Chapter 2: Report of Past Operations

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2. REPORT OF PAST OPERATIONS

2.1. Report of Past Operations Summary

This Report of Past Operations is part of the background information assembled in the preparation of the Forest Management Plan. This summary of previous forest management activities in Forest Management Licence #3, includes natural disturbances, road construction, water crossings, access management, harvest areas, harvest volumes, renewal activities, road decommissioning, research and monitoring. These previous activities include softwood Quota Holders, such as Spruce Products Ltd., hardwood Quota Holders, and Louisiana-Pacific Canada Ltd. hardwood operations.

This Report of Past Operations acts as a point of reference from the year 2006, which was the submission of the previous Forest Management Plan for Forest Management Licence #3 (FML #3). Annual Reports for FML #3 from 2006 to present are the main source of information for this chapter. Other sources of fibre outside of FML #3 are not covered in this report, including Crown wood that was harvested on Forest Management Units 12 and 14 (Porcupine Mountain Provincial Forest) under the authority of the Mountain Quota Holder Forest Management Plan for that area.

Natural disturbances, such as forest fires, insects, and disease, have not significantly affected FML #3 since 2006. However, in June of 2012, a significant wind event caused the blowdown of approximately 14,300 ha of forest on the north end of the Duck Mountains. Beaver flooding continued to have a significant effect on the landscape but is not mapped or quantified.

Over a ten-year average, 20% of forest roads utilized were comprised of newly constructed roads, while the remaining 80% of roads were pre-existing access. All new forest roads were decommissioned, but existing access was maintained. Access management of roads was a continued focus. Water crossing structures were prescribed on a site-specific basis and risk-ranking.

The area harvested by Quota Holders (softwood and hardwood) and Louisiana-Pacific Canada Ltd. was below average, mostly due to the 2007-2009 recession. Likewise, harvest volumes were below average, contributing to an undercut of both hardwood and softwood, from 2006 to present.

All harvest areas were regenerated either through natural regeneration (vigorous hardwood root suckering) or by the planting of conifer seedlings. Tree planting of conifer seedlings averaged 1.1 million seedlings per year. Areas that were difficult to access for tree planting used a helicopter to transport both seedlings and tree planters. The practice of caching seedlings under a pile of snow has been discontinued in favour of the helicopter.

Through various research and conservation partnerships, ecological, social and economic elements of Sustainable Forest Management have been advanced. Ducks Unlimited Canada provided significant knowledge about the distribution and characteristics of boreal wetlands and waterfowl, forest roads and wetland crossings, and the significance of carbon storage in wetlands.

2.2. Natural Disturbances

Natural disturbances that occurred within the Forest Management Licence # 3 area include fire, blow down, insects, diseases, and beaver flooding.

2.2.1. *Fire Summary*

One of the most common natural disturbance agents in Manitoba was forest fire. In the period from 2006 to 2019, there have been few fires (Table 2.1). Some years have fires, some years have no fires. There have not been any recent catastrophic large fires (*e.g.* 50,000 ha or greater).

Table 2.1 Fire history in Forest Management Licence 3 from 2006 to 2019 (source: Province of Manitoba).

	Area (ha) by cover group							
Fire Year	**Hard wood**	**Soft wood**	**Mixed wood**	**Non Forest**	**Non Productive**	**Potentially Productive**	**TOTAL area (ha) burnt by Year**	**Percent of FML #3 burnt per year**
2006	24.5	39.3	51.0	175.4	16.0		**306.2**	0.003%
2007	178.4	29.9	15.5	2,382.9	8.1		**2,614.8**	0.025%
2008	151.8	6.1	34.6	2,375.6	0.8	157.6	**2,726.4**	0.027%
2009	239.0		7.9	20,063.8	13.6	7.6	**20,331.8**	0.198%
2010							**-**	0%
2011	118.5			6,754.4			**6,872.9**	0.067%
2012	420.5		19.9	5,142.0	81.1	89.9	**5,753.4**	0.056%
2013							**-**	0%
2014	23.4			37.1			**60.5**	0.001%
2015	1,387.4	9.9	4.8	996.4	176.6	11.7	**2,586.7**	0.025%
2016	107.3	0.3	23.8	2,434.2	26.7		**2,592.2**	0.025%
2017		12.8		0.3			**13.2**	0.000%
2018	100.5	3.9	9.4	206.1	3.8		**323.7**	0.003%
2019			0.2	0.1			**0.3**	0.000%
Cover Type totals	**2,650.7**	**85.5**	**157.5**	**40,361.9**	**322.7**	**266.8**	**43,858.3**	0.427%

The location of these infrequent and small fires are shown in Figure 2.1.

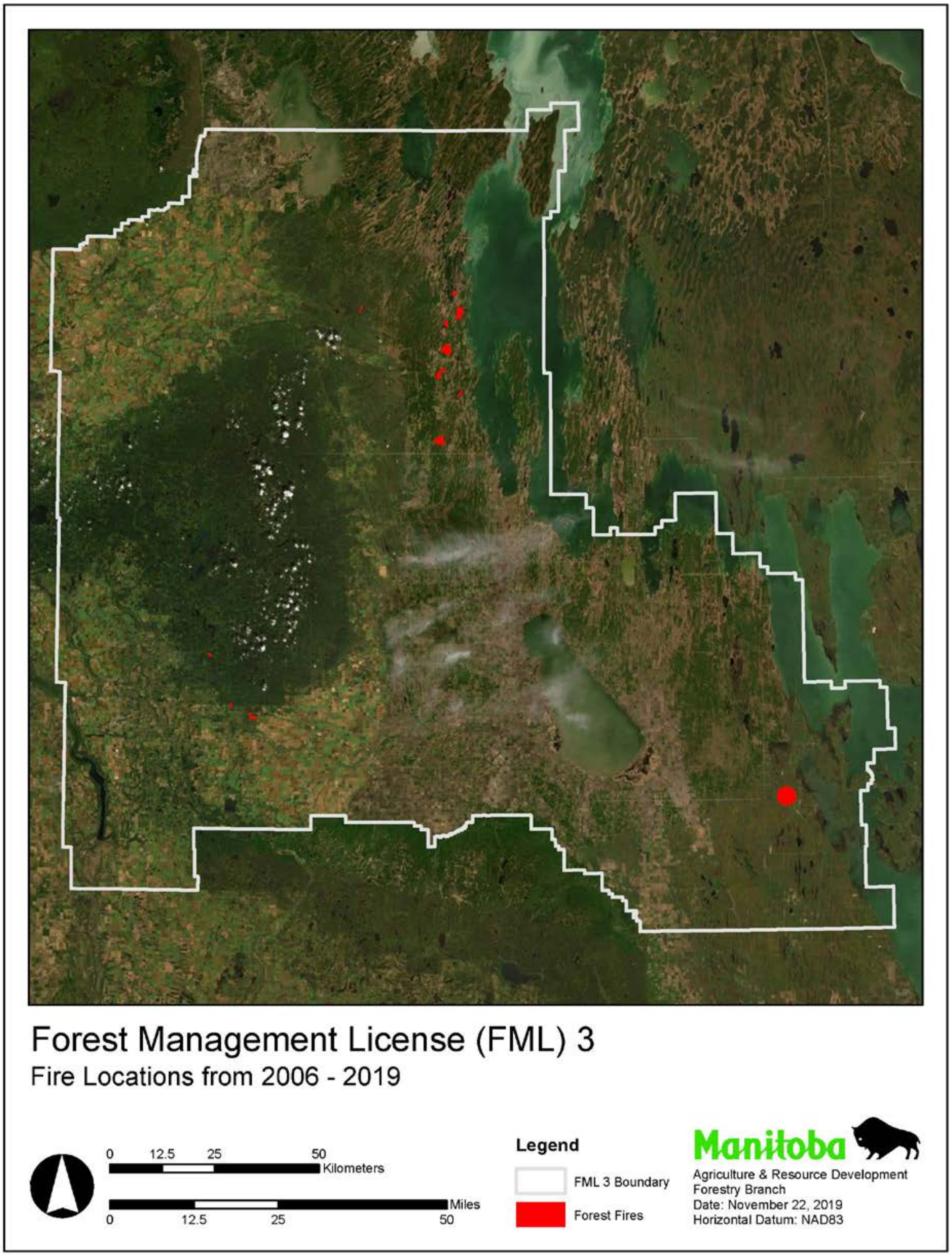


Figure 2.1 **Forest Management Licence 3 fire locations from 2006 to 2019 (Province of Manitoba).**

2.2.2. Blowdown

In June 2012 a windstorm occurred in the northern portion of the Duck Mountain area (Figure 2.2). Large areas of forest were affected, and aerial photography was captured in fall 2012. Delineation of the affected areas began at the end of 2012 and into 2013. While the degree of impact varies from minor to severe, within FMU 11 approximately 6,000 hectares were affected and in FMU 13 approximately 8,300 hectares were blown down.

Smaller windstorms have occurred in the licence area since 2002 but have not been mapped.

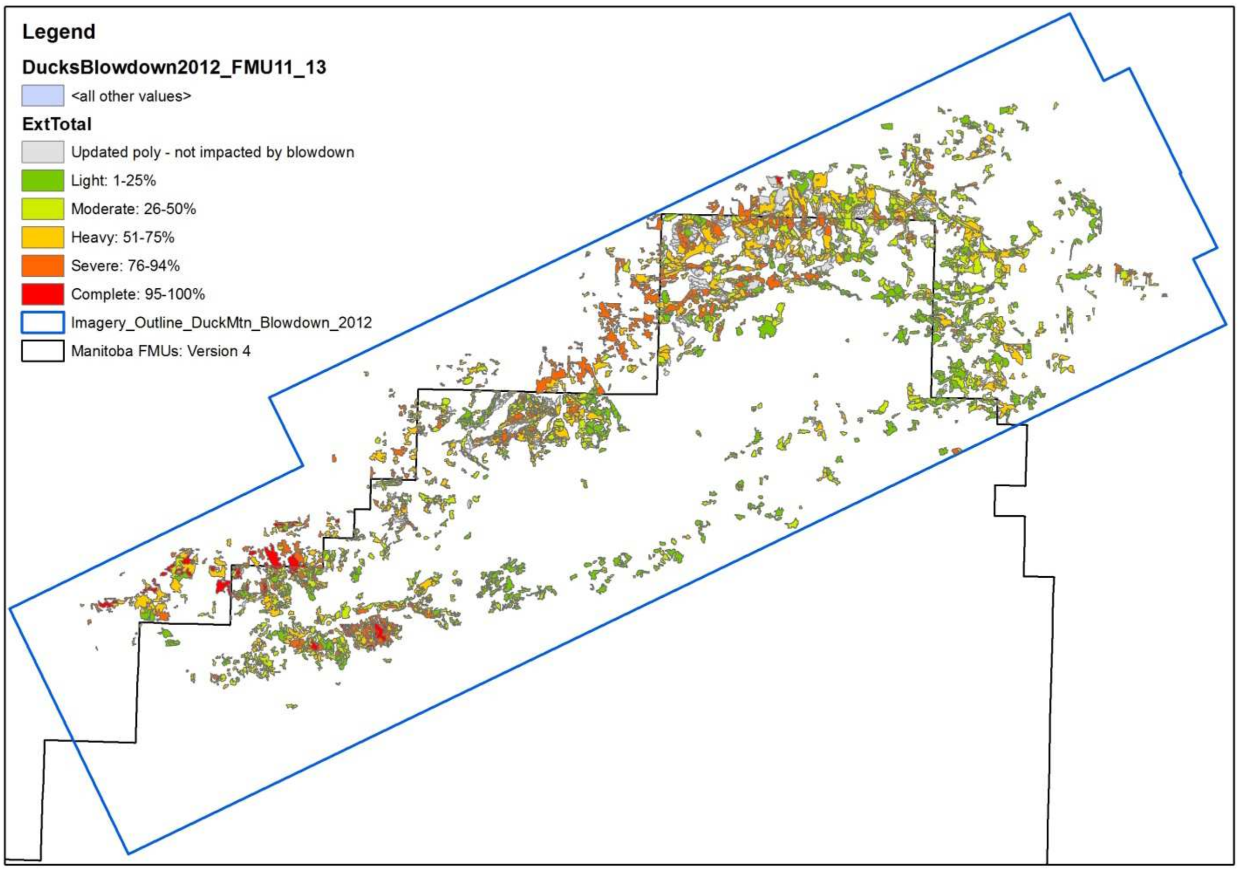


Figure 2.2 Northern portion of Duck Mountain Provincial Forest, illustrating severity of impact of the June 2012 blowdown event (Sustainable Development).

2.2.3. Insects Summary

Forest insects are a natural part of boreal ecosystems in endemic or low levels. Typically, these low insect levels only defoliate a portion of a tree, and do not cause mortality in whole stands of trees. However, epidemic or extreme levels of forest insects cause noticeable damage to single trees and stands of trees.

Forest insect monitoring, mapping, and control is a provincial responsibility of the Manitoba government. The Province mapped the defoliation or death of trees and stands of trees, rather than the forest insects directly. The Province maps the stands in which defoliation and or tree death is related to significant insect infestations.

Annual aerial monitoring for major forest insects is performed by the Province of Manitoba. Aerial surveys are flown 27 km apart, on north-south transects (Figure 2.3). Major forest insect damage mapped in FML #3 included: spruce budworm (*Choristoneura fumiferana*); jack pine budworm (*Choristoneura pinus*); and forest tent caterpillar (*Malacosoma disstria*). There was significant mortality of larch trees, which triggered additional monitoring for eastern larch beetle (*Dendroctonus simplex*) from 2010-2014. Many mixed conifer stands of black spruce and larch are now mostly black spruce, due to mortality from the eastern larch beetle.

Spruce budworm population levels remained low to moderate, until a recent outbreak in the south-western part of the Duck Mountain. Planners and the provincial government are modifying harvest plans to attempt to minimize the white spruce mortality that spruce budworm can cause.

Jack pine budworm levels in the Western Region were negligible. Small pockets of jack pine budworm were evident on the northwest and northeast fringes of the Duck Mountain Provincial Forest.

Forest tent caterpillar increased in population in 2013, peaking in localized areas across FML #3 in 2016. Some areas of FML #3 have seen moderate to severe levels of defoliation by this native insect. This defoliation has continued over FML #3 until 2016 but is expected to decline.

Other insects exist in the forest, such as Poplar borer (*Saperda calcarata)*; root collar weevils, and various shoot weevils. However, none of these insects caused severe damage to large areas of forest. None of these insects caused enough damage to be able to map their effect on the forest.

