Dauphin) provides residents the opportunity to take part in year round recreational swimming, aquasize, competitive swimming, water sports, and lessons. The Kinsmen Aquatic Centre accommodates up to 200 people and includes a water slide, wave pool, hot tub, and four lane 25 meter pool.

Swan Valley Credit Union Aquatic Centre (Swan River) and waterpark is located in the Richardson Recreation and Wellness Centre. It includes a four lane competition pool, zero entry leisure pool, waterslide, swirl pool, and sauna.

Skate Park (Swan River) features approximately 8,000 square feet of integrated plaza and bowl terrain. The Swan River Lions Skate Plaza is the only full-size, permanent concrete skateboard park in the Parklands region. The facility is also a favorite for BMX bike riders and was designed for use by snowboarders in the winter months.

Ball diamonds are a common recreational sports feature in most communities. Larger communities have multiple baseball diamonds for large tournaments.

Soccer fields have grown in number as soccer becomes more popular.

Community halls provide great venues for many events and activities such as family reunions, weddings, or community celebrations

Golf courses are common in the area, and include:

Dauphin https://golfdauphinlake.ca/

Swan River https://www.swanrivergolf.com/

Roblin https://golfroblin.com/

Gilbert Plains https://www.golfgilbertplains.com/

Prairie Lake Lodge Golf Course & Country Club https://asessippiparklandtourism.com/entities/prairie-lake-lodge-golf-course/

Ste. Rose and Winnipegosis also have golf courses, but no website.

Benito has a new sport, disc golf

http://valleybiz.ca/businessdirectory/Shaker-City-Disc-Golf-82-3.htm

Fishing – there are sport fishing opportunities in the Parklands almost year round. The Provincial Fisheries Branch and the Swan Valley Sport Fishing Enhancement Inc. work to maintain and improve fish populations and fishing opportunities. Swan Valley Sport Fishing

Manitoba's Angler Guide https://www.gov.mb.ca/waterstewardship/fish/pdf/angling_guide.pdf

Hunting – there are waterfowl, upland game, and large game hunting opportunities across the Parklands.

3.2.10.2 Cultural Values

Cultural values provide improvements to quality of life in the Parklands area.

Dauphin Ukrainian Festival is a Canada-wide National festival every August long weekend at Selo Ukraina, south of Dauphin. This festival showcases Ukrainian culture, food, dance, music, ceremonies, arts, and crafts. The Selo Ukrainia site also boasts a Ukrainian Heritage Village, Memorial Park, and the Ukrainian Musicians Hall of Fame, described at this website: https://cnuf.ca/

Elbert Chartrand Friendship Centre in Swan River is a non-profit community centre and Aboriginal program/service delivery organization. The friendship center provides services to Aboriginals, including Inuit, Métis, First Nations, Non-Status Aboriginal, and Non-Aboriginal people who live in urban areas, detailed in the website: http://www.elbertchartrandfc.com/

Swan Valley Folk Festival is a multi-cultural event held each June. There are usually 20 different booths, one for each ethnic background, highlighting the diverse cultural background in the Swan Valley. Booths are decorated with traditional items from their host country, and staff are dressed in traditional clothing. Ethnic food from many cultural backgrounds can be sampled. Entertainment includes a wide variety of spectacular music, dance, and colorful ethnic attire.

Manitoba Communities in Bloom program promotes community development, and can increase community involvement and civic pride. It encourages all sectors of the community to work together to develop best practices to achieve clean, green sustainable communities that celebrate their heritage and unique potential. Participating communities are evaluated by judges with a bloom rating (1 to 5), a community highlight is also identified. An Evaluation Report focuses on beautification, environmental action, heritage conservation, urban forestry, landscaped areas, and floral displays, as described in the website: http://www.mbcommunitiesinbloom.ca/

3.2.10.3 Historic Values

Historic values provide improvements to quality of life. There are many opportunities in the area to see and experience local history.

Swan Valley Historical Museum
The Swan Valley Historical Museum is a museum and pioneer village that portrays the history and culture of the Swan River Valley. In addition to the main building which have archives, antiques and artifacts on display, visitors can explore over a dozen historical buildings with authentic furnishings from the area. The site also includes operational clay bake ovens as well as a selection of vintage machinery.

Historic Buildings, Collections, and Heritage Sites
There are several other museums, historic buildings, and heritage sites throughout the Swan Valley that document and celebrate our rich history. Built in 1902, Harley House is a rare example of a Red River frame structure in western Manitoba and also one of the oldest surviving homes in the Swan Valley. The Lumax Family Heritage Museum features many treasured items, dating from as far back as 1898. The Village of Cowan has a restored one-room school house that offers a small window into the past.

Trappers Museum at the Duck Mountain Forest Center is currently under construction, and when finished will be filled with historical items that highlight the historical importance of trapping in the region.

Historic Cowan Trail Celebration
Cowan Trail was the first access into the area used by pioneer settlers that moved into the Swan Valley in 1898. The Cowan Trail celebrations is held the fourth Saturday of August each year. It includes a pancake breakfast for all, wagon and horse ride entourage, followed by the ATV derby.

3.2.11. Economic Development Policies

The Province of Manitoba has pledged to enhance the Province's economic development capabilities. Therefore, a Manitoba-wide framework for economic alignment and growth was recently created (Deloitte 2017), and is categorized by economic endowments, economic development assets and tools, and policy considerations.

The City of Dauphin has a community development plan (City of Dauphin, 2010). The development plan identifies issues that will receive priority such as land-use compatibility, servicing efficiencies and costs, development constraints, environmental sustainability, and community quality of life.

The Town of Swan River has a valley-wide economic development policy, created by the Swan Valley Regional Initiative for a Strong Economy Inc. (RISE). This was established by a group of municipalities who recognized the necessity of an active, strategic approach to economic development. The name "RISE" reflects the mandate of increasing economic growth to ensure a sustainable and viable future for the Swan Valley region.

The RISE Board of Directors is comprised of two representatives from each municipality that is financially supporting the initiative. To date, the Town of Swan River, Town of Minitonas, RM of Swan River, and RM of Minitonas have each committed 3 years of funding to RISE.

Strategic planning sessions involving municipal officials from each of Swan Valley's seven municipalities identified the following three areas as RISE priorities:

1. Creating a Climate for Economic Growth
2. Supporting the Retention and Expansion of Local Businesses
3. Developing the Region as a Visitor Destination

3.2.12. Conclusions

The Parklands Region of Manitoba's population has been in a slight but steady decline. The Province of Manitoba has been increasing in population, especially in the City of Winnipeg. The City of Dauphin and the Town of Swan River have been growing, but most Parklands towns and villages have declined. Populations in the Rural Municipalities substantially declined between 2011 and 2016, with the exception of the RM of Dauphin.

The ages of residents in the Parklands Region differs from the Provincial distribution of age. The proportion of senior citizens is much higher in the Parklands Region, especially the 85 year old and over age class. Therefore, the median age of residents in the Parklands is almost a decade higher than the Province of Manitoba's median age. There are slightly less young (0 to 14 year old) people in the Parklands Region than the Provincial average.

There are many different languages spoken in the Parklands Region. The mother tongue of Parklands Region residents includes English, Ukrainian, French, Ojibway, German, Cree, Filipino, and many other languages from across the world.

The Parklands Region reports lower median incomes than the average for Manitoba. Swan River, Dauphin, Ste. Rose du Lac, and Minitonas report higher than average 2016 family income within the Parklands Region. The villages of Benito, Bowsman, and Ethelbert report lower than average 2016 family income within the Parklands Region.

The Parklands Region's main employment sector is agriculture and forestry, which are lumped together as a single category by Statistics Canada. The second largest sector is health care and social assistance, followed by wholesale and retail trade.

During the last 15 years, the impact of the construction and operation of LP's OSB plant, as well as the attendant office, have provided and economic boost to the towns of Swan River and Minitonas. While the two surrounding regional municipalities have continued to experience population declines, the two towns closest to the mill have experienced population increases on the order of 10% between 1990 and 2005, which makes them unique in the Parklands region. The relative vitality of these communities is also expressed in increases in employment, income, and housing prices.

