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

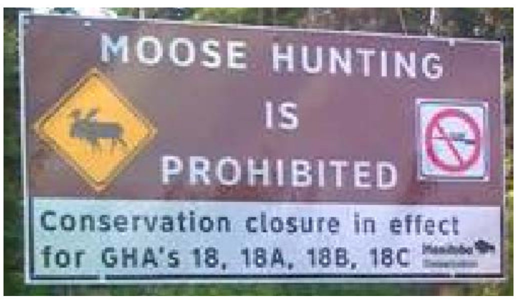
Moles, shrews, mice, voles, eastern chipmunk, snowshoe hare, and porcupine spend most of their life history on the ground. Small ground mammals other than the vagrant shrew use a variety of habitats from wet areas near waterbodies to moist or dry softwood, mixedwood, or hardwood. The vagrant shrew uses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

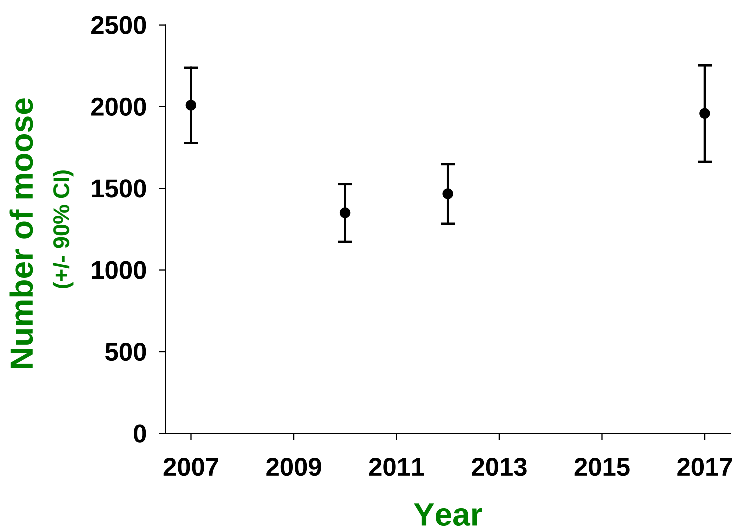


Figure 3.59 Moose population estimates for the Duck Mountain population (Wildlife and Fisheries Branch).

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/km². 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

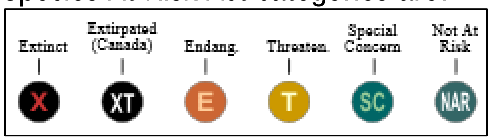
COSEWIC and the Species at Risk Act

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 spraguei*)
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 (5^{th} 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.

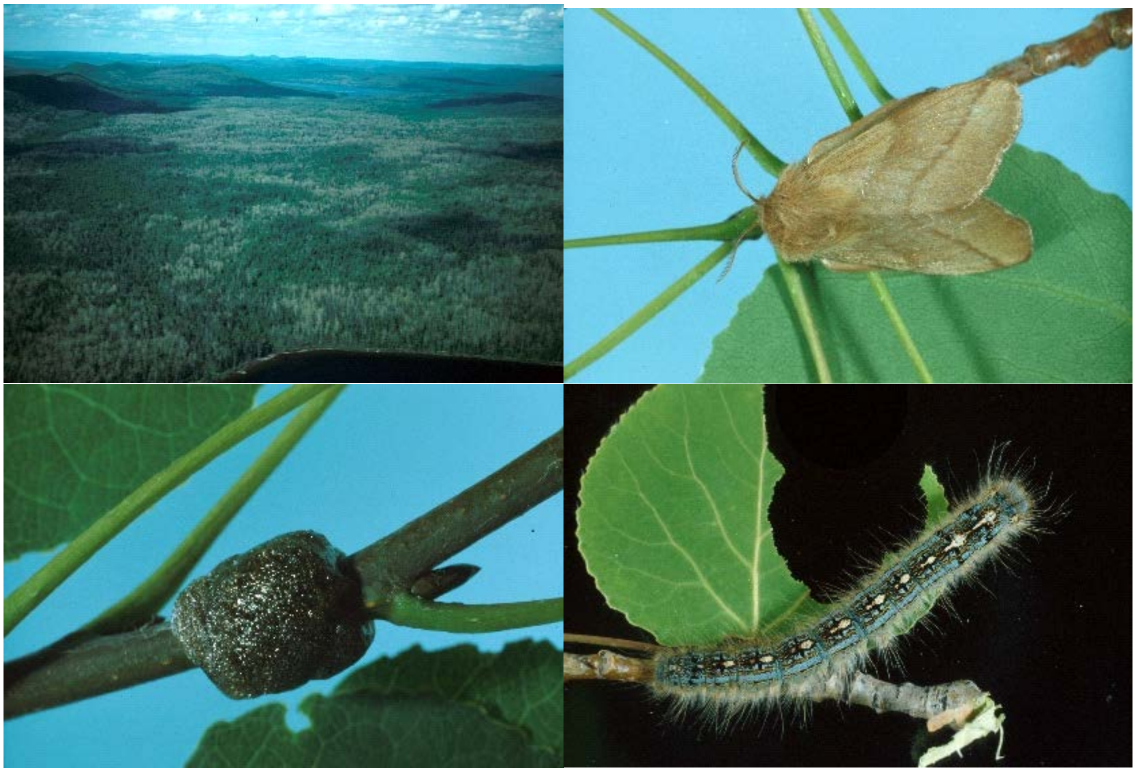


Figure 3.61 Forest tent caterpillar image series: aerial view of defoliation of trembling aspen, top left; adult female moth, top right; egg band, bottom left; and larva and feeding damage on trembling aspen, bottom right (all photos NRCAN 2003b; credits Luc Côté and Thérèse Arcand).

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 (6^{th} 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.