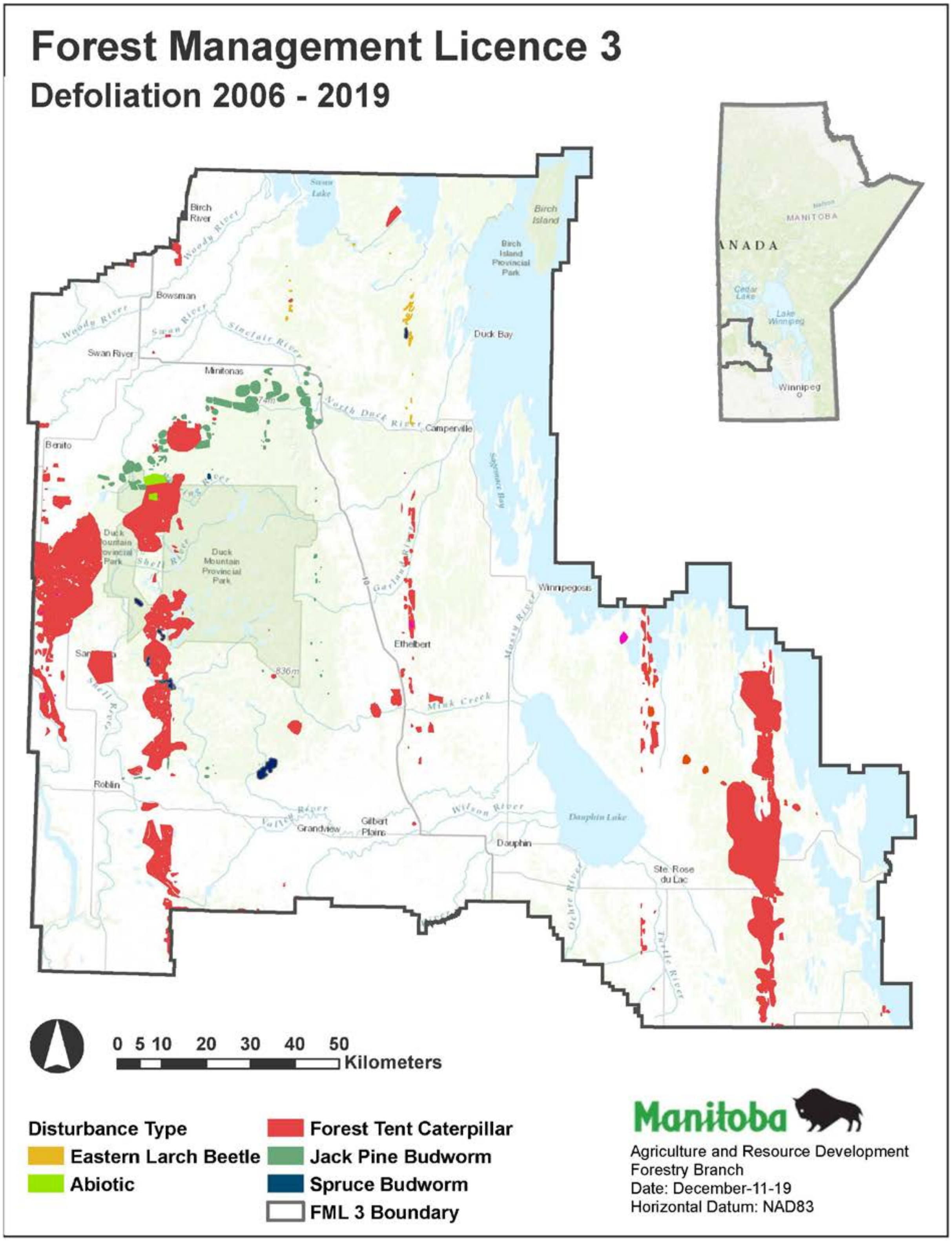


Figure 2.3 2006 to 2019 insect defoliation mapping in FML # 3 (Province of Manitoba).

2.2.4. Disease Summary

Similar to forest insects, if forest diseases are at a low level, only individual trees are affected or die within stands of many trees. During the 2006 to 2019 period in FML #3, forest diseases did not cause widespread stand mortality, and were not mapped by the provincial government.

There are many different diseases in the forest. The more prevalent and common forest diseases in FML #3 include:

- Red ring rot or white pocket rot (*Phellinus pini);*
- Yellow Stringy Rot (*Perenniporea subacida*);
- Aspen trunk rot (*Phellinus tremulae*) evidenced by conks on older aspen. Aspen trunk rot was very common and widespread across FML #3;
- Hypoxylon Canker (*Hypoxylon mammatum*) kills individual aspen trees, and was also widespread;
- Armillaria root rots (*Armillaria ostoyae, Armillaria calvescens, and Armillaria sinapina);*
- Eastern dwarf mistletoe (*Arceuthobium pusillum*) and Jack pine dwarf mistletoe (*Arceuthobium americanum*); and
- Western Gall Rust (*Endocronartium harknessii*) in the center of the Duck Mountain.

2.2.5. Beaver Flooding

Beavers (*Castor canadensis*) have both positive and negative effects on boreal ecosystems. The active beaver feeding zone along waterways kills aspen for food but releases white spruce from competition. Beaver dams flood parts of the forest, changing the landscape and creating habitat that can be used by fish, waterfowl, shorebirds and amphibians (Kavanagh 2006). Negative effects include flooding upland forest, blocking streams, and contributing to excessive water run-off when dams break.

2.3. Road Construction, Access Management, and Decommissioning

Road construction can have a significant effect on the forest landscape. Measures were put into place to reduce new road construction by utilizing active or pre-existing roads and trails wherever possible. While existing or traditional access routes have remained open, newly built roads were managed and closed through slash roll-back, berms, and/or gates. In cases where an existing road was upgraded for the purposes of harvesting operations, the road was closed after use and returned to its original access condition.

2.3.1. Road Location

Road locations are shown on the map (Figure 2.4). Forestry roads were located to connect to the existing road network. The agriculture area has a grid road network on a one mile by two-mile grid. Less forestry roads needed to be located in the agricultural area, due to ample existing road access. In the Duck Mountain Provincial Forest, existing roads (*e.g.* highways #366 and #367, Sarah Lake Road) were utilized. Temporary forest access roads were located that connect to the pre-existing road network.

Several criteria were taken into consideration when forest roads location are designed:

- topography
- location and types of watercourses and wetlands,
- proximity to lakes and unique features,
- critical wildlife habitat locations,
- location of existing roads and trails
- cultural features or other protected areas
- number of cut blocks to be accessed
- season of use
- other users

Once a road location was planned, the road right-of-way was ground checked to ensure that the proposed road location would not conflict with any of the criteria.

Forest access roads were constructed on stable soil types. Roads were also located away from major waterbodies and watercourses, where possible, to minimize potential effects on aquatic habitats. Forest areas known to support unique or critical habitats were avoided, as were any sensitive cultural heritage sites. To minimize forest disturbance, the number of cut and fill operations were minimized. Roads were constructed on natural benches, moderate slopes and ridges, wherever possible.

When constructed, forest road ditches were directed into the adjacent forest vegetation, in order to minimize the potential for sediment to be transported directly into any watercourse. The forest vegetation filtered sediment carried by surface runoff. Exposed soil material in road ditches was stabilized using surface roughening techniques and seeding. All debris accumulated through road clearing and construction operations was stored away from any watercourse or waterbody to prevent this material from potentially entering these areas.

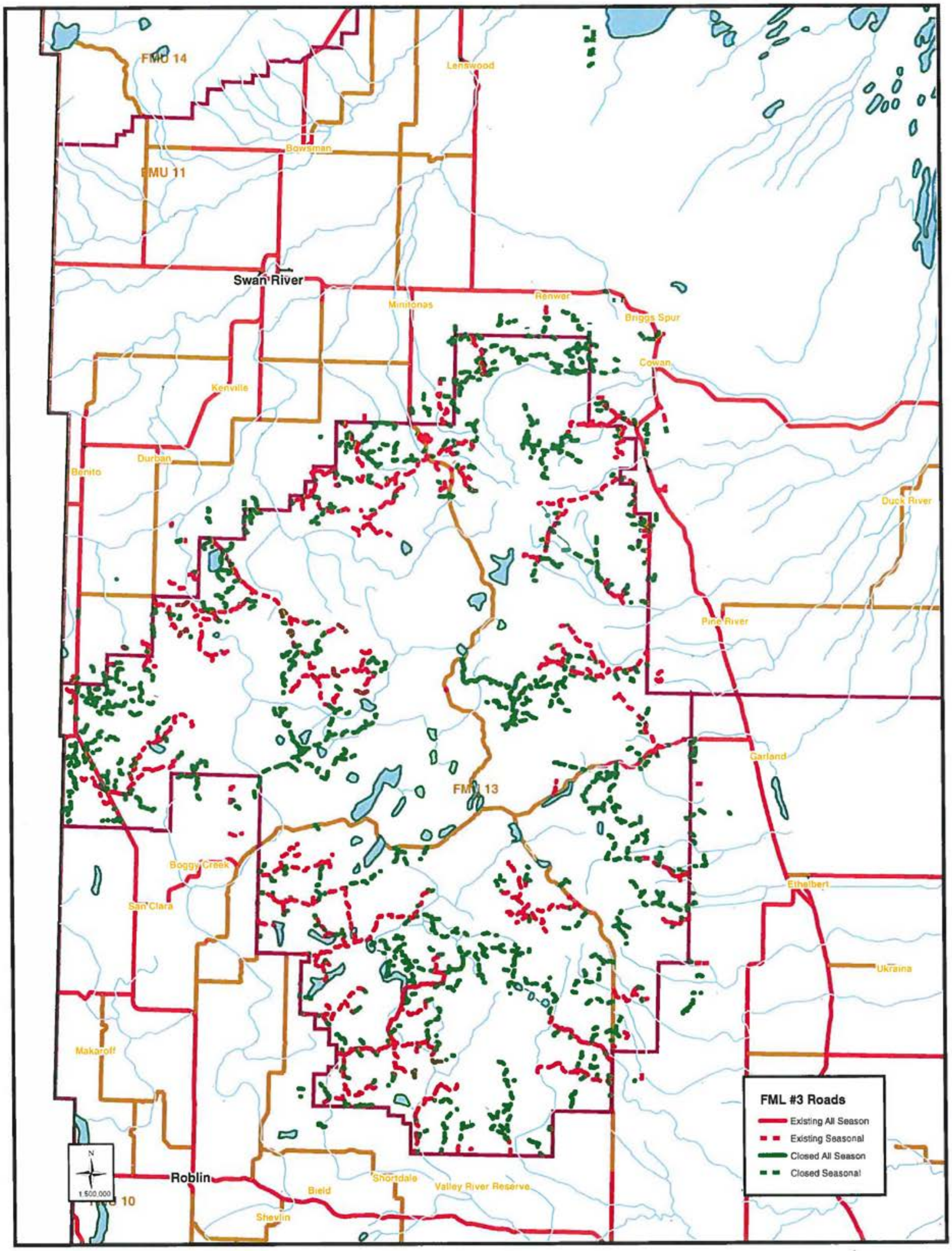


Figure 2.4 Roads in Forest Management Licence # 3.

2.3.2. Road Construction Description

The following road definitions were used in FML #3 for season of road use:

All-Season – an all-weather road. Roads in this group require precut rights-of-way before roads are constructed. These roads may include ditching and graveling.

Dry/Frozen – clay base road, sections of dry/frozen roads may need ditching and graveling. Traffic ceases on these roads after a significant rainfall and must wait for the road to dry out. Low grade roads with some grade work and ditching where necessary and may include gravel.

Frozen – winter only roads across wet areas (can only operate when road was frozen). Little to no development occurs with frozen roads.

2.3.2.1. *Right of Way Clearing*

The width of road Right-of-Ways (ROWs) were determined by road construction and maintenance needs and by site specific environmental considerations. The following factors influenced ROW clearing widths:

- Visual screening for wildlife and aesthetics.
- Need for road grade drying.
- Unstable and difficult terrain for construction.
- Safety concerns.

The organic horizon and herbaceous vegetation was maintained on the approaches adjacent to the watercourse crossings, where possible. Top soil was piled apart from logging debris and used for road and landing reclamation, where feasible.

Road construction was avoided within 100 m of the high-water mark of any permanent stream, and 30 m of an intermittent stream or natural spring. In situations where construction could not be avoided, careful planning was used to minimize the potential for erosion and sedimentation. Associated road construction activities such as borrow pits, landings, camp and storage sites in buffer zones were minimized.

2.3.2.2. *Road Construction*

Road back slopes had a regular profile from the top of the cut to the bottom of the ditch with no hanging banks or sharp cut ditches. Ditches were constructed to the same grade as the road and be sufficiently deep to drain the subgrade unless limited by topography.

The number of borrow pits and gravel pits developed for road construction and maintenance were kept to a minimum. The use of existing gravel pits was a priority. All gravel pits required the appropriate permits from the Province of Manitoba. Gravel pits were not located near groundwater source areas.

Run-off ditches and other erosion control devices were installed during road construction and were maintained to:

- Minimize water movement and erosion along ditches, on the road surface and on cut-and-fill slopes.
- drainage was provided as required, for water from springs or seepage areas.
- ditch drainage into directly into watercourses was avoided, instead water was directed from the Right-of-Way into the surrounding vegetation in as short a distance as possible.

Final erosion control measures were installed after road construction. These measures included re-vegetation, seeding, establishment of silt fence, and removal of unstable fill material. Site disturbance was minimized during road construction to reduce the extent of reclamation required during road abandonment.

2.3.2.3. *Road Useage*

Typically, wood was hauled out of the cutblock on an in-block road, then hauled on a short bush road (either an upgraded existing road or a new road) to the existing road network. The harvesting of both hardwoods and softwoods were done simultaneously to enhance road utilization. The roads were used to haul both softwood and hardwood at the same time, which resulted in a shorter haul period and allowed for quicker road decommissioning.

A summary of road construction by road class is outlined in Table 2.2 and Figure 2.6. It should be noted that the majority of newly constructed roads were closed on an annual basis, following completion of harvest and renewal operations. As a result, the total road lengths include roads that have now been closed – therefore the information is on the amount of construction that occurred, rather than the extent of the currently existing road network.

Figure 2.5 In-block road construction.

Table 2.2 Annual road construction.