There are some recreational (*e.g.* Duck Mountain Provincial Park), cultural (*e.g.* Elbert Chartrand Friendship Centre, Dauphin Ukrainian Festival), and historic values (*e.g.* Swan Valley Historical Museum) that contribute to the socio-economic conditions in the Parklands Region. Some of these values provide direct income, other values provide indirect income or spinoff benefits. Cultural and historic values provide improvements to quality of life in the Parklands Region.

3.3. LAND USE

The current land uses are described in this section. Note that many different land uses can occur on the same land. For example, provincial forest is simultaneously used for recreational trails, hunting, trapping, outfitting, and timber harvesting.

3.3.1. Traditional Land Use

There are currently five First Nations reserve areas in Forest Management Licence #3. They are Pine Creek, Ebb and Flow, O-Chi-Chak-Ko-Sipi, Wuskwi Sipihk and Tootinaowaziibeeng (Valley River). First Nations Reserves, Treaty Land Entitlements, and Treaty Land Acquisitions are shown in
Figure 3.77. There are also numerous Metis residents in the licence area. The Metis claim traditional use in the entire licence area.

Traditional land use of these Indigenous communities, Treaty 2, and the Metis, are trapping, hunting and fishing, and gathering food, medicines, clothing, tools, and furs. There are also medicinal and spiritual plants used by First Nations that are found throughout the region. No specific information has been provided by these Indigenous communities to date, therefore there are no specific details available.

Indigenous communities within FML #3 and outside FML #3, Treaty 2, and the Metis each consider the entire area as their traditional land use.

Sacred, ceremonial, and burial sites exist in the area, but the location of these very sensitive sites have not been disclosed by Indigenous or Metis communities to the licence holder. However, the licence holder has a place on the Geographic Information System (GIS). This is a confidential GIS layer file where any disclosed sacred, ceremonial, or burial sites would be kept. This GIS layer file has some existing heritage sites, where sensitive information has been passed on to the planning forester. In addition, the Manitoba government has provided the licence holder with some archeological and cultural data on the GIS. Almost all of this information is generalized, non-spatial, and is expected cultural use versus mapped actual finds.

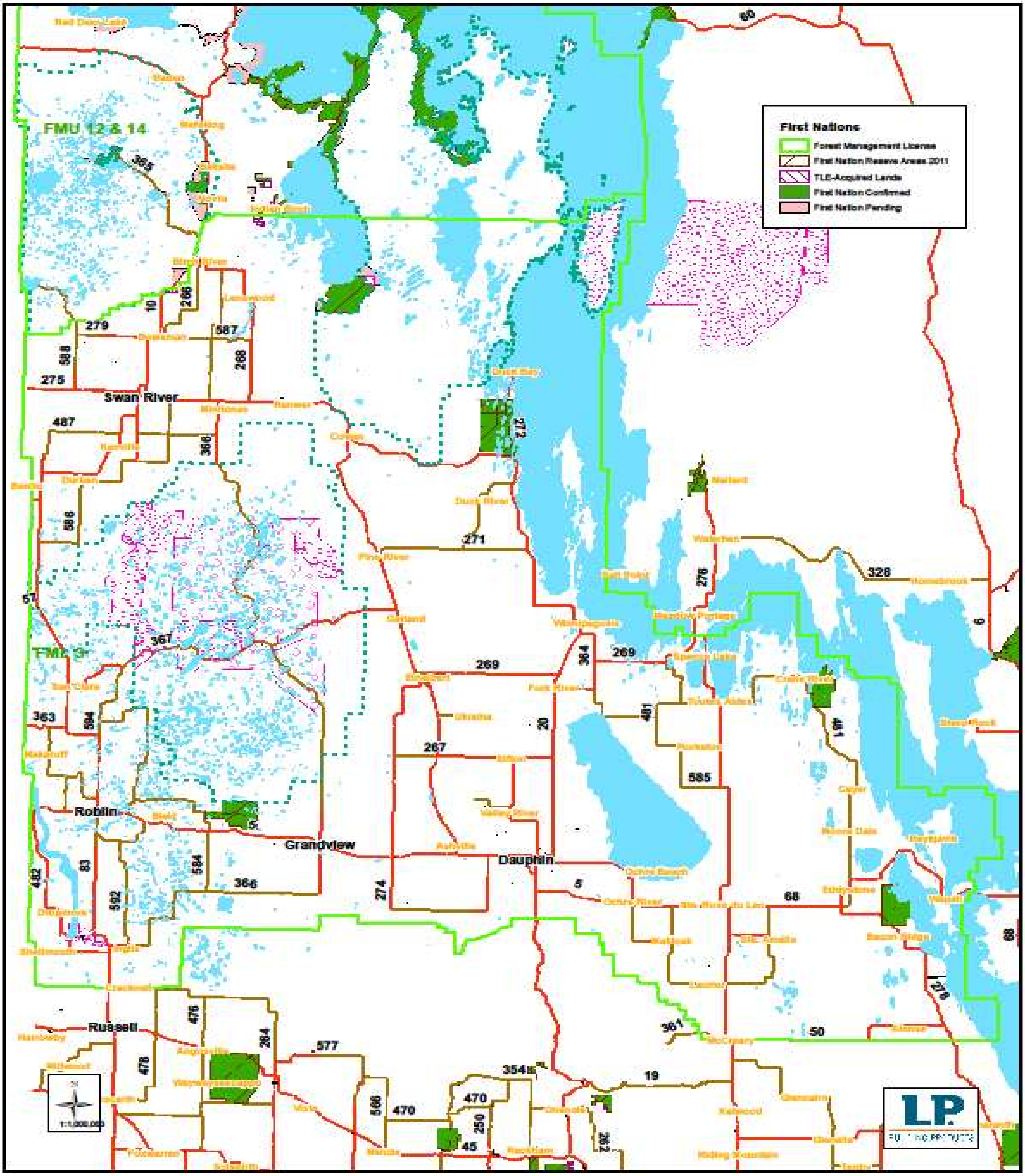


Figure 3.79 First Nations Lands.

3.3.2. Transportation

Most of the licence area is serviced by provincial or municipal road networks. These roads provide access to the Duck Mountain and harvest areas in FMU 10 and 11.

The provincial highways have weight restrictions based on truck configuration, road class, bridge class, and season of use. There are three classes of roads, RTAC, A1, and B1. Each class has specified weight limits. The following website covers all this information. http://www.gov.mb.ca/mit/mcd/mcpd/twlm.html

This legend from the provincial website (Figure 3.78) shows the different classes of highways and bridges.

Figure 3.80 Classes of roads and bridges.

There are two regional airstrips in the licence area located at Dauphin and Swan River. There are also four smaller airports located at Roblin, Gilbert Plains, Ste. Rose and McCreary.

Swan Valley and Dauphin are serviced by rail in the area. Canadian National operates the line that goes to the LP mill at Minitonas and the Pioneer grain elevator north of Swan River.

3.3.3. Crown and Private Lands

Forest Management Licence # 3 is a combination of crown and private land. FML #3 is 2,585,822 hectares that is divided into three Forest Management Units (FMU's), FMU 10, 11 and 13. FMUs 10 and 11 have a combination of Crown and private lands, with FMU 10 being primarily private land (Table 3.39). FMU 13 contains both the Duck Mountain Provincial Forest and Duck Mountain Provincial Park, and is all Crown land.

Table 3.40 Crown, Private, and First Nations Land in FMUs 10 and 11.

Forest Management Unit	Area Water (ha)	Private Land Area (ha)	Crown Land Area (ha)	First Nations Land Area (ha)	Total Area (ha)
FMU 10	145,569	937,641	*300,154	12,960	1,396,170
FMU 11	155,952	246,928	393,277	16,860	813,017

** area estimate due to the area north of Crane River not being included in the Crown land layer file. There is approximately 32,600 hectares not designated.*

The Crown lands in FMUs 10 and 11 have many different categories. Table 3.40 summarizes of the major categories in FMU's 10 and 11.