	EXISTING ROADS				NEW ROADS				
Year	All Season	Dry Frozen	Frozen	Sub total	All Season	Dry Frozen	Frozen	Sub total	GRAND TOTAL (km)
2006-2007	17.7	128.9	42.3	**188.9**	0.0	76.3	56.9	**133.2**	**322.1**
2007-2008	141.0	39.9	47.8	**228.7**	20.1	7.1	29.9	**57.1**	**285.8**
2008-2009	83.9	14.9	31.7	**130.5**	9.5	7.5	14.6	**31.6**	**162.1**
2009-2010	62.5	24.2	12.0	**98.7**	6.1	4.1	7.1	**17.3**	**116.0**
2010-2011	106.4	34.1	14.0	**154.5**	3.4	18.0	10.1	**31.5**	**186.0**
2011-2012	93.8	26.0	18.0	**137.8**	2.2	7.2	6.0	**15.4**	**153.2**
2012-2013	71.6	34.5	25.8	**131.9**	2.5	15.3	5.3	**23.1**	**155.0**
2013-2014	65.5	61.3	16.8	**143.6**	0.0	22.8	2.5	**25.3**	**168.9**
2014-2015	60.7	62.3	32.5	**155.5**	0.8	24.7	10.8	**36.3**	**191.8**
2015-2016	56.4	58.9	15.9	**131.2**	0.0	10.8	11.2	**22.0**	**153.2**
2016-2017	46.5	68.2	16.3	**131.0**	0.0	13.7	7.2	**20.9**	**151.9**
2017-2018	41.6	97.1	37.9	**176.6**	0.0	20.5	10.7	**31.2**	**207.8**
2018-2019	**56.4**	**64.8**	**45.8**	**167.0**	**0.0**	**10.5**	**16.1**	**26.6**	**193.6**
Totals	**904.0**	**715.1**	**356.8**	**1,975.9**	**44.6**	**238.5**	**188.4**	**471.5**	**2,447.4**
			Existing roads	**81%**			New roads	**19%**	

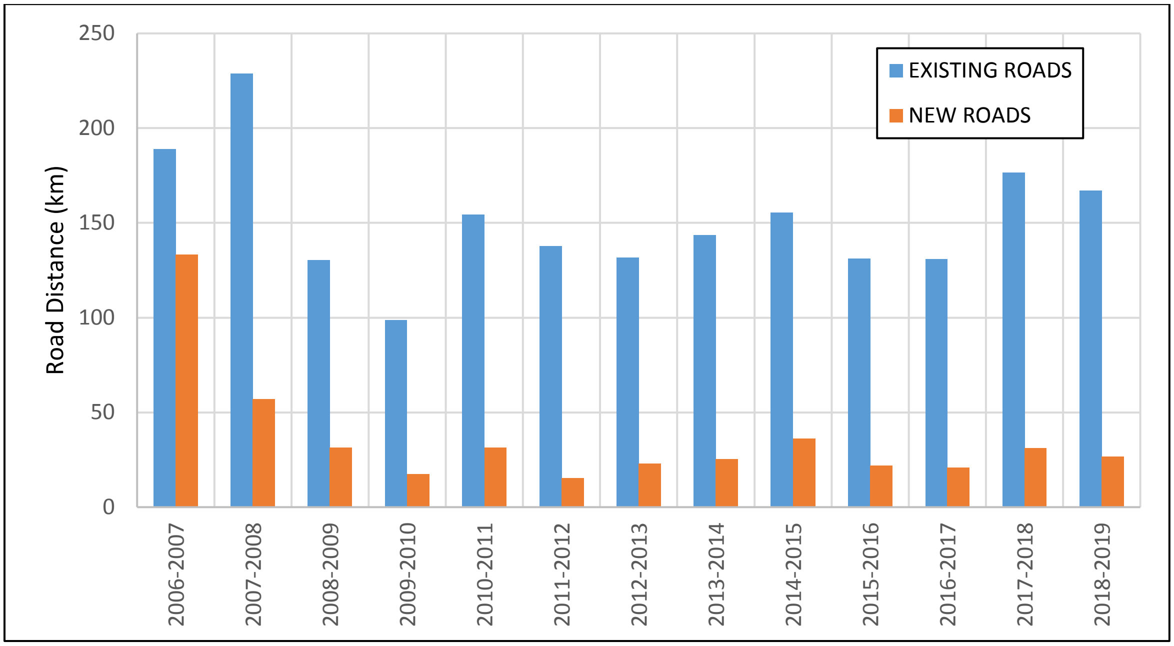


Figure 2.6 Existing road usage and new road construction in FML # 3.

In cases where follow-up silviculture activities were prescribed, a temporary road closure was constructed until the scarification equipment and planting contractors had completed their work. These areas were promptly closed following the completion of silvicultural activities. Temporary closures were also used in areas if harvested wood was decked at the landing in tree lengths, until slashed and hauled following road restriction periods.

2.3.3. Road Status

The road status of existing all weather and seasonal access forestry roads are referred to as existing when they are open (solid or dashed black lines on map - Appendix 1). The majority of roads used to haul wood are existing roads. The minority of roads used to haul wood are new roads.

Roads that were decommissioned are considered closed. Closed roads are depicted by a green line on the map (Appendix 1). The majority of roads closed and decommissioned were seasonal roads, and a small percentage of closed roads were all-weather roads.

2.3.4. Access Management

Ungulate populations (moose, elk, and deer) are sensitive to increased hunting pressure that typically follows unmanaged road access. To protect ungulate populations, logging road access was managed by using a variety of methods (Figure 2.7) including:

- temporary road closures, such as dirt berms
- long-term road closures, such as removal of a culvert or bridge
- road decommissioning
- roll-back of slash and organic matter back onto the road
- gates
- combinations of the above-listed techniques

Figure 2.7 Access management examples including road closures or crossing removals.

2.3.5. Road Reclamation and Decommissioning

Most forest roads were short-term and were decommissioned after harvest (Figure 2.8). New roads were closed when harvest and renewal activities were complete (Table 2.3). Existing access was returned to its' previous use (*e.g.* an ATV trail would be restored to ATV access only).

Figure 2.8 Road decommissioning being carried out in a harvest block (left); decommissioned road (right).

Table 2.3 Road decommissioning metrics in FML # 3.

	Temporary Road Closures					Decommissioned Roads					
Year	**All Season**	**Dry Frozen**	**Frozen**	**in block**	**subtotal**	**All Season**	**Dry Frozen**	**Frozen**	**in block**	**subtotal**	**GRAND TOTAL (km)**
2017-2018	0.0	2.7	0.0	0.0	**2.7**	0.0	21.4	0.0	105.8	**127.2**	**129.9**
2018-2019	0.0	67.5	55.9	16.9	**140.3**	0.0	1.5	5.9	93.0	**100.4**	**240.7**
Totals	**0.0**	**70.2**	**55.9**	**16.9**	**143.0**	**0.0**	**22.9**	**5.9**		**227.6**	**370.6**
			Annual average (km)		*71.5*					*113.8*	*185.3*

Note that road decommissioning tracking didn't begin until 2017-2018

2.3.6. Road Decommissioning Success

Upon closure and decommissioning of roads, areas are returned as close to their original state as possible, and included:

- Removal of watercourse and drainage structures;
- Re-contouring to an acceptable land form;
- Cross-ditching to disperse runoff and suspended sediments into vegetated areas;
- Rollback of retained clearing debris and stripped topsoil;
- Re-vegetation or reforestation or both; and
- Following winter operations, windrowed grader banks of snow may be pushed back at identified locations to prevent spring runoff from forming channels/gullies in roadbed.

Roads that met the above-listed guidelines were considered successfully decommissioned.

2.4. Water Crossings

Water crossings included a wide variety of natural water features, such as:

- Permanent streams
- Seasonal streams
- Permanent drains
- Ephemeral drains
- Beaver floods
- Natural spring
- runoff

All water crossing are risk ranked as either high, medium, or low, based on these criteria:

- risk class – high: fish-bearing;
- risk class – medium: potentially fish-bearing and steep slopes; and
- risk class – low: not fish-bearing and gentle slopes

The type of water crossing structure prescribed is based on both risk ranking and site-specific features. Generally, portable bridges or snow and ice crossings were used for crossing streams, while culverts were used for crossing drains, swales, and beaver floods.

2.4.1. Water Crossing Locations

Water crossing locations were chosen based on these specific guidelines:

- The crossing location should be free of downed woody material and be positioned at the narrowest point along the straight segment of the reach.
- The crossing location must be positioned at right angles to the watercourse and where there is enough area to construct gentle, direct and stable road approaches.
- Water crossings must provide uninhibited access for fish migration to both upstream and downstream habitats year-round.
- In areas known to support or potentially support fish, portable bridges, snow and ice crossings or open bottom culverts are preferred.
- The removal of riparian vegetation along proposed crossing locations must be kept to a minimum on newly constructed forest roads.

2.4.2. Stream Assessments

Detailed stream assessments were conducted on proposed water crossings that have the potential to support fish or fish habitat. The assessment data were summarized and used to develop forest road access strategies and water crossing development plans that minimized disturbance to aquatic environments. Where stream assessments were warranted, information was collected on a variety of stream attributes (Table 2.3) within a sample reach of 100 m. Data were collected on stream hydrology, morphology, in-stream cover and substrate habitat characteristics, as well as fish and invertebrate communities that inhabit the watercourse. The information was then summarized and used to assist in prescribing the most appropriate water crossing type for that stream.

Once a stream or river was confirmed to have fish or fish habitat, stream assessments are no longer needed on that stream or river. Therefore, the need for stream assessments have decreased over time as the stream information has increased.

Table 2.4 Stream Assessment summary for FML #3.

Operating Year	# Stream Assessments
2006-2007	3
2007-2008	1
2008-2009	2
2009-2010	1
2010-2011	0
2011-2012	0
2012-2013	0
2013-2014	0
2014-2015	0
2015-2016	0
2016-2017	0
2017-2018	0
2018-2019	0
Totals	**7**

2.4.3. Water Crossing Types

There were three main types of water crossings used: bridges, culverts, and snow and ice crossings.

2.4.3.1. *Bridges*

Bridge crossings often prescribed are engineered portable structures that can be installed with relative ease. Typical construction considerations for forest road bridges are described as follows:

- Bridge footings will be constructed out of stabile material to prevent sedimentation. Logs, timbers, and soil wrapped in geotextile are some examples of appropriate footings.
- Wing walls will be constructed on all bridge installations and will remain in place during unfrozen conditions (spring, summer, and fall).
- Disturbance to the existing streamside vegetation will be minimized during construction. This will ensure natural re-vegetation after decommissioning as well as stabilization while the structure is active.

2.4.3.2. ***Culverts***

Culvert crossings were typically installed during dry conditions in the spring, summer and autumn months. In some cases, small PVC culverts were used to assist continuous flow during winter months within a winter snow and ice crossing. The following general procedures and considerations were used for culvert installations:

- were designed to support a Q100 flood event.
- Were planned for periods of low flow; if the watercourse is flowing, the flow was blocked temporarily to enable dry installation.
- Large boulders or rocks were removed from streambed in order to prevent culvert damage.
- While maintaining the original slope of the watercourse, the culvert was embedded approximately 10% of its diameter.
- Geotextile may be laid underneath culvert if suitable base material was not present.
- Suitable backfill material was then placed around culvert and compacted to ensure culvert stability.
- The inlets and outlets were rip rapped or re-vegetated if conditions warrant (slope, flow, channel width *etc.*).

2.4.3.3. ***Snow and Ice***

Temporary snow and ice crossings were common structures constructed during winter operations. The following guidelines were implemented during the construction of snow and ice crossings:

- Construction of snow and ice crossings occurred during freezing temperatures for water.
- Snow pushed into watercourse was free from dirt and or logging debris.
- Clean snow may be hauled in from an outside location if not present on site.
- Water was pumped onto snow to strengthen and stabilize crossing.
- During deactivation a trench was constructed in order to allow for unobstructed flow during the spring melt.

Site-specific choices were made about stream crossing type (*i.e.* bridge, culvert, or snow and ice crossing). The annual water crossing installations are summarized in Table 2.5.

Table 2.5 Water crossing installation summary.

Year	Portable Bridge	Culvert	Snow & Ice	Total
2006-2007	4	11	13	**28**
2007-2008	7	4	16	**27**
2008-2009	4	14	6	**24**
2009-2010	0	6	6	**12**
2010-2011	4	20	7	**31**
2011-2012	2	11	8	**21**
2012-2013	3	18	6	**27**
2013-2014	9	25	2	**36**
2014-2015	2	18	11	**31**
2015-2016	1	8	7	**16**
2016-2017	1	18	10	**29**
2017-2018	2	17	10	**29**
2018-2019	1	16	11	**28**
Total	**40**	**186**	**113**	**339**

2.4.4. Water Crossing Conditions

The condition of water crossings is displayed in Figure 2.9. Crossings are referred to as existing when they are active (black symbols on map). Crossings that are removed are referred to as rehabilitated. Rehabilitated crossings are depicted by a green symbol.

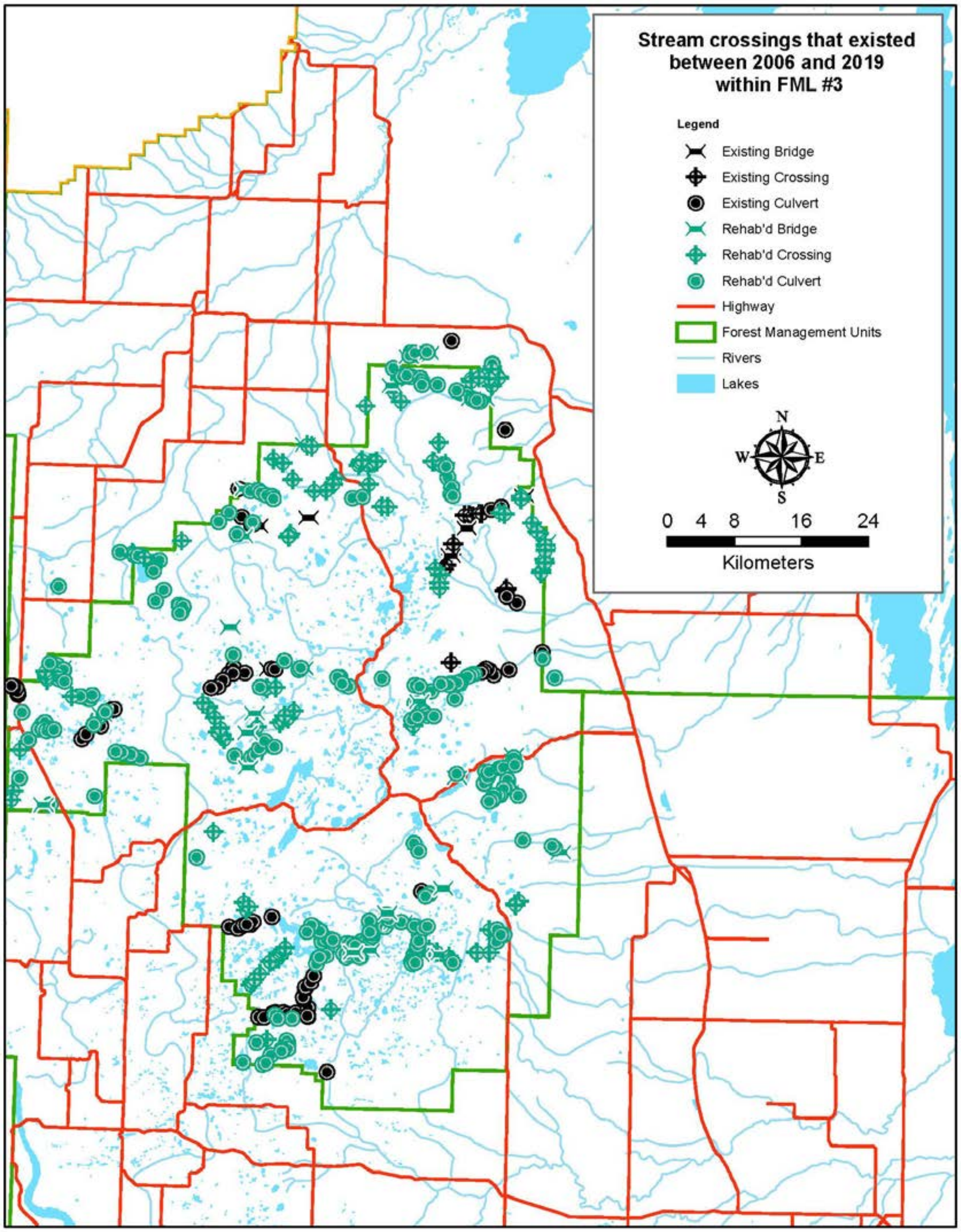


Figure 2.9 Water crossings in Forest Management Licence # 3.