Table 3.41 Crown Land Major Categories.

Forest Management Unit	Provincial Forest Area (ha)	Provincial Parks Area (ha)	* Protected Areas Area (ha)	Community Pastures Area (ha)	* Wildlife Management Areas Area (ha)	Ag Crown Area (ha)	Total Area (ha)
FMU10	0	2,450	4,735	40,017	18,046	125,094	300,154
FMU11	**167,992	58,101	512	8,887	0	157,785	393,277

**Both Alonsa and Cayer areas are complex, since they are Wildlife Management Areas first, but contain a protected area within each WMA*
*** The FMU 11 Provincial Forest number includes 18,792 ha of Crown land designated as Ag Crown Land. Also Birch Island is designated as Provincial Forest, Park and Protected Area (15,916 ha) was therefore removed from the Provincial Forest and left in Provincial Parks.*
****Kettle Stones area is classified by the Province as both park and protected area*

In Agro-Manitoba, Crown lands have been assigned operational land use codes intended to guide the type(s) of land use and development allowed on a given parcel of Crown land. For further information on Crown land codes contact the local Provincial Lands Branch office.

The area of FMU 13 totals 376,635 ha. 142,096 hectares of FMU 13 is the Duck Mountain Provincial Park (approximately 38%). The Duck Mountain Park is broken into three classes, Backcountry (46,836 ha), Recreational Development (8,803 ha) and Resource Management (86,422 ha). Each of these categories has specific management objectives.

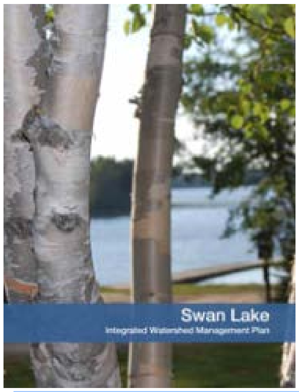
3.3.4. Integrated Watershed Management Plans

There are five Conservation Districts (CDs) in Forest Management Licence #3 (FML #3): Swan Lake, Intermountain, Alonsa, Turtle River, and Lake of the Prairies. These CDs are a partnership between the Province and local municipalities. The CDs protect, restore, and manage land and water resources on a watershed basis. Currently there are 18 CDs in Manitoba.

Conservation districts can also be designated water planning authorities for integrated watershed management planning in Manitoba (Figure 3.79). There are currently 23 Integrated Management Plans in various stages of completion across the Province. FML #3 has five integrated management plans wholly or partially in its boundaries.

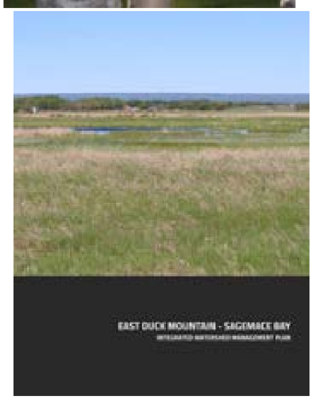
Figure 3.81 Map of Integrated Watershed Management Plans in Manitoba (Province of Manitoba).

Integrated Watershed Management Plan uses an inclusive planning process to identify watershed issues and share knowledge. It is presented as a plan of action that combines the needs of people and diverse industries, while being supportive of ecosystems within the watershed. An integrated plan considers all land activities within the watershed that impact water quality and quantity. The following websites are the locations of the five watershed management plans in Forest Management Licence #3.



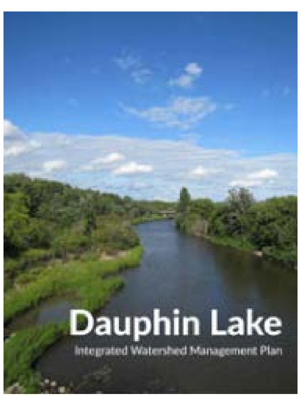
The Swan River Integrated Watershed Management Plan encompasses the area of land that contributes water to the Swan Lake and includes the Swan and Woody Rivers. The Swan Lake Watershed Conservation District is leading plan development in partnership with the Provincial government and a team of supporting agencies, interest groups, and watershed residents.

http://www.manitoba.ca/sd/waterstewardship/iwmp/swan_lake/swan_river.html



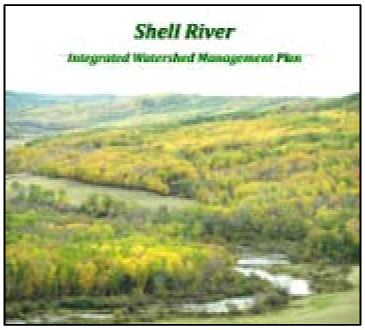
The East Duck River integrated watershed management plan encompasses the area of land that contributes water to Lake Manitoba, and includes the North, Pine, Garland, Fishing and Mossy Rivers. The Intermountain Conservation District is leading plan development in partnership with, the Provincial government and a team of supporting agencies, interest groups and watershed residents.

http://www.manitoba.ca/sd/waterstewardship/iwmp/east_duck/east_duck.html



The Dauphin Lake Integrated Watershed Management Plan encompasses the area of land that contributes water to the Dauphin Lake and includes the Drifting, Wilson, Vermillion, and Turtle Rivers. The Intermountain Conservation District and Turtle River Watershed Conservation District are leading plan development in partnership with, the provincial government and a team of supporting agencies, interest groups, and watershed residents.

http://www.manitoba.ca/sd/waterstewardship/iwmp/dauphin/dauphin.html



The Shell River Integrated Watershed Management Plan encompasses the area of land that contributes water to the Shell River, and includes Lake of the Prairies, Shell River, and Boggy Creek. The Lake of the Prairies Conservation District is leading plan implementation in partnership with the Provincial government and a team of supporting agencies, interest groups and watershed residents.

http://www.manitoba.ca/sd/waterstewardship/iwmp/shell_river/shell_river.html

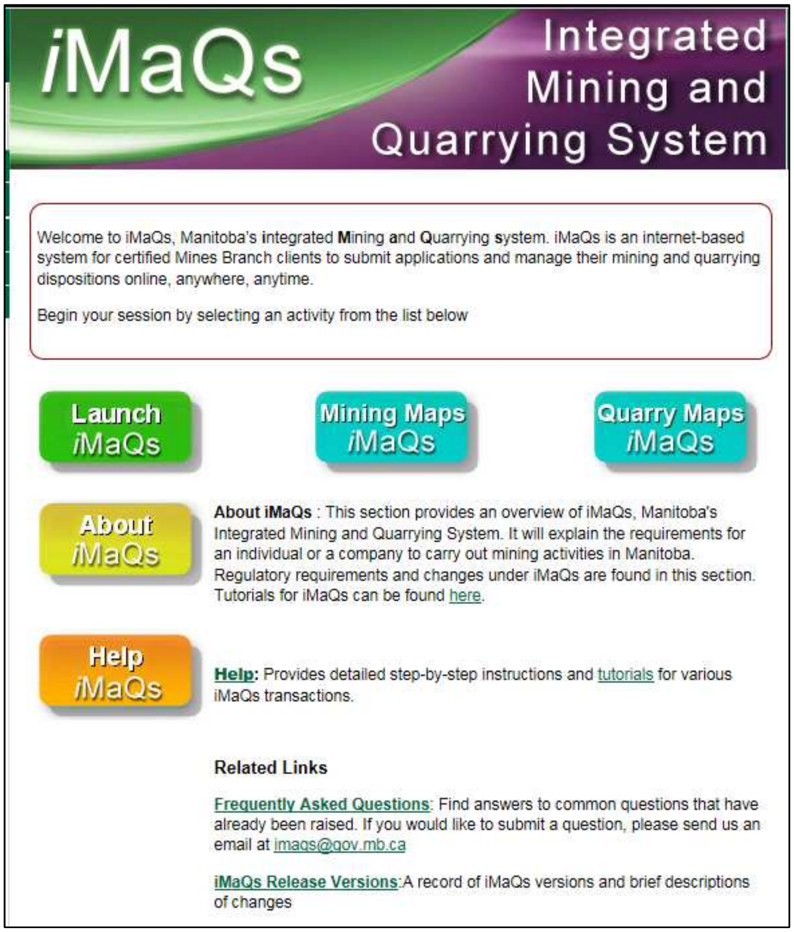
The Westlake Integrated Watershed Management Plan encompasses the area of land that contributes water to west side of Lake Manitoba and includes the Garrioch Creek and the Portia marsh. The Alonsa Conservation District developed the plan in partnership with the provincial government and a team of supporting watershed stakeholders.