*note a second copy of this map with a much larger scale and detail exists in Appendix 1.

2.4.5. Water Crossing Decommissioning

Once harvesting was complete and the forest road was deactivated, water crossings along the road are removed and decommissioned (Table 2.6).

Table 2.6 Water crossing rehabilitation and decommissioning summary by crossing type.

Year	Portable Bridge	Culvert	Snow & Ice	Total
2006-2007		*not actively tracked*		
2007-2008		*not actively tracked*		
2008-2009		*not actively tracked*		
2009-2010		*not actively tracked*		
2010-2011	0	0	9	**9**
2011-2012	5	32	16	**53**
2012-2013	4	13	14	**31**
2013-2014	4	16	15	**35**
2014-2015	1	25	2	**28**
2015-2016	1	14	2	**17**
2016-2017	11	47	13	**118**
2017-2018	3	35	21	**59**
2018-2019	0	10	23	**33**
Totals	**29**	**192**	**162**	**383**

The following water crossing decommissioning activities vary by site, and may include one or more of the following procedures:

- establishment of sediment control fences on land and instream where required;
- Removing the structure (culvert or bridge);
- Removal and sloping of fill used to construct crossing;
- Sloping the roadbed away from the watercourse;
- Track walking the slopes;
- Installation of cross ditches to divert runoff from roadbed into standing vegetation;
- Stabilization of the exposed soil by spreading grass seed and covering with either Rolled Erosion Control Products (RECP), straw mulch or slash debris from harvesting and road construction activities;
- Permanent (long term) decommissioning can also involve the planting of trees and shrubs, as well as other bioengineering techniques;
- Snow and Ice crossings are decommissioned by digging a shallow trench in the ice to prevent spring runoff from backing up and scouring the banks on flowing streams. On swales the snow and ice melts naturally in the spring;
- Once the work is completed, sites were monitored on a semi-annual basis to ensure that the soil stabilization techniques applied are working effectively.

Temporary water crossing decommissioning involves removing the structure (*e.g.* culvert), sloping the roadbed away from the watercourse, track-walking the slopes, installing cross ditches to divert runoff from roadbed into standing vegetation, and stabilizing the exposed soil by spreading grass seed and covering with either Rolled Erosion Control Products or straw mulch. The same crossing may be re-installed in later years (*e.g.* reusing the same road for second-pass harvest).

Permanent decommissioning involves removing the structure, sloping the road fill material away from the watercourse to near natural conditions prior to construction, track-walking the slopes, and installing cross ditches to divert runoff water from the roadbed into standing vegetation (Figure 2.10) The exposed soil was then seeded and covered with either erosion matting or straw mulch.

Snow and Ice crossings were decommissioned by digging a shallow trench in the ice to prevent runoff from backing up and scouring the banks on flowing streams. The snow and ice crossing then melts naturally.

Figure 2.10 Water crossing decommissioning examples.

2.4.6. Water Crossing Inspections

All installed, maintained, and deactivated water crossings in FML #3 were monitored. The water crossing inspection program monitored (Table 2.6) the conditions of active, deactivated, and rehabilitated crossings each spring and fall. This identifies any issues at crossings that could lead to failures or deposition of material into streams. Crossing inspections include: proper culvert alignment; culvert blockage; culvert damage or corrosion; and whether or not the culvert has become perched over time. The water crossing inspection also monitors the effectiveness of the erosion and sediment control measures.

Each stream was photographed, and comments were made on a water crossing inspection form. The Stream Team reviewed inspections and made decisions regarding follow-up maintenance activities, if necessary. Water crossing inspections were conducted until the vegetation reaches a level where the potential for erosion was no longer a concern.

Table 2.7 Number of water crossing inspections.

Operating Year	# Crossing Inspections
2006-2007	264
2007-2008	170
2008-2009	146
2009-2010	110
2010-2011	170
2011-2012	198
2012-2013	164
2013-2014	168
2014-2015	123
2015-2016	177
2016-2017	183
2017-2018	190
2018-2019	189
Total	**2,252**

2.4.7. Water Crossing Decommissioning Success

Water crossing decommissioning success was verified by water crossing field inspections. LP staff follow the field procedure entitled 'Field Procedures for Water Crossing Inspections' (2018). This procedure requires a field inspection, completion of a water crossing checklist, and photos of the decommissioned water crossing.

Overall water crossing decommissioning success was characterized by:

- Normal water flow of the original water feature
- erosion and sediment control techniques withstood spring runoff and peak flow events
- vegetation reached a sufficient level to stabilize soil

Water crossing decommissioning success was further verified by final inspections from the Manitoba Government. Conservation Officers completed a 'Timber Inspection Report', which has a stream crossing sub-section within the 'cut block area compliance' section.

Water crossing MGL-C16 is an example of a successful water crossing decommissioning. The crossing was first proposed in 2012, a steel bridge installed in 2012, decommissioned in 2013, and monitored until fall 2014. MGL-C16 was deemed successful, and no longer needed to be monitored after the fall of 2014.

Proposed crossing MGL-C16 (across) was submitted in the 2012 operating plan. The water crossing prescription had a preferred structure of a portable bridge.

A steel bridge was installed in 2012 (winter picture). The site was monitored, checklist completed, and photographed.

Once operations were complete, the steel bridge was removed. The decommissioned site was monitored, checklist completed, and photographed in fall 2013.

The decommissioned site was monitored a second year, checklist completed, and photographed in fall 2014.Water crossing MGL-C16 was deemed successfully decommissioned.

2.5. Planning and Harvesting

Harvest block design was an important component of forest management. Research suggests harvest plans should attempt to emulate natural disturbance patterns in order to provide structural diversity in the regenerating forest and to promote Sustainable Forest Management. In the boreal forest the primary natural disturbance was fire. Fires create landscape mosaics of various sized patches of standing burned and unburned trees (softwood and hardwood), large and small openings and irregular boundaries, often following natural features. Harvest block design implemented various natural disturbance pattern elements on the ground. Site specific considerations such as wetlands, special ecological features, boundaries following natural features to maximize forest edge, and other unique features were all used during block design.

2.5.1. Harvest Shape

Numerous forest resource values were considered in the design of harvest blocks at the stand and landscape levels. These values include watersheds, exceptional features, protected areas, silviculture, aesthetics, wildlife habitat, wetlands, riparian areas, harvesting economics, site features, stand types, and the needs of other stakeholders.

Harvest block shapes were designed utilizing natural boundaries, water features, roads and trails, administrative areas (*e.g.* parks and Forest Management Units), exceptional features (*e.g.* mineral licks and cabins), stand boundaries and stakeholder or public input. The resulting blocks were designed to minimize the effect on aquatic and terrestrial ecosystems, aesthetics and stakeholder or public concerns. Using natural boundaries can also reduce impacts of natural events such as blow down.

Harvest block boundaries were designed to follow natural boundaries (Figure 2.11). The harvest block shape is affected by planning for water features, wetlands, wildlife features, topography, and riparian habitat.

Figure 2.11 Harvest block that shows harvest shape, leave areas, riparian zones, and buffers.

2.5.2. Leave Areas

Leave areas were retained within harvest blocks. Generally, the in-block leave areas were identified if they were discernable on the imagery used. Leave areas included small wetlands, meadows, non-operable areas, areas of blow down and/or any other discernable features. Some areas such as parts of a block with high softwood understory or immature trees also became leave areas.

Leave areas outside the cutblock boundary were also left for future harvest (*i.e.* second and third pass harvest blocks) and to provide wildlife habitat. These areas were approximately the same size as the adjacent harvest block. Second and third-pass harvest blocks are eligible for harvest once the adjacent harvest block regeneration has reached the regeneration height specified in the government guidelines (3 meters for hardwood and 1 meter for softwood regeneration). The timing of the future harvest can be shortened or lengthened for specific sites if there are habitat concerns, timber loss from disease or blowdown or harvest timing concerns.

2.5.3. Riparian Management Areas

Management of riparian areas along water features was done at the planning stage. Forests along water features were managed and buffered depending of site specific characteristics and the social values of the water feature. Each riparian area along water features was examined and appropriate management or buffers were mitigated with Manitoba government representatives.

The guidebook Forest Management Guidelines for Riparian Management Areas (2008) helped government and forest industry planners make informed management decisions about the forest adjacent to riparian areas. This process focused on social, ecological, and economic criteria. The use of these keys helped create appropriate management prescriptions for riparian management areas.

2.5.4. Buffers

Buffers were incorporated in planning for wildlife features, including:

- Eagle, osprey and heron rookery nests
- Active stick nests larger than 60 cm (owl, hawk, raven)
- Bat caves
- Snake hibernacula
- Mineral licks
- Springs
- Native grass meadows
- Large mammal dens (*e.g.* bear den)

Forest Management Guidelines for Terrestrial Buffers (2010) guided government and forest industry planners' buffer decisions.

2.5.5. Harvest Methods

The method of harvest used in Forest Management Licence #3 was almost always variable retention harvesting, described below. However, selective harvesting of large white spruce sawlogs has been a method used by small Quota Holders. Forest health outbreaks may warrant clearcut harvesting in order to control a specific insect or disease. Clearcutting was an appropriate harvest method for salvage logging.

2.5.5.1. *Variable Retention Harvesting*

Variable retention harvesting provided a variety of wildlife habitat and helped to conserve biodiversity at the stand level. The practice of variable retention harvesting referred to keeping live and dead standing wildlife trees, protecting understorey vegetation, and leaving coarse woody material behind after harvest (Figure 2.12). The characteristics of variable retention harvesting varied depending on the nature of the harvest area.

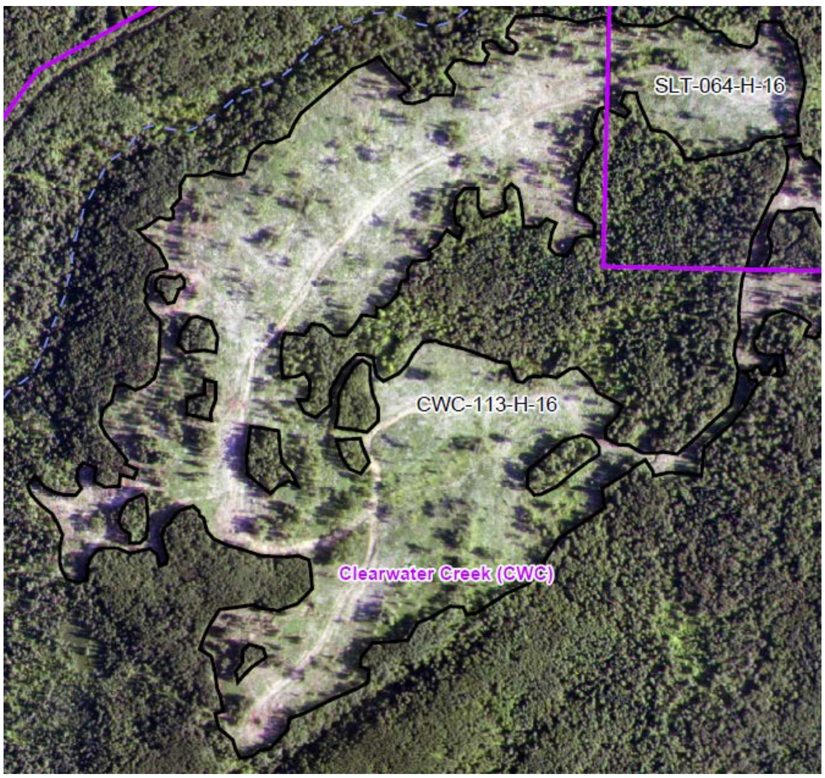


Figure 2.12 Aerial imagery of variable retention harvesting, characterized by retention patches and single trees purposefully left within the cutblock boundary.

The variable retention target was to maintain a minimum of 8 to 12 wildlife trees per hectare. Approximately five percent or greater of the standing forest volume was maintained within harvest areas. Wildlife trees were left in a combination of variable-sized patches and single trees. Snags and coarse woody debris were also retained, often in conjunction with live tree patches.

2.5.5.2. ***Snags***

Live trees eventually die and become snags. Dead standing trees (*i.e.* snags) provide forage, nesting and cover habitat for a number of primary and secondary cavity dependent species as well. Dead standing trees fall down and become coarse woody material. Therefore, forest habitat needed to conserve the presence of native animal species was continuously provided.

Snags were maintained within harvest areas. Snags were most often retained inside wildlife tree patches. Snags were also maintained within the cutblock.

2.5.5.3. ***Coarse Woody Debris***

Coarse woody debris provided habitat for many species and was an important component in sustaining elements of biodiversity. Coarse woody debris was considered essential for conserving forest biodiversity. Various practices were employed in order to encourage an abundant source of coarse woody material left within harvest areas. Logging operations were required to top and limb all harvested trees at the stump in order to ensure the maintenance of woody material left scattered throughout cutovers.

Various practices were employed to encourage the maintenance of coarse woody material in the harvest areas. Coarse woody debris (CWD) refers to sound and rotting logs and stumps that provide habitat for plants, animals, and insects, and was a source of nutrients for soil development that were found in both natural and harvested areas. CWD provided an important structural habitat element that promoted biodiversity at a stand level.

2.5.5.4. ***Understory Softwood***

Immature white spruce occupying the understory of the hardwood ecosystems were protected, when the density of white spruce was high enough to warrant understory protection. Logging contractors were encouraged to leave softwood understory trees within variable retention clumps, wherever possible. Softwood understory protection was common in small localized areas, even within pure hardwood areas with only a few mature softwood trees.

2.5.5.5. *Wildlife Debris Piles*

In designated harvest blocks, wildlife debris piles have been constructed to promote small mammal habitat. Based on concerns expressed during discussions with local trappers, debris piles were created in harvest areas in the Duck Mountains. These piles were constructed within 100 m of the block boundary and riparian features to encourage use of the harvest area by marten and other small mammals. The debris piles provided cover between residual patches, which helped to establish wildlife travel corridors through harvested areas connecting the adjacent forest. The piles also provide cover for many species of small mammals, which were a food source for marten.