http://www.manitoba.ca/sd/waterstewardship/iwmp/west_lake/west_lake.html

3.3.5. Mining claims and leases

Forest Management Licence #3 has mining claims, quarry leases, surface leases, exploration permits, and quarry withdrawals. Most of the mining activity consists of quarry withdrawals for gravel extraction. Two websites show the extent of the mining activity.

https://web33.gov.mb.ca/imaqs/



https://web33.gov.mb.ca/mapgallery/mgm-md.html

3.3.6. Commercial trapping

The Duck Mountain Registered Trap Line Section has 31 Registered Trap Lines (RTL's). Four of these trap lines are registered to Tootinaowaziibeeng First Nation along the south end of the Section. There are also three large Registered Trapping Blocks, Crane River, Camperduck, and Red Deer Shoal River, located along the east and northeast sides of the licence area. The remainder of the area in Forest Management Units (FMU's) 10 and 11 is classed as open trapping areas.

The trappers in the Duck Mountain are represented by the Duck Mountain Trappers Association. This association meets once a year and LP attends these meetings to provide updates and answer questions. LP provides maps and harvest information to any trappers who request

maps. The trappers are also represented by the Manitoba Trappers Association. The following is a website on trapping in Manitoba:
http://www.gov.mb.ca/sd/wildlife/trapping/index.html

3.3.7. Commercial guiding

Licenced bear and deer outfitters conduct the commercial guiding in the region. A guide licence is required for hunting purposes. The following website specifies the requirements for a licence:
http://www.gov.mb.ca/sd/wildlife/guidelic/index.html

Bear outfitters/guides have specific areas they are allowed to bait and hunt bears during the spring and fall bear seasons. Each outfitter has a specific number of bear tags. The deer outfitters/guides have a specific number of tags but no specific area. The following is a website for the Manitoba Lodge and Outfitters Association:
https://mloa.com/

3.3.8. Commercial fishing

Commercial fishing occurs on Swan Lake, Lake Winnipegosis, and Lake Manitoba. Fishing is an important source of income for the communities and fishermen. For more information on commercial fishing check the Wildlife and Fisheries Branch website:
http://www.gov.mb.ca/sd/waterstewardship/fisheries/commercial/commercial.html

3.3.9. Tourism

This tourism section includes recreational trails, ecotourism, camping, fishing, boating, and hunting in the area. A good overview of tourism in the Swan Valley can be found at:
http://discoverswanvalley.ca/

3.3.9.1 Recreational Trails

There are many trails in the Duck Mountain that are used by hikers, mountain bikers, snowmobiles, ATVs, trappers, cross-country skiers, horse riders, and wagons. LP works cooperatively with the Provincial government and the recreation organizations to maintain and/or enhance the trails that are encountered during harvest activities.

Duck Mountain Provincial Park has hiking trails, cross country ski trails, and one designated ATV trail. LP was a member of the Trails Working Group that worked with Parks staff to establish the ATV trail to Mossberry Lake.
https://www.gov.mb.ca/sd/parks/pdf/public/duck_mountain_trails_working_group_final_report.pdf

There are also a number of hiking and cross country ski trails at the Duck Mountain Forest Center located off highway 366, approximately 16 km south of the Town of Minitonas.

Thunderhill is a multi-use area and its' trails are used by hikers and mountain bikers in the summer and by cross country skiers in the winter. There is also a downhill ski area on Thunderhill.

Settlers and the logging industry established many of the trails used today. Many of these trails are the only access to the backcountry zones. The following website has information on most trails in the licence area: https://www.alltrails.com/

*3.3.9.1.1 **The Great Trail (Trans-Canada Trail)***

The Great Trail, formerly known as the Trans-Canada Trail, is a cross-Canada recreational trail system that began in 1992. The trail extends over 24,100 kilometers and the network consists of over 400 community trail sections. Each trail section is developed, owned, and managed locally by organizations and all levels of government.

The Crocus Trail is a 138 kilometer portion of The Great Trail, and begins at the Saskatchewan border near Madge Lake. The trail extends south through the Duck Mountain Provincial Forest through the Towns of Roblin and Inglis, and ends in the Town of Russell. The trail surface consists of grass, gravel, dirt, and pavement.

Hiking, cycling, cross-country skiing, and horseback riding are popular activities on the trail. Several species of birds, mammals, plants, and other wildlife are commonly encountered. Historical sites accessible from the trail include schools, churches, an arboretum, and two provincial parks (Duck Mountain and Assessippi).

LP assisted with technical support and helped choose the location of the Crocus Trail (The Great Trail) for the portion that is in the Duck Mountain Provincial Forest. LP has also contributed financially to the trail committee to assist with trail development.

http://www.trailsmanitoba.ca/explore-manitoba-trails__trashed/western-uplands-mixed-grass-prairie/crocus-trail/

3.3.9.1.2 Historic Cowan Trail

The Cowan trail is a historical trail that starts near the village of Cowan and heads west to the Swan Valley, south of Minitonas (Figure 3.80). The trail is named after James Cowan and was used by the first pioneer settlers that moved into the Swan Valley in 1898. A stone monument was erected and dedicated on August 9, 1998 by the Minitonas and area Sportsmen Club. The monument sits at the start of the trail, where the railroad ended and the first pioneers set out on foot to settle.