Wildlife debris piles (WDPs) were constructed from logging slash, tops, limbs, and larger logs. Piles were located approximately 50 to 100 m from block or riparian edges to facilitate immediate use by marten and other animal species. Proximity to residual tree patches within harvested areas was considered prior to establishment. WDPs provided cover habitat between residual patches, which helps establish travel corridors through harvested areas. When piles were constructed, large elevated pieces of coarse woody debris or ‘stringers’ were placed connecting the pile to the adjacent forest. This provided access to WDPs in the winter through openings created between the snow and stringer and in summer along the logs.

In forest areas where pine marten were known to inhabit, wildlife debris piles were placed within cutovers along the edges of adjacent stands to promote aggregations of small mammals that pine marten typically prey upon. Marten also used these piles as cover habitat as they travel through harvest areas. Wildlife debris piles also provided den habitat and contributed to travel corridors through harvest areas. The maintenance of wildlife debris piles provided critical habitat over the short-term and medium-term.

2.5.6. Harvest Area

The area harvested within FML #3 was represented by several metrics, including:

- Area harvested by softwood Quota Holders, hardwood Quota Holders, and Louisiana-Pacific Canada Ltd. hardwood;
- Area of watersheds in a harvested state (within the Duck Mountains only); and
- Disturbance size metrics (*e.g.* average cut blocks size, minimums, and maximums).

2.5.6.1. *Area Harvested*

Annual area harvested includes all hardwood, mixedwoods, and softwood stands, of both Quota Holders and Louisiana-Pacific Canada Ltd. harvested areas (Table 2.8).

Table 2.8 Annual area harvested by Forest Management Unit.

	Area Harvested (ha)			
Year	**FMU 10**	**FMU 11**	**FMU 13**	**Total**
2006-2007	26.3	214.6	2,123.3	**2,364.2**
2007-2008	309.9	205.6	2,190.8	**2,706.4**
2008-2009	10.0	92.2	1,028.3	**1,130.5**
2009-2010	17.7	247.9	820.2	**1,085.7**
2010-2011	33.6	146.8	1,633.6	**1,814.1**
2011-2012	0.0	274.3	1,307.5	**1,581.8**
2012-2013	22.6	144.3	1,075.3	**1,242.3**
2013-2014	68.9	112.0	1,634.8	**1,815.7**
2014-2015	105.9	73.2	2,476.4	**2,655.5**
2015-2016	0.0	54.5	1,278.7	**1,333.2**
2016-2017	70.7	72.8	1,497.0	**1,640.5**
2017-2018	0.0	268.7	1,860.3	**2,129.0**
2018-2019	0.0	220.5	1,960.1	**2,180.6**
Totals	**665.6**	**2,127.6**	**20,886.3**	**23,679.5**
averages	***60.5***	***163.7***	***1,606.6***	***1,821.5***

Less area was harvested during the economic recession during the years 2008 and 2009 (Figure 2.13).

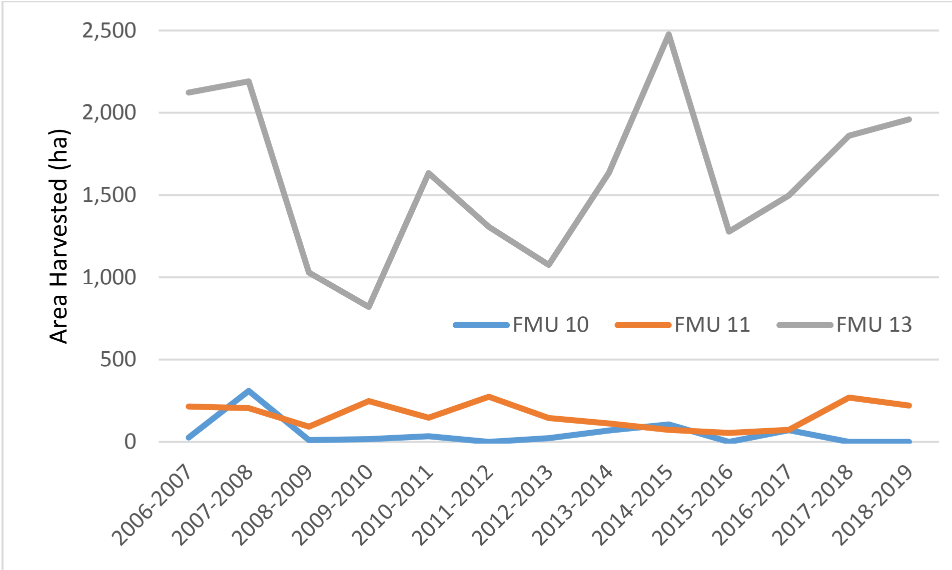


Figure 2.13 Annual area harvested by Forest Management Unit.

Annual area harvested is also shown by ecological strata. The ecological strata are based on ecosystem groups of both soils and vegetation (Figure 2.14).

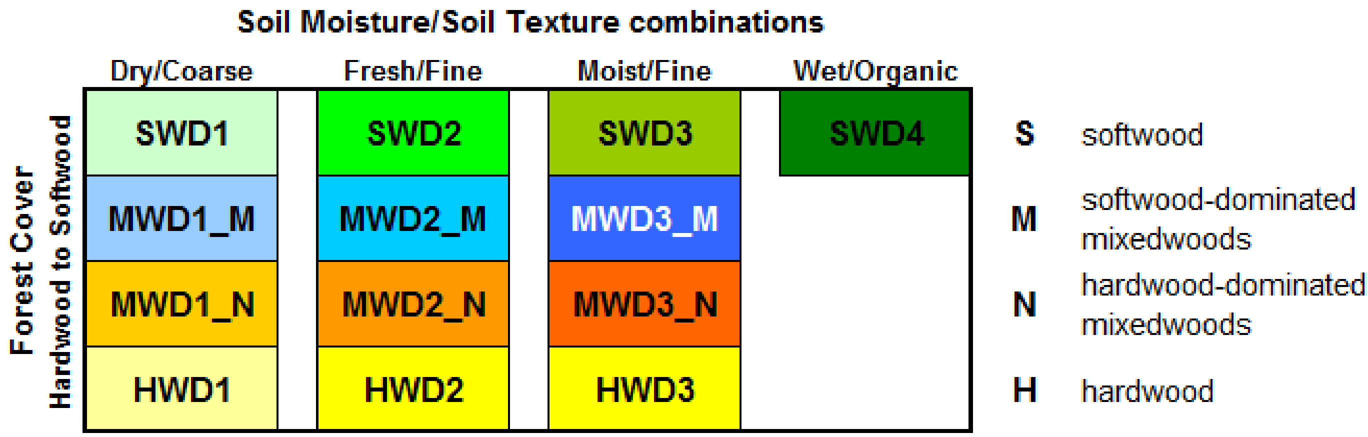


Figure 2.14 Ecological strata for FML # 3.

The annual area harvested by ecological strata is shown in Table 2.9. The most common ecological strata harvested are HWD2, MWD2_N, MWD2_M, SWD2 and SWD3. The remaining less-common strata have significantly less harvesting activity.

Table 2.9 Annual area harvested by ecological strata.

	H			N			M			S				
Year	HWD 1	HWD2	HWD 3	MWD 1_N	MWD 2_N	MWD 3_N	MWD 1_M	MWD 2_M	MWD 3_M	SWD 1	SWD 2	SWD 3	SWD 4	total areas (ha) by year
2006-2007	122	1,301	9	28	512	24	0	110	0	0	128	93	36	**2,364**
2007-2008	231	930	19	108	959	42	0	90	1	1	172	140	13	**2,706**
2008-2009	28	238	12	88	402	19	0	102	0	0	143	81	17	**1,130**
2009-2010	112	295	195	46	258	14	0	43	0	0	31	69	24	**1,086**
2010-2011	188	600	8	72	651	35	0	106	1	0	63	59	32	**1,814**
2011-2012	1	562	8	18	596	17	0	184	3	2	51	130	12	**1,582**
2012-2013	54	544	25	6	392	5	0	51	0	0	100	52	13	**1,242**
2013-2014	74	681	14	112	531	32	0	72	0	13	148	128	12	**1,816**
2014-2015	106	1,336	6	11	638	15	0	291	2	4	176	62	8	**2,655**
2015-2016	8	430	6	2	361	10	0	161	0	0	239	87	30	**1,333**
2016-2017	46	682	20	37	425	11	0	68	3	65	204	59	21	**1,641**
2017-2018	205	595	18	132	521	18	0	346	0	5	393	74	42	**2,349**
2018-2019	61	866	8	195	463	9	0	104	17	49	265	115	30	**2,161**
total area by strata	1,236	9,060	345	854	6,709	249	0	1,727	27	140	2,114	1,148	289	23,880

A map showing all harvested areas, including softwood quota holders, hardwood quota holders, and Louisiana-Pacific Canada Ltd. hardwood harvest, is shown in Figure 2.15.

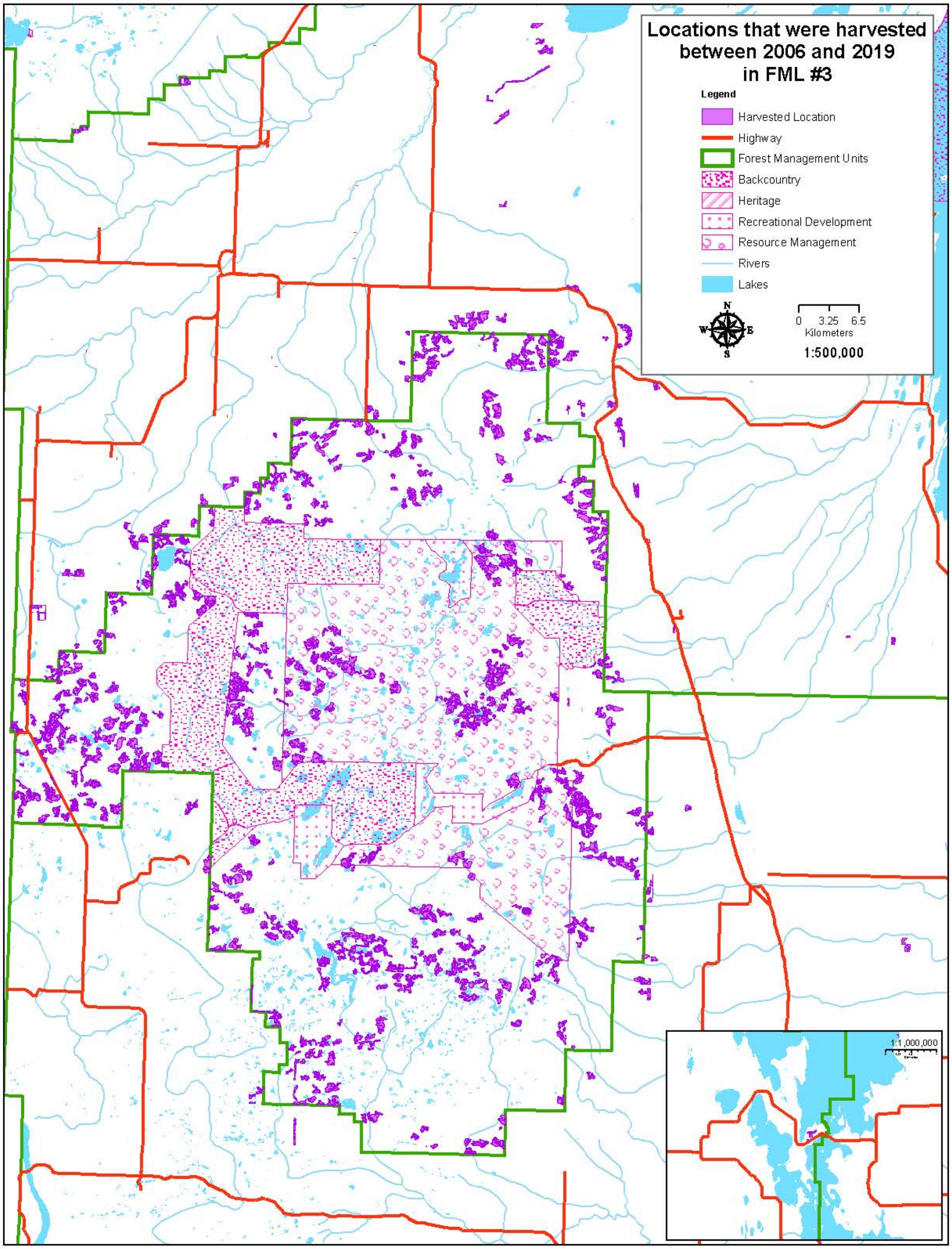


Figure 2.15 Area harvested in Forest Management Licence # 3 (2006 to 2019).

*note a second copy of this map with a much larger scale and detail is in Appendix 2.

2.5.6.2. ***Watershed Area in a Harvested State***

Environment Act License (2191E) states in Section 17 (ii) that:

> *The Licensee shall: "limit the area in a watershed which is in a harvested and not sufficiently regenerated state, as determined by subsection 17(i) of this Licence"*

A watershed analysis of existing and proposed harvesting operations was calculated at the basin level to track the actual percentage of forested land within each watershed in a 'harvested state'. Cut blocks were considered to be in a 'harvested state' for five years following harvest for hardwood species, and 15 years post-harvest for softwood species. After regenerating trees reach a minimum height (2 m for softwood and 3 m for hardwood), cut blocks were considered forested and no longer in a 'harvested state'. The percent of productive forest in a harvested state by basin was significantly less than the existing 30% maximum in all basins (Figure 2.16). Most basins have decreased in percent of a harvested state between 2011 and present, except the Central Valley basin.