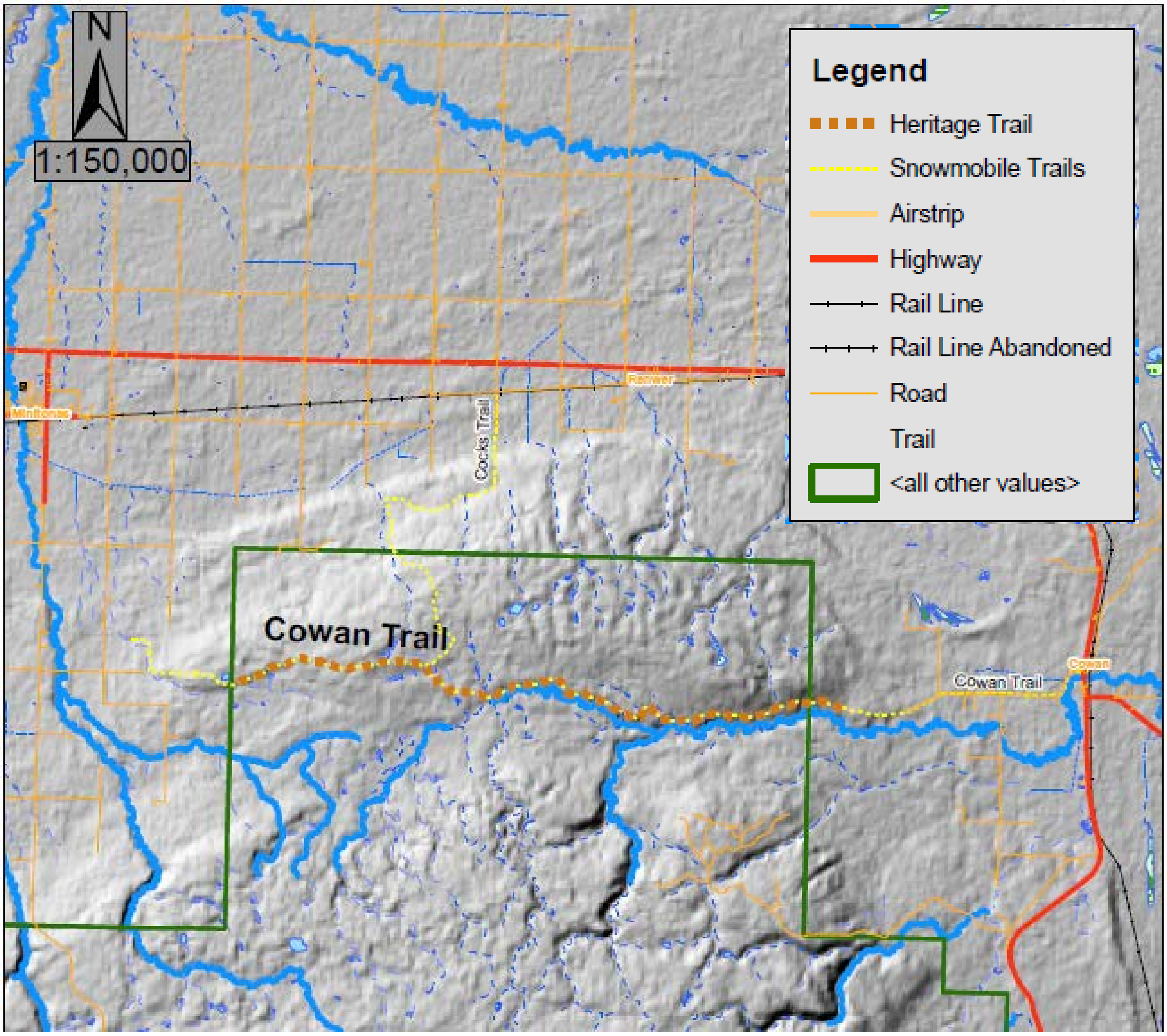


Figure 3.82 Cowan heritage trail.

The Cowan Trail Celebration is held annually in late summer in Cowan. Festivities include a six hour horse drawn wagon and horse trail ride that begins in the morning after a pancake breakfast. An ATV derby, covering approximately 70 kilometers of trail, begins in the afternoon. The day ends with a BBQ supper and dance.
http://www.mhs.mb.ca/docs/sites/cowantrailmountain.shtml
http://www.mhs.mb.ca/docs/sites/cowantrail.shtml

3.3.9.1.3 Snowmobile Trails

An abundance snowmobile trails exist in the Parklands region. There are six clubs registered with Snowman (Snowmobilers of Manitoba Incorporated) in the Parklands Region. These clubs provide signage, grooming, and maintain of snowmobile trail networks in the Parklands Region. The six clubs are the Dauphin Snowmobile Club, Intermountain Snowmobile Club, North Mountain Riders, Ochre River, Roblin Snowmobile Association, and the Swan Valley Snowmobile Association.

These six clubs maintain over 1,500 km of trail that connect to trails in the north (The Pas), Interlake (Ashern), south (Neepawa and Russell) and west to the Saskatchewan trail system. These clubs also erect and maintain warm up shelters along the trails. These shelters have facilities such as wood stoves or fireplaces, pit privies, and tables for snowmobilers to have rest stops as they use the trails.

The Swan Valley Snowmobile Association that looks after three warm up shelters and grooms over 370 kilometers of trails in the Swan Valley area and north Duck Mountain. The Cowan Trail, Wellman Lake Trail, Pretty Valley Trail, and Benito Trail are the main routes. These trails connect to the south with Dauphin, Intermountain, and Roblin snowmobile club routes, and to the west with the Saskatchewan trail system.

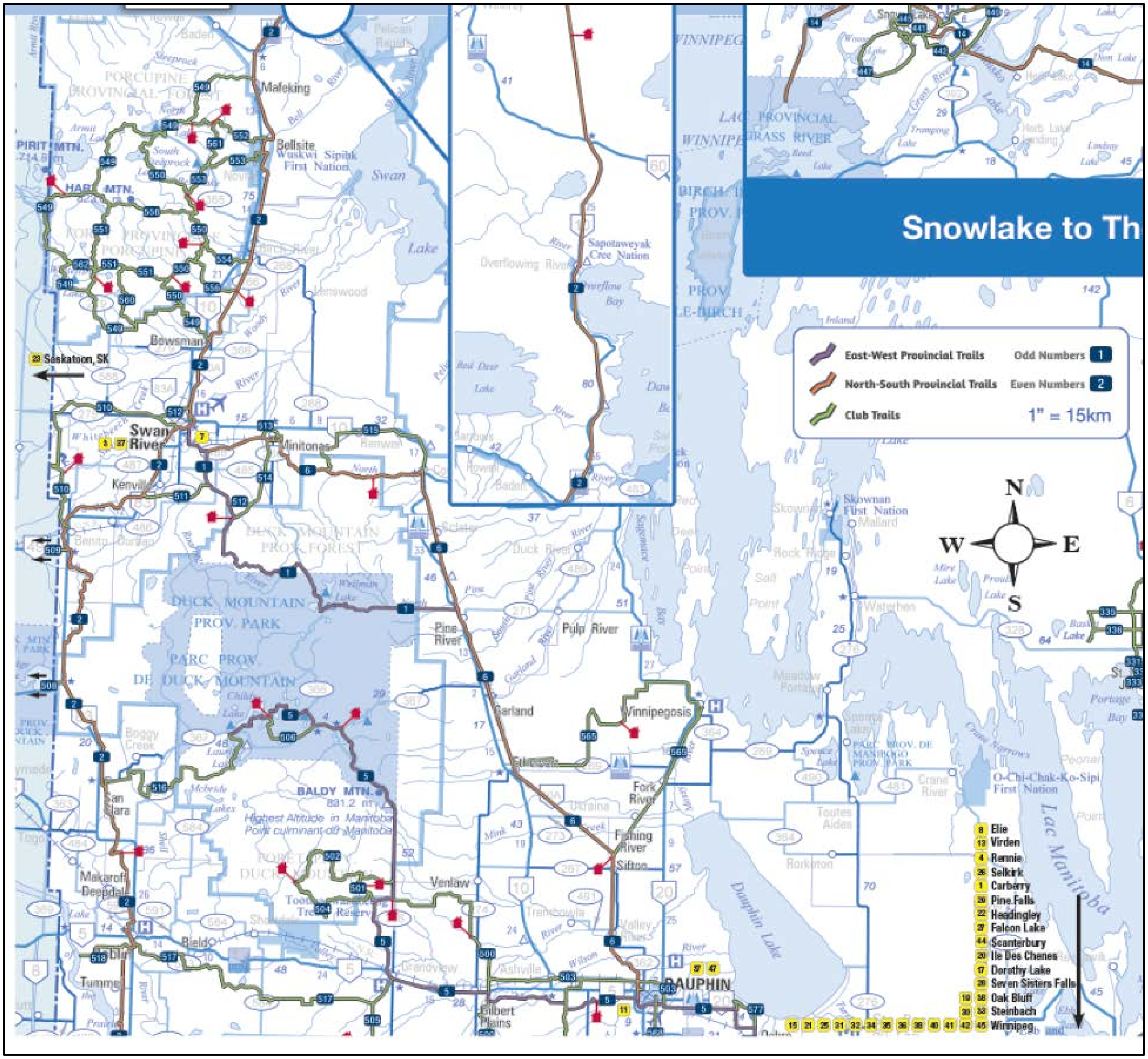
The North Mountain Riders Club looks after eight warm up shelters and grooms more than 450 kilometers of trails in the Swan Valley area and Porcupine Mountains. These trails connect north to The Pas, west to Saskatchewan, and south to the Swan Valley Snowmobile Association networks.