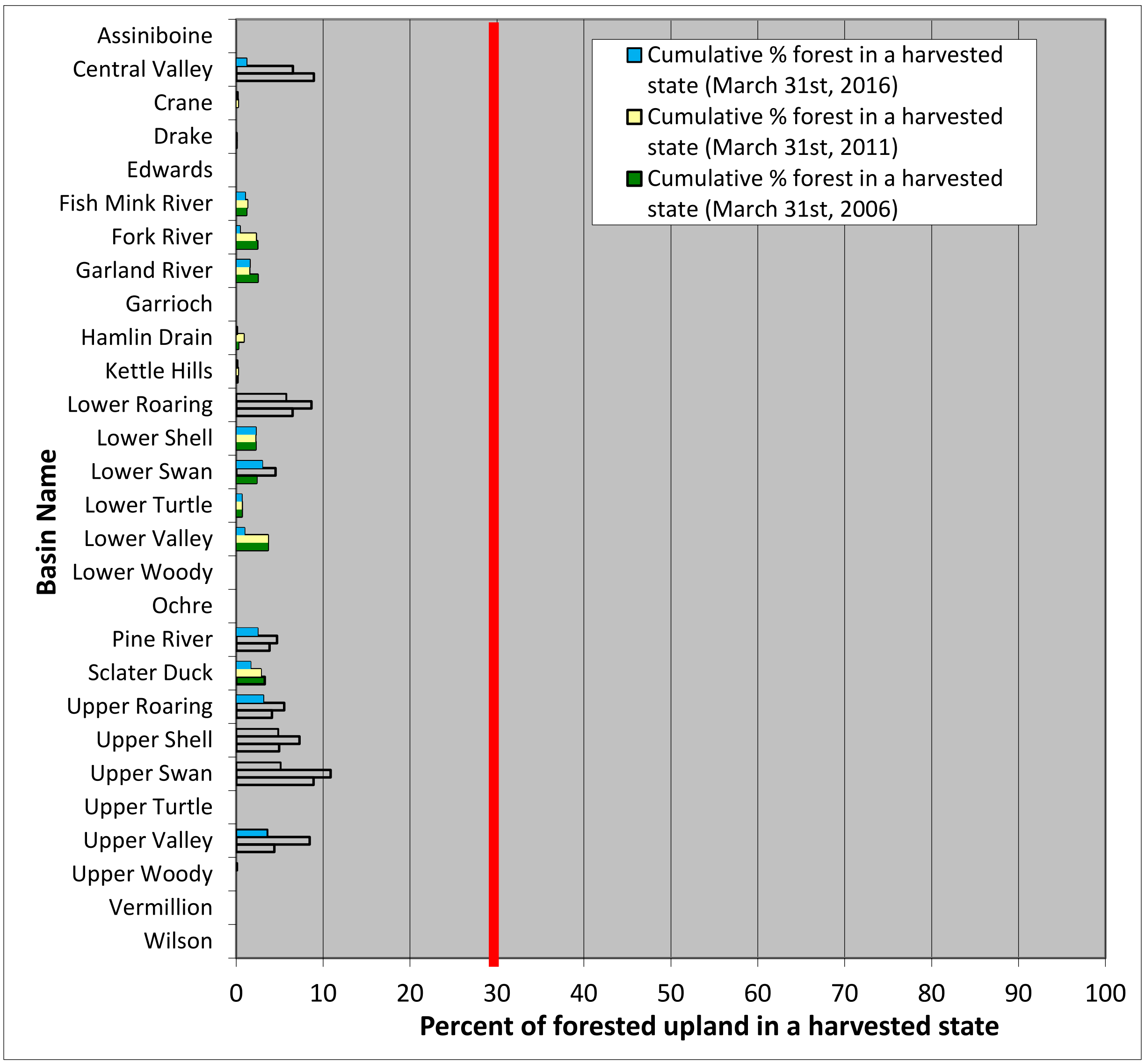


Figure 2.16 Percentage of each basin in a harvested state (2006 to 2016) was less than the 30% restriction (red line).

2.5.6.3. *Disturbance Sizes*

Cut blocks had a relatively consistent average size of approximately 30 ha since 2006 (Table 2.10 and Figure 2.17). Variability of disturbance sizes (Table 2.11 and Figure 2.18) contributes to coarse-filter biodiversity.

Table 2.10 Historical cutblock sizes.

averages	*63*	*30.3*	*1.3*	*104.2*	*24.0*

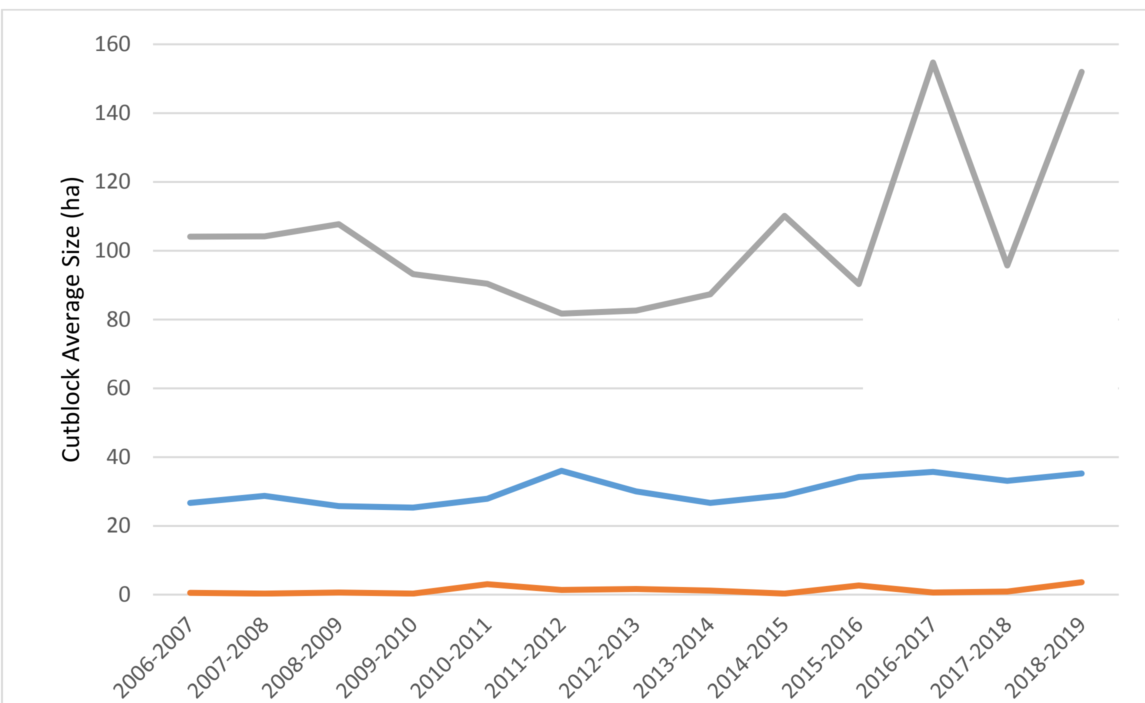


Figure 2.17 Historical disturbance sizes.

Table 2.11 Disturbance area by 20 ha size classes.

	Area (ha) by Disturbance Size (20 ha classes)					
Year	0.1 20.0 ha	20.1 40.0 ha	40.1 60.0 ha	60.1 80.0 ha	80.1 100.0 ha	100.1 ha plus
2006-2007	429.3	556.4	712.4	493.1	0.0	104.1
2007-2008	495.9	757.2	715.8	267.0	358.9	104.2
2008-2009	243.3	237.9	152.4	215.2	174.6	107.7
2009-2010	156.9	409.8	221.7	204.2	93.2	0.0
2010-2011	290.2	707.8	377.1	269.0	169.9	0.0
2011-2012	215.9	254.1	377.5	571.0	163.4	0.0
2012-2013	227.5	515.4	552.7	515.4	82.6	0.0
2013-2014	289.2	776.9	639.5	126.6	173.8	0.0
2014-2015	379.8	832.4	607.9	416.5	179.2	212.2
2015-2016	124.2	359.8	441.2	146.5	261.5	0.0
2016-2017	141.3	414.3	362.0	370.1	93.1	259.7
2017-2018	274.2	750.8	455.4	514.3	354.2	0.0
2018-2019	279.0	452.5	461.3	484.0	352.0	152.0
Totals	**3,546.6**	**7,025.2**	**6,076.9**	**4,592.8**	**2,456.4**	**939.8**
Averages	***272.8***	***540.4***	***467.5***	***353.3***	***189.0***	***72.3***

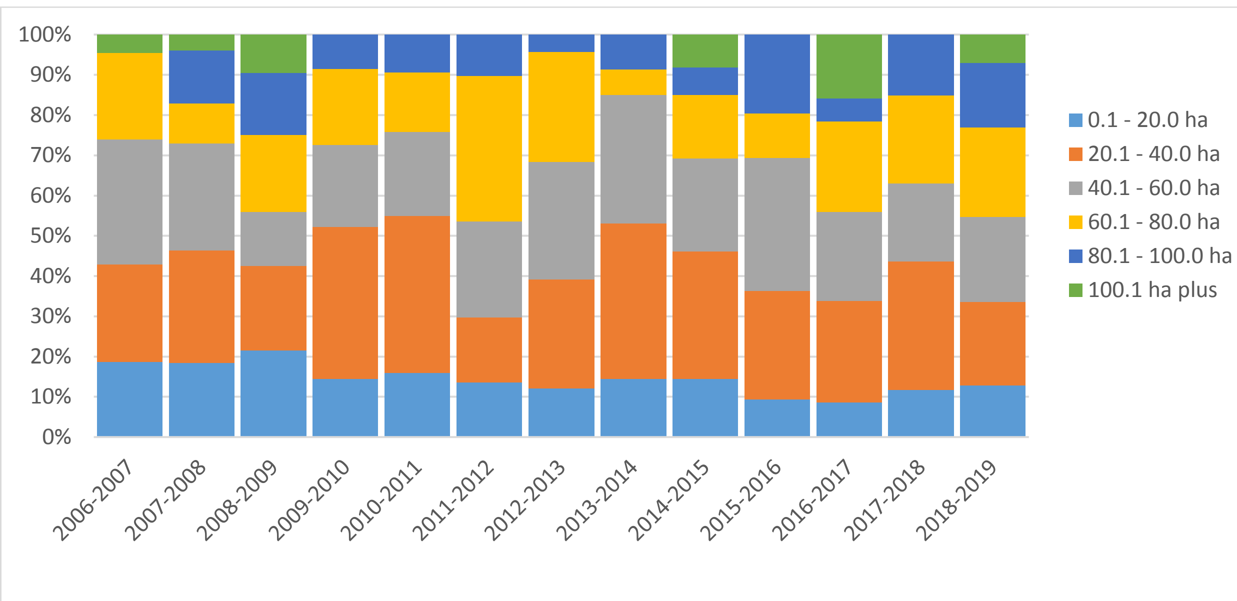


Figure 2.18 Disturbance area percent by 20 ha size classes.

2.5.7. Harvest Volumes

Wood volume was an important metric to track. Each Forest Management Unit within FML #3 has an annual maximum softwood and hardwood volume or AAC (Annual Allowable Cut). The actual softwood and hardwood volumes were compared to the AAC maximums as well as minimums, maximums, and five-year averages. LP has a maximum hardwood harvest level of 100,000 m3 during the bird breeding season, May, June, and July. The volume of hardwood harvested during this period is tracked and compared to the 100,000 m^3 threshold.

2.5.7.1. *Softwood and Hardwood Volumes Compared to the Allowable Cut*

FMU 10 softwood AAC (Annual Allowable Cut) is only 210 m^3 per year. No pure softwood blocks were planned to obtain this small volume of softwood. It merely allows for some residual softwood to be harvested from a hardwood or mixedwood block. In some years no softwood was harvested, while other years the Quota Holders exercised their right to a three-year volume average which exceeds the AAC (Table 2.12 and Figure 2.19).

Table 2.12 Softwood actual harvest compared to Annual Allowable Cut for Forest Management Unit 10.

	FMU 10		
Operating Year	**Actual Swd harvest (m^3)**	**Swd AAC (m^3)**	**% of AAC**
2006-2007	335	210	160%
2007-2008	594	210	283%
2008-2009	130	210	62%
2009-2010	0	210	0%
2010-2011	148	210	70%
2011-2012	0	210	0%
2012-2013	0	210	0%
2013-2014	0	210	0%
2014-2015	125	210	60%
2015-2016	0	210	0%
2016-2017	258	210	123%
2017-2018	0	210	0%
2018-2019	0	210	0%
swd totals	**1,590**	**2,730**	**58%**
undercut		*1,140*	

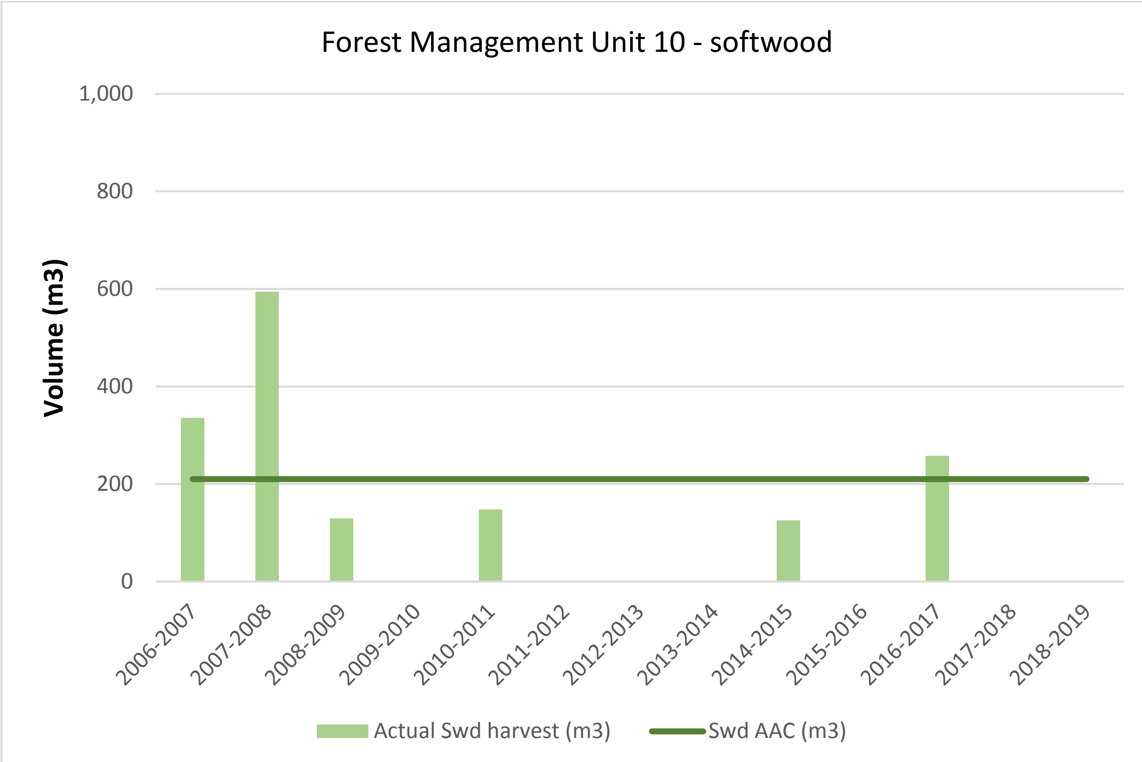


Figure 2.19 Softwood actual harvest compared to Annual Allowable Cut for Forest Management Unit 10.

FMU 10 hardwood volumes come from two sources: open crown land; and leased crown land. Therefore, Table 2.13 reports on both sources of hardwood.

Table 2.13 Hardwood actual harvest compared to Annual Allowable Cut for Forest Management Unit 10.

Operating Year	FMU 10 Open Crown			FMU 10 Leased Crown		
	Actual Hwd harvest (m^3)	Hwd AAC (m^3)	% of AAC	Actual Hwd harvest (m^3)	Hwd AAC (m^3)	% of AAC
2006-2007	3,109	7,850	7%	6,045	128,220	5%
2007-2008	10,163	7,850	28%	28,462	128,220	22%
2008-2009	1,658	7,850	1%	0	128,220	0%
2009-2010	3,146	7,850	2%	0	128,220	0%
2010-2011	1,363	7,850	4%	3,469	128,220	3%
2011-2012	0	7,850	0%	0	128,220	0%
2012-2013	3,669	7,850	47%	0	128,220	0%
2013-2014	7,932	7,850	101%	1,838	128,220	1%
2014-2015	11,401	7,850	145%	5,893	128,220	5%
2015-2016	0	7,850	0%	0	128,220	0%
2016-2017	9,287	7,850	118%	0	128,220	0%
2017-2018	0	7,850	0%	0	128,220	0%
2018-2019	0	7,850	0%	0	128,220	0%
hwd totals	**51,727**	**102,050**	**51%**	**45,707**	**1,666,860**	**3%**
undercut		*50,323*			*1,621,153*	

To date, slightly more open crown land volume has been harvested in FMU 10 than leased crown land volume (Figure 2.20). Note that in some years, no hardwood is harvested in FMU 10.