The following websites are from some of the Snowman clubs in the licence area:

https://www.northmountainriders.com/
http://svsaa.ca/
https://snoman.mb.ca/
https://www.northmountainriders.com/sled-town---swsan-river
http://tinyurl.com/y6v8clwp
http://www.dauphinsnowmobileclub.com/

Note that not all snowmobile clubs have websites.

The following two-page map (Figure 3.81) is from the Snowman website (maps Snowman-north and Snowman-west), that shows the trail systems in the licence area.



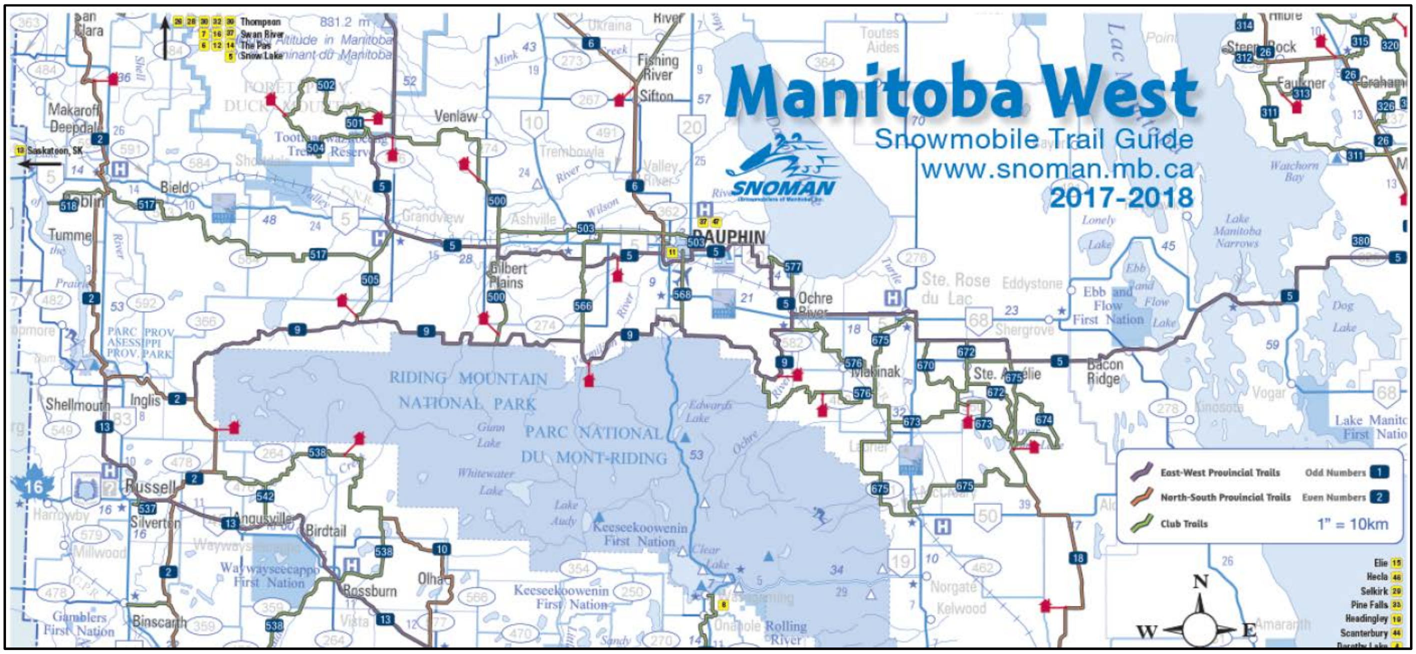


Figure 3.83 Snowmobile maps of the licence area (source: Snowman website).

https://snoman.evtrails.com/#

LP works cooperatively with the snowmobile clubs to maintain trails when harvesting is scheduled along existing trails. LP maintains a GIS layer of the snowmobile trails in the Duck Mountain (Figure 3.82) and Porcupine Mountain to assist with planning around the trails. Snowmobile trails are considered when planning future harvest areas.

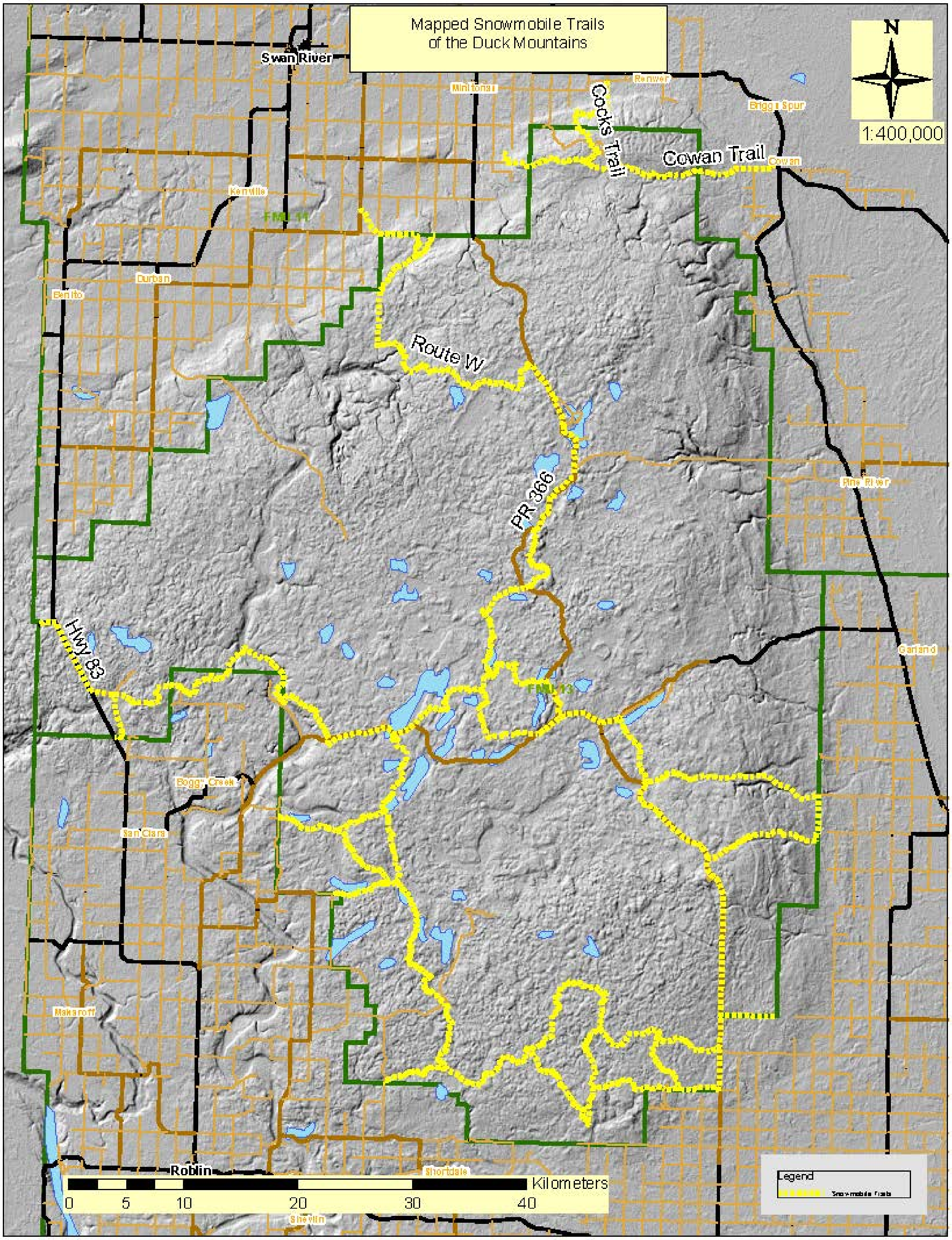


Figure 3.84 Mapped snowmobile trails in the Duck Mountain.