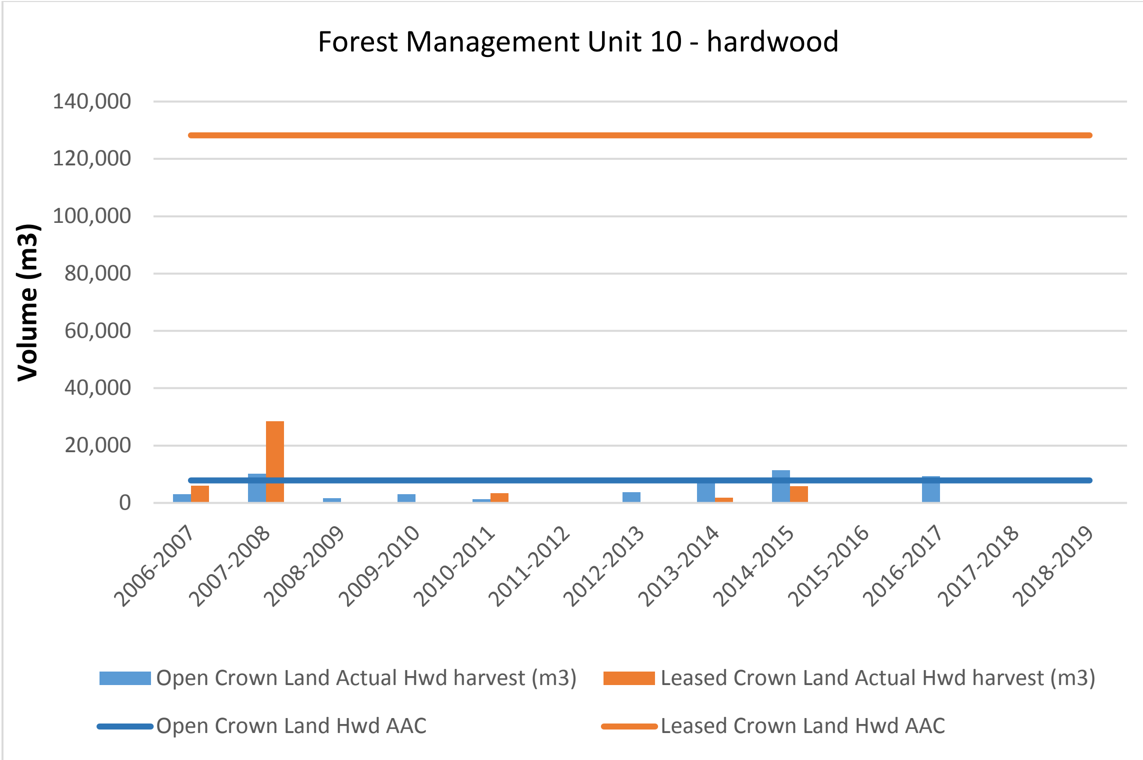


Figure 2.20 Hardwood actual harvest compared to Annual Allowable Cut for Forest Management Unit 10.

Only a small portion of FMU 11 softwood annual allowable cut has been utilized (Table 2.14 and Figure 2.21). The softwood AAC was changed on April 1st, 2018 to 26,819 m^3, an increase of 8,189 m^3. Most of the softwood in FMU 11 is harvested from mixedwood blocks. The softwood quota volume in FMU 11 is 5,649 m^3.

Table 2.14 Softwood actual harvest compared to Annual Allowable Cut for Forest Management Unit 11.

	FMU 11		
Operating Year	Actual Swd harvest (m^3)	Swd AAC (m^3)	% of AAC
2006-2007	3,725	18,630	20%
2007-2008	97	18,630	1%
2008-2009	76	18,630	0%
2009-2010	4,695	18,630	25%
2010-2011	1,319	18,630	7%
2011-2012	1,601	18,630	9%
2012-2013	2,468	18,630	13%
2013-2014	660	18,630	4%
2014-2015	981	18,630	5%
2015-2016	343	18,630	2%
2016-2017	320	18,630	2%
2017-2018	1,233	18,630	7%
2018-2019	9,272	26,819	35%
swd totals	**26,791**	**250,379**	**11%**
undercut		***223,588***	

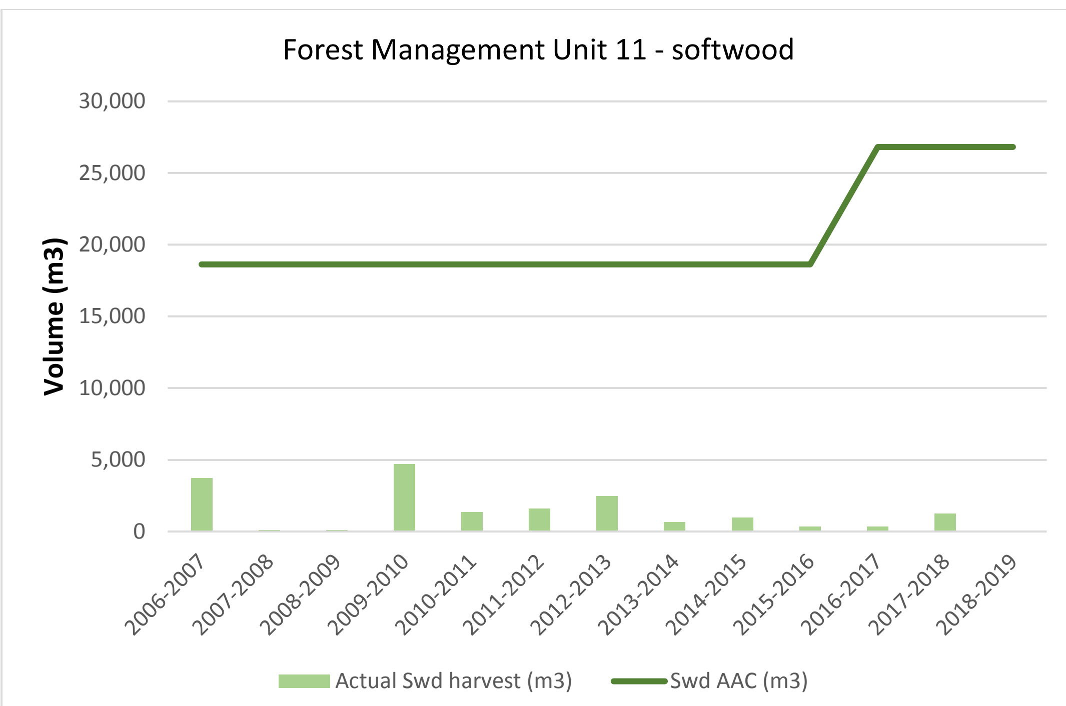


Figure 2.21 Softwood actual harvest compared to Annual Allowable Cut for Forest Management Unit 11.

FMU 11 hardwood volumes came from two sources: open crown land and leased crown land up until April 1st, 2018. The AAC in FMU 11 was amalgamated to one volume (92,004 m^3) after this date. The table reports on both sources of hardwood up to the 2017-18 season. Prior to this date more open crown land volume than leased crown land volume has been harvested (Table 2.15 and Figure 2.22). To date FMU 11 has been undercut.

Table 2.15 Hardwood actual harvest compared to Annual Allowable Cut for Forest Management Unit 11.

	FMU 11 Open Crown			FMU 11 Leased Crown		
Operating Year	Open Crown Land Actual Hwd harvest (m^3)	Open Crown Land Hwd AAC (m^3)	% of AAC	Leased Crown Land Actual Hwd harvest (m^3)	Leased Crown Land Hwd AAC (m^3)	% of Leased Crown AAC
2006-2007	30,521	51,310	26%	6,717	92,890	7%
2007-2008	24,920	51,310	22%	7,074	92,890	8%
2008-2009	16,879	51,310	12%	0	92,890	0%
2009-2010	41,276	51,310	30%	1,592	92,890	2%
2010-2011	17,321	51,310	20%	11,728	92,890	13%
2011-2012	29,041	51,310	20%	5,108	92,890	5%
2012-2013	35,824	51,310	25%	6,096	92,890	7%
2013-2014	15,850	51,310	11%	3,124	92,890	3%
2014-2015	16,685	51,310	12%	0	92,890	0%
2015-2016	9,978	51,310	7%	0	92,890	0%
2016-2017	10,367	51,310	11%	1,802	92,890	2%
2017-2018	48,600	51,310	53%	0	92,890	0%
2018-2019	22,494	92,004	22%		*	
hwd totals	**319,754**	**1,822,404**	**18%**	**43,241**	**1,114,680**	**4%**
undercut		*1,502,650*			*1,071,439*	

*Leased Crown land AAC was amalgamated into Open Crown land in 2018-2019

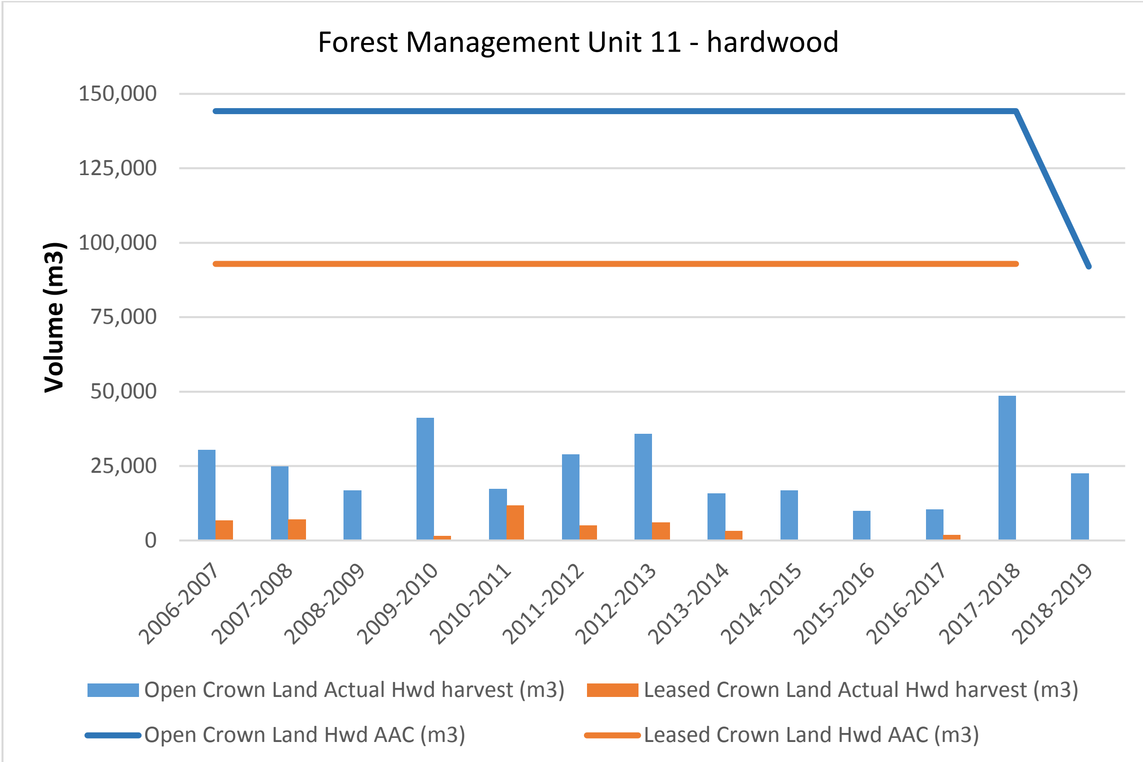


Figure 2.22 **Hardwood actual harvest compared to Annual Allowable Cut for Forest Management Unit 11.**

FMU 13 (Duck Mountain Provincial Forest) consists of open crown land only. There is no leased land within the boundaries of the Duck Mountain Provincial Forest. Both softwood and hardwood volumes are reported together (Table 2.16 and Figure 2.23) for FMU 13.Softwood harvest has been 85% of the annual allowable cut since 2006.The hardwood Quota Holders and Louisiana-Pacific Canada Ltd. have utilized 62% of the hardwood annual allowable cut since 2006.

Less hardwood and softwood was cut than normal during the global recession in 2008 and 2009, due to lower demand for forest products. In 2015-2016, the Minitonas OSB mill was temporarily shut down to convert from Orientated Strand Board (OSB) to siding production, which resulted in less wood processed during the 2015-2016 operating year.

Table 2.16 Softwood and hardwood actual harvest compared to Annual Allowable Cut for Forest Management Unit 13.

Operating Year	FMU 13			FMU 13		
	Actual Swd harvest (m3)	Swd AAC (m3)	% of AAC (m3)	Actual Hwd harvest (m3)	Hwd AAC (m3)	% of AAC (m3)
2006-2007	154,883	176,606	88%	314,976	348,823	90%
2007-2008	175,605	176,606	99%	320,428	348,823	92%
2008-2009	116,137	176,606	66%	142,090	348,823	41%
2009-2010	85,420	176,606	48%	105,455	348,823	30%
2010-2011	174,994	176,606	99%	231,997	348,823	67%
2011-2012	168,926	176,606	96%	171,294	348,823	49%
2012-2013	118,358	176,606	67%	148,175	348,823	42%
2013-2014	142,308	176,606	81%	212,151	348,823	61%
2014-2015	178,366	176,606	101%	348,876	348,823	100%
2015-2016	147,234	176,606	83%	125,022	348,823	36%
2016-2017	178,686	176,606	101%	193,526	348,823	55%
2017-2018	236,506	234,022	101%	208,287	311,934	67%
2018-2019	180,208	234,022	77%	255,789	311,934	82%
totals	**2,057,631**	**2,410,710**	**85%**	**2,778,067**	**4,460,921**	**62%**
undercut		*353,079*			*1,682,854*	

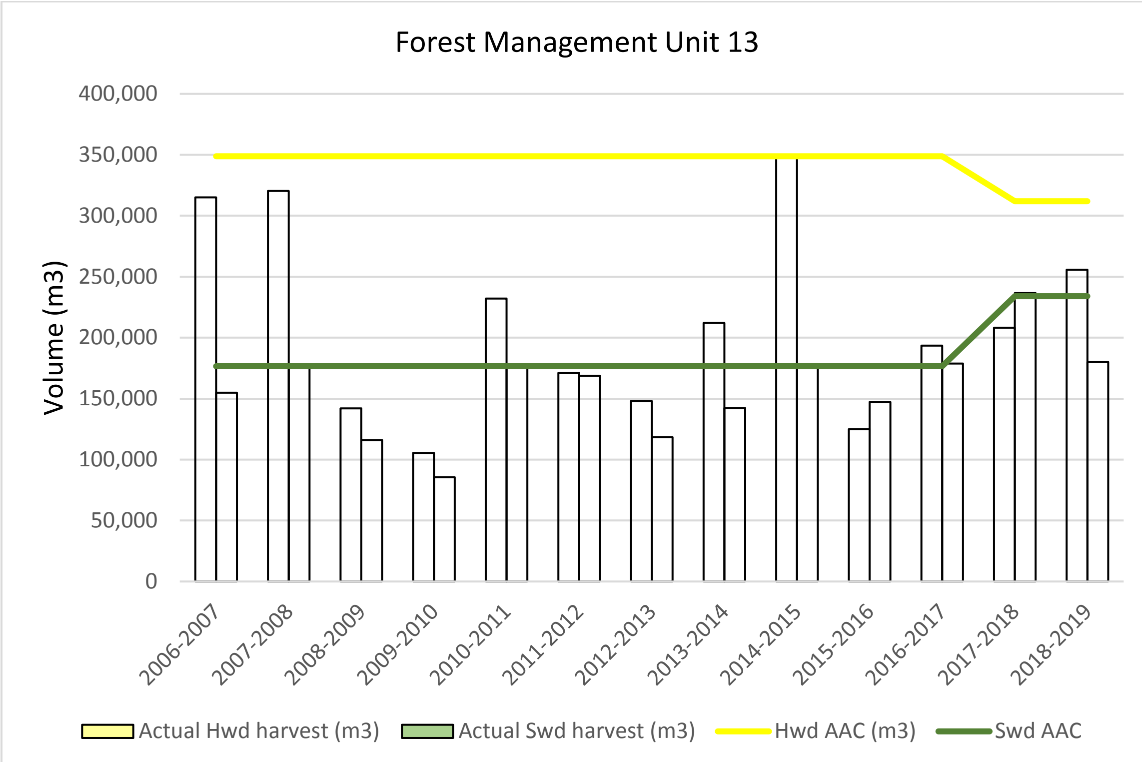


Figure 2.23 Hardwood and softwood actual harvest compared to Annual Allowable Cut for Forest Management Unit 13.

2.5.7.2. *Maximum and Minimum Harvest Levels*

The Forest management Licence #3 Agreement specifies a maximum hardwood harvest level of 900,000 m^3 per year, and a minimum five-year average harvest level of 400,000 m^3 (from FML #3 and FMUs 12 and 14). The total harvest for each year shows that the maximum harvest level has not been exceeded (Figure 2.24). Note that there was no softwood minimum or maximum requirement in the Forest Management Licence Agreement.

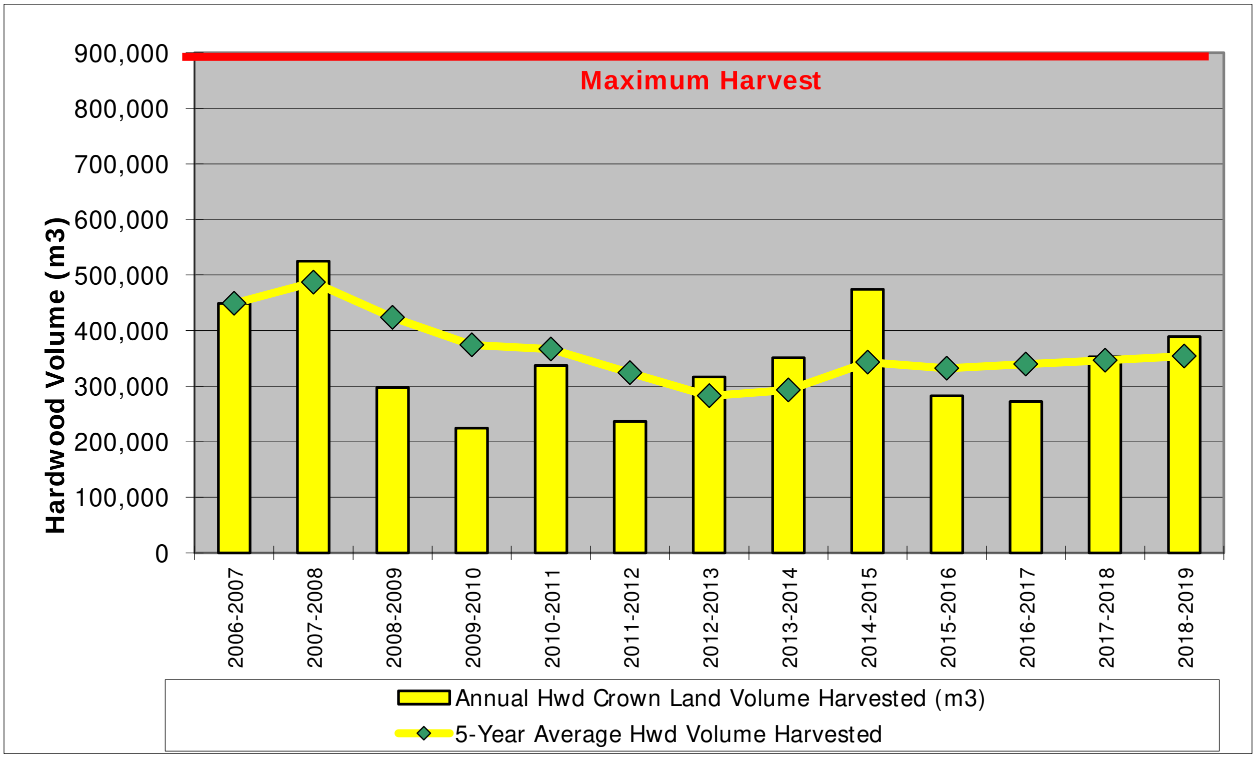


Figure 2.24 Annual hardwood harvest and five-year average hardwood harvest.

2.5.7.3. *Annual Harvest Volume during Bird Breeding Season*

To reduce the potential impacts of hardwood operations on breeding birds, LP was required to minimize harvest of hardwoods in May, June and July of each year. Harvest of hardwoods may not exceed a total of 100,000 m^3 for these three months according to Manitoba Environment Act License 2191E (1996).

The amount of LP hardwood harvest during the bird breeding season is consistently less than the 100,000 m^3 maximum Figure 2.25. Storing a larger winter inventory in the mill yard helps reduce the need to harvest during the summer bird breeding season. Quota holder harvest during the bird breeding season is not tracked.

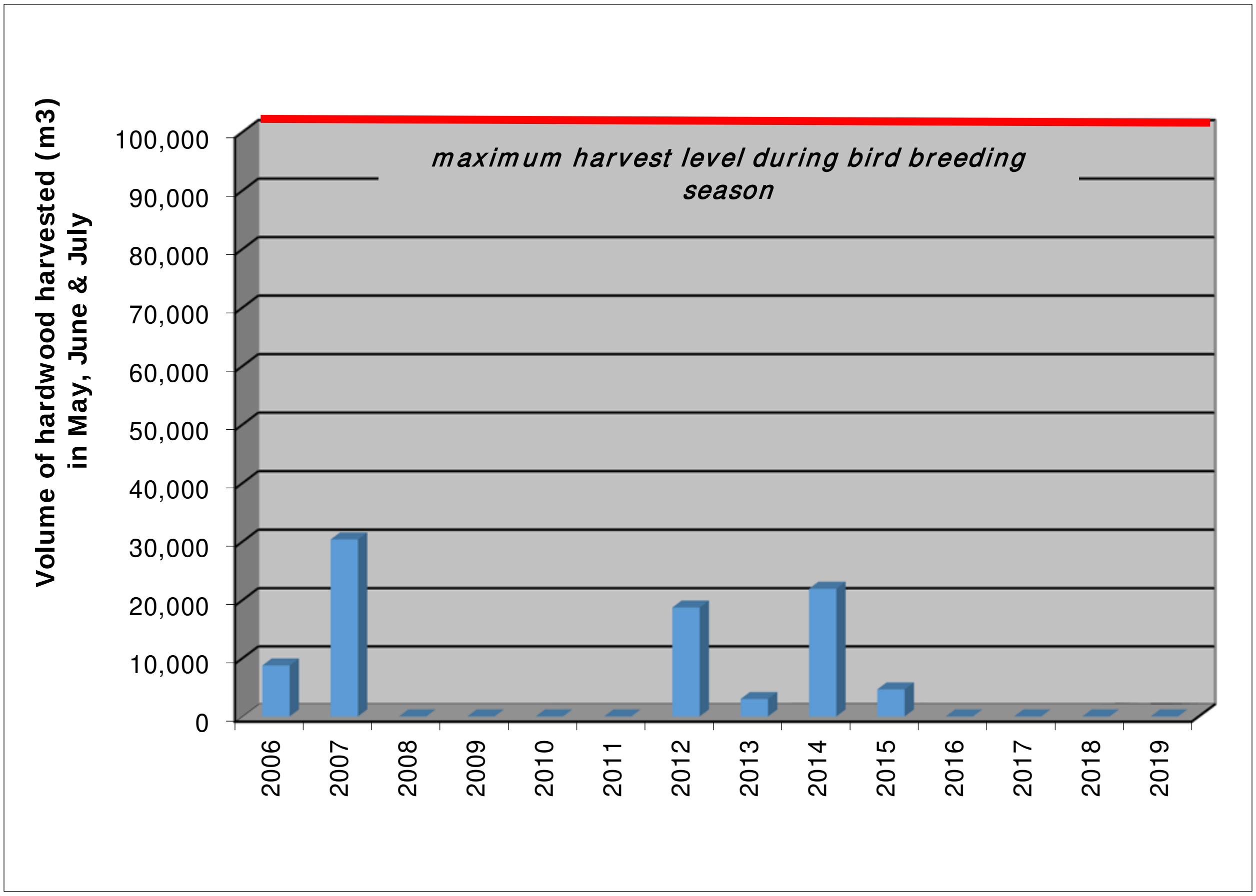


Figure 2.25 Volume of hardwood harvested during the bird breeding season (May to July), with a comparison to the annual maximum harvest level.

2.5.8. Crown Fees

Crown fees consist of three separate charges:

1) **Stumpage** – fee for the right to harvest trees from Crown land. The stumpage money collected was general revenue for the Province of Manitoba.

2) **Forest Renewal Charge (FRC)** – fee for renewal of harvested sites. Note that since Jan. 1st, 2007 softwood renewal efforts were funded directly by the Mountain Forest Section Renewal Company (MFSRC). Specifically, the MFSRC directly pays for tree planting, site preparation, and surveys as these renewal expenses occur (approximately $5.75 per m^3).No softwood renewal money was paid to the provincial government.

   Hardwood renewal efforts were funded directly ($0.50 per m^3) and managed by LP. LP directly pays for hardwood regeneration surveys and any other hardwood renewal costs. No hardwood renewal money was paid to the provincial government. Quota Holder hardwood renewal money was deposited into the FML #3 hardwood renewal fund and used to fund hardwood regeneration surveys on hardwood Quota Holder cut blocks.

3) **Fire Protection Charge (FPC)** – fee to offset the fire fighting and fire prevention costs the Province of Manitoba undertakes to protect forest resources. A $0.17 per cubic metre was uniformly charged for both softwood and LP and Quota Holder hardwood.

Table 2.17 summarizes all Crown fees paid by softwood and hardwood users in FML #3, from 2006 to 2019.

Table 2.17 Total hardwood and softwood fees paid for wood harvested within FML #3 (source: Province of Manitoba).

Year	Hardwood Stumpage Fees ($)	Softwood Stumpage Fees ($)	** Hardwood Renewal Fees ($)	Softwood Renewal Fees ($)	Hardwood Protection Fees ($)	Softwood Protection Fees ($)	Totals
2006-2007	$1,384,774	$456,906	$222,761	$1,036,169	$75,739	$26,330	**$3,202,678**
2007-2008	$1,146,938	$223,351	$150,000	$500,000	$94,787	$29,869	**$2,144,946**
2008-2009	$427,299	$335,376	$150,000	$500,000	$27,307	$19,327	**$1,459,309**
2009-2010	$446,435	$147,635	$134,410	$457,269	$43,475	$15,852	**$1,245,075**
2010-2011	$608,755	$308,805	$126,884	$687,000	$59,296	$29,998	**$1,820,738**
2011-2012	$299,765	$298,431	$85,647	$623,000	$29,120	$28,990	**$1,364,954**
2012-2013	$437,999	$206,103	$146,420	$859,859	$31,105	$53,181	**$1,734,667**
2013-2014	$386,444	$307,075	$207,415	$900,518	$261,512	$28,269	**$2,091,233**
2014-2015	$620,515	$400,306	$31,750	$1,108,472	$60,564	$32,762	**$2,254,369**
2015-2016	$330,438	$358,999	$3,053	$892,383	$27,188	$26,506	**$1,638,566**
2016-2017	$995,925	$841,849	$10,533	$1,799,678	$47,753	$53,604	**$3,749,342**
2017-2018	$1,603,909	$1,018,428	$8,072	$1,271,617	$39,021	$38,293	**$3,979,340**
2018-2019	*	*	*	*	*	*	*****
Totals	**$8,689,196**	**$4,903,263**	**$1,276,945**	**$10,635,965**	**$796,867**	**$382,981**	**$26,685,217**

* waiting for numbers from the Province of Manitoba

** hardwood renewal fee tracking changed in 2014-2015 (internally funded hardwood renewal)

2.6. Harvesting Practices and Associated Activities

2.6.1. Harvest Equipment Used

All harvest operations are mechanical logging operations. The harvest equipment used varies slightly, but typically consists of the following equipment options by harvesting stage.

Felling – Feller bunchers were used to cut standing trees. A saw cuts each tree, while the accumulator arms allow for several trees to held and form a 'bunch'. The bunch of whole trees is then laid on the forest floor.

Topping and limbing – Power saws or stroke delimbers were commonly used to delimbing the branches off the stem, and to cut the top off.Power saws weare more commonly used for topping and limbing hardwood, while softwoods were often stroke delimbed.

Skidding – A grapple skidder was used to move bunched tree stems to roadside for processing and hauling.

Slashing – A slasher or processor head on an excavator processed tree-length stems at roadside. Hardwood tree-lengths were processed into 2.54 m (8 foot) lengths. Softwood tree-lengths that are sawlogs were processed into 5.1 m (16 foot), 3.8 m (12 foot), or 3.2 m (10 foot) lengths. Softwood chipperwood had variable lengths.


Loading- A swing loader on a tracked excavator was used to load processed logs onto a haul truck.


Hauling – The wood was then hauled to a mill. Trailer configurations included Super B (8 axle), B-train (7 axle), or Tridem (6 axle).

2.6.2. Wood Storage and Processing Areas

Softwood storage sites (Figure 2.26) were established throughout FML # 3 on a yearly basis. Some wood was skidded to roadside within the cut block for further processing or chipping with a portable chipper at a later time. In other instances, wood was forwarded, or moved off-site, to a location that provided all weather access roads to the wood for processing or chipping. There was typically a small amount of incidental hardwood that was forwarded to these sites as