3.3.9.1.4 Horse Trails

Many of the trails in the Duck and Porcupine Mountains can be used by horses and wagons. There are no designated horse trails in the mountains. However there is a riding club in Birch River that uses the trails in the mountains. The Birch River Riding Club hosts an annual horse trail ride on the second weekend of August. The event runs for two days and follows trails in the Duck Mountain north of Boggy Creek. The horse ride starts on designated route Q, is located south of the Madge Lake turn off on Highway #83.

The Cowan Trail Celebration is another horse and wagon trail ride, and follows the Cowan Trail west of Cowan. The Duck Mountain Park allows horse use on most trails, including the trails in the Backcountry zone.

Wagons West out of Roblin, MB offers trail rides, riding camps for kids and families, and training for 2 one-week periods each year.

3.3.9.1.5 Hiking Trails

Duck Mountain Provincial Park has numerous trails providing visitors with plenty of opportunities that range from pleasant one-hour walks to rugged overnight camping trips. The trails go through the mountain's boreal forest, lakes, and wetlands. The following are descriptions of some of these trails.

Shining Stone Self-guiding Trail
Explore a peninsula that juts into West Blue Lake. Brochure is available at the trailhead. Return distance 1.1 km; allow 45 min.

Blue Lakes Hiking Trail
Terrain varies from level ground to rolling hills, with some steep slopes. Trail surface varies from packed topsoil, to clay and peat moss that may be wet at times. Return distance 5.5 km; allow 2 h 30 min.

Childs Lake Hiking/Ski Trails
This network of loop trails is on the west shore of Child’s Lake. Distances and facilities are shown on the trailhead map and on a site map available from district offices.

Copernicus Hill Hiking Trail
Path winds to the top of the hill where you'll find a monument to the Polish-born Nicolaus Copernicus (1473- 1543); a plaque describes his work that changed the course of human history. A viewing tower provides a spectacular northward view. From here, hikers can access the Glad Lake trail. Return distance, from the Prieston Lake trailhead, is 1.2 km; allow 1 hour.

Glad Lake Hiking/Ski Trail

Terrain varies from level to rolling, with a few steep slopes. Trail surface varies from packed topsoil to clay and peat moss. Short stretches may be wet in summer. Hikers can connect with the Copernicus Hill trail. Return distance 3.8 km; allow 1 h 30 min. Available for skiing in winter.

Shell River Valley Trail

Situated a few minutes' drive west of Childs Lake campground, the trail leads hikers through forest cover, a meadow, past the Shell River and through a calcium bog. Following a fairly steep incline to the viewpoint is effort well spent, and hikers are rewarded with a spectacular view of the Shell River valley. During the day you may see elk beds in the meadow or hear coyotes near sunset. Return distance 4.5 km; allow 1 h 30 min.

Spray Lake Trail

Terrain varies from level ground to rolling hills, with some steep slopes. Surface varies from packed topsoil, to clay and peat moss. Short loop: return distance 1.9 km; allow 1 h 15 min. Long loop: 3.5 km; allow 2 h.

Baldy Mountain Trail

Trailhead is situated on top of Baldy Mountain along with a picnic site. A short distance along the trail, hikers will find an old cabin and stable that were built in the early forestry days of Duck Mountain. They are located on the old Central Trail that was used for travel from Grandview before PR 366 was constructed. Return distance 0.6 km; allow 30 min. The looped hiking trail leads to a viewpoint above a wetland where you will find waterfowl and beaver activity. Return distance 3 km; allow 2 h. Viewing tower (Figure 3.83) provides a southward view of the Grandview Valley and slope of Riding Mountain beyond it; interpretive signs portray the use of Duck Mountain's resources through the ages.

Figure 3.85 Baldy Mountain viewing tower (Parks Branch).

Mossberry Lake Trails

This multiple-use network of trails between Blue Lake and Childs Lake is available for hiking, cycling, horseback riding, ATV, or horse and wagon. The Mossberry Trail is an approved designated trail that includes snow mobile as an approved travel method. It is the only ATV trail in Park. Further information on distances and regulations is available on a free map that is available from district and campground offices.

https://www.gov.mb.ca/sd/parks/popular_parks/western/duck_info.html#things

*3.3.9.1.6 **Pike's Peak Trail***

The Pike's Peak trail is not in the licence area but is a popular trail in the Porcupine Mountains west of Bowsman (Figure 3.84). The trail is 6.1 km long and is rated as moderate difficulty. The Pike's Peak trail is an unmaintained trail that provides multiple views of the Bowsman River Canyon. The outlook faces the southwest from what is called Pike's Peak and provides excellent views of the sunset.

Figure 3.86 Map of Pike's Peak Trail.

3.3.9.1.7 Cross-country Skiing

There are two groomed cross-country ski trails in Duck Mountain Provincial Park. The trails are located at Glad Lake and Childs Lake. The Childs Lake trail has a warm up shelter. These hyperlinks are maps of each trail.
http://www.gov.mb.ca/sd/parks/pdf/maps/winter_maps/winter_duck_mtn_glad_regatta.pdf
http://www.gov.mb.ca/sd/parks/pdf/maps/winter_maps/winter_duck_mtn_child.pdf

The Duck Mountain Forest Centre trails are also used as cross-country ski trails in the winter. There are three loops that make up 5.3 km of trail. The outside loop trail is shown in Figure 3.85.

Figure 3.87 Cross-country ski trail at the Duck Mountain Forest Center.

3.3.9.1.8 Mountain Biking

Most of the trails mentioned in the above sections can also be used by mountain bikes. Swan Valley has a cycling club called Tread the Thunder is a volunteer organization promoting and developing mountain biking at Thunder Hill (Figure 3.86), located in the Swan Valley. Thunderhill is located 23 km west of Hwy 83 on road 487. The bike club uses the downhill ski slopes and other trails on the Thunderhill; this is one of the best mountain biking areas in the Province. Thunderhill also has some unique features such as a diamond shale bank and magnetic hill.
http://www.skithunderhill.ca/index.php?option=com_content&view=article&id=47&Itemid=60

Figure 3.88 Map of Tread the Thunder Trails (Tread The Thunder website).

3.3.9.1.9 Canoe Routes

There are two designated canoe routes in the Duck Mountain Provincial Park, Chain Lakes, and Beaver Lakes. The following link is maps of the canoe routes.

http://www.gov.mb.ca/sd/parks/pdf/park_maps/2009_trail_rec_maps/chain_blue_spray_canoeing.pdf

There is also a canoe route near Dauphin on the Valley River.

3.3.9.2 Parks and Special Places

The Parklands area contains a number of large escarpments that rise out of the surrounding plains that are part of the Manitoba Escarpment. Some of these have been set aside as parks and/or provincial forests. Further north are the Porcupine Hills, north of Swan River, which is designated as a provincial forest. Duck Mountain is south of Swan River and is designated as both a provincial forest and park. Riding Mountain, south of Dauphin, is designated as a national park.

Duck Mountain Provincial Park is the largest park in the licence area, with an area of 1,424 km^2. The park is situated inside the larger Duck Mountain Provincial Forest. It is characterized by forested uplands interspersed with lakes, river valleys, wetlands, and streams, characteristic of the area's glacial origins. Duck Mountain is classified as a Natural Park, its' purpose is to preserve areas that are representative of the Western Upland Natural Region (Manitoba Conservation 2007), and to accommodate a diversity of recreational opportunities and resource uses. The park has two Backcountry zones that encompass the Shell Valley and Pine River Valley and escarpment. Baldy Mountain, in the south end of the park, is the highest point in Manitoba. The park's Resource zone is a major source of timber that flows north to mills in the Swan Valley and south to Roblin Forest Products. Recreation zones are around lake and cottaging areas such as Wellman, Glad, and Child's Lakes.

Duck Mountain Wildlife Refuge is a road-type refuge, meaning a 300 m buffer has been applied along major roads and trails within Game Hunting Area 18 where the harvest of all species and discharge of firearms is not permitted.

Duck Mountain has two unique travertine (calcified) beaver dams, one in the Shell Valley and the other north of Boggy Creek (Figure 3.87).

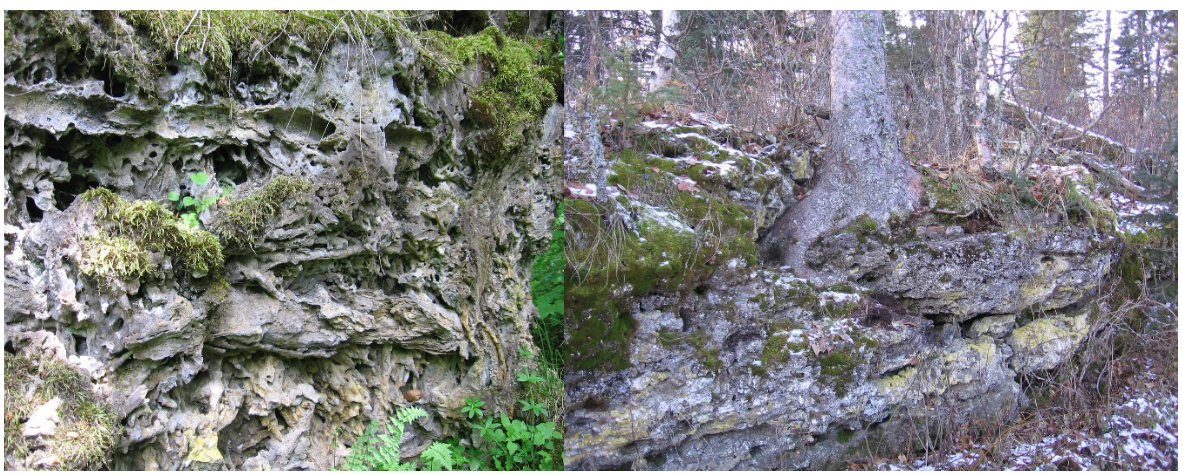


Figure 3.89 Unique travertine beaver dams in the Shell Valley (left) and Boggy Creek (right).

There are also some smaller parks in the region. The Kettle Stones Provincial Park is located northeast of Swan River in the Kettle Hills area. It features large sandstone Kettle Stones left behind when the glaciers retreated. It is generally believed the kettles are so named because they resemble household kettles or kettle drums. The area also features open meadows that have Manitoba's and possibly Canada's most northwestern patches of big bluestem – a grass associated with the tall grass prairie.

Assessippi Provincial Park is located south of Roblin along the Assiniboine River Valley. This park features the Lake of the Prairies, an impoundment created when the Shellmouth Dam was constructed on the Assiniboine River. Angling is a popular activity associated with the dam. The park also has a small backcountry zone and heritage zone where the original settlement was located. The Assessippi Ski Area and Winter Park is also a popular attraction in the area.

Just to the east of Assessippi is the town of Inglis that has the Inglis Elevators National Historic site. There are five wooden grain elevators that have been restored in the community. These elevators are examples of the wooden elevators that served the prairies throughout most of the 20^{th} century.

Manipogo Provincial Park is located north of Ste. Rose on the shores of Lake Manitoba. Manipogo is designated as a recreational development and is primarily a campground and beach.

There are also two very small provincial recreational development parks. The Springwater Provincial Park is located along highway 10 between Cowan and Garland. This location had a spring that provided water and a small rest stop. It has since been closed. The Swan River Provincial Park is a small picnic site located along the Swan River on the northeast side of Swan River.

The Cowan Bog Ecological Reserve is located just north of Cowan and 35 km east of Swan River. This site contains deep peat and black spruce. This site has several species of wild orchids including Dragon's Mouth that is a rare plant in Manitoba.

The Noel Hamm Wildlife Refuge is a land refuge located in Pretty Valley. This is a quarter section which the landowner worked with the government to set aside as a wildlife refuge. It is located along the Roaring River south of Swan River. The Harry Cox Wildlife Refuge was Private Land on the West Favel River, but was donated to the Crown.

The Nature Conservancy of Canada has purchased a number of easements between Riding Mountain and Duck Mountain. The purpose is to provide a corridor for wildlife movement between the two mountains.

There are Wildlife Management Areas (WMAs) in the Forest Management Licence 3 area. These are all located in the east and east central portion of the licence. The WMA names are Alonsa, Cayer, Point River, Weiden, and Westlake.

3.3.9.3 Recreational fishing

Recreational fishing is a popular activity in the Parklands Region. The area has many lakes, rivers, and streams with an abundance of native species such as walleye, northern pike and perch. Many of the lakes and streams have been stocked with not only walleye but various trout species. Pine River is the trout capital of Manitoba and is known for its' brook trout. The Fisheries Branch website has a complete list of species stocked, anglers' guides, and other fisheries related information: http://www.gov.mb.ca/waterstewardship/fish/index.html

The FML #3 planning team works with the Manitoba government to ensure water quality is maintained on all water bodies. Erosion control on roads and water crossings, buffer zones, season of harvest and other techniques are used to maintain water quality, as per the provincial Riparian Management Stream Crossing Guidelines (MNR 1996).

3.3.9.4 Licenced hunting

Hunting is a popular activity in the Parklands Region. There are hunting seasons for elk, white tailed deer, black bear, upland game birds and waterfowl in the region. Black bear and deer outfitters provide opportunities for non-residents to hunt these species. There is currently a closure of moose hunting due to a concern over moose populations.

Access for big game hunting in Game Hunting Area 18 is controlled by designated routes. Licenced big game hunters are restricted to vehicle travel on designated routes only. For complete information on hunting, refer to the Manitoba Hunting Guide on the Manitoba government website:
http://www.gov.mb.ca/sd/wildlife/hunting/

The Manitoba Wildlife Federation (MWF) is also active in the region. This group works with government and other stakeholders to ensure wildlife populations are managed sustainably and continue to provide hunting opportunities. More information can be found on their website:
http://mwf.mb.ca/

3.3.9.5 Campgrounds

Duck Mountain Provincial Park has campgrounds at Wellman/Glad Lake, Blue Lakes, Singush Lake, and Childs Lake. These campgrounds provide serviced and unserviced sites for a variety of camping experiences.

There are also provincial campgrounds in Assessippi and Manipogo Provincial Parks. These are small provincial parks primarily classed as recreational development.

Many of the towns in FML #3 have community campgrounds. These provide a variety of sites from full service to unserviced sites.

3.3.9.6 Tourism

Tourism is an important activity in the Parklands region; there are many opportunities to explore and experience the area. The Parklands Region offers many activities that have already been mentioned. In addition, there are ecotourism companies, geocaching, golf, museums, and other activities. There are tourism guides and websites for many of the communities in the region:

http://discoverswanvalley.ca/
http://www.roblinmanitoba.com/index.php?pageid=VISINT
http://parklandtourism.com/
http://www.tourismdauphin.ca/

3.3.10. Non-Timber Forest Products

The forested lands are also sources of non- timber products. Edibles from the forest include: chokecherries, blueberries, pin cherries, saskatoons, mushrooms, and fiddleheads. These are often eaten fresh, or the berries are processed into jam or jelly.

Craft producers use birch bark and willow for baskets, spruce boughs for wreaths, antlers for art and sculptures. There are also medicinal and spiritual plants used by First Nations that are found throughout the region.

3.3.11. Local Use of Timber

Most of the harvesting in the licence area is by Louisiana-Pacific Canada Ltd., Spruce Products Ltd., and Roblin Forest Products. There are a number of small sawmills in the area, such as Riehl's Lumber and Logging.

Fuelwood harvesting is done throughout the area. Many of the Crown wood Quota Holders harvest fuelwood for private sales. Intermountain Contracting is the largest fuelwood processor in the area. The Quota Holder policy is available on the Forestry and Peatlands Branch website: https://www.gov.mb.ca/sd/forestry/manage/cutting_right.html

The Manitoba Metis Federation harvests fuelwood for members who are not able to harvest fuelwood for themselves. There is also a small volume of rails and posts harvested by local landowners.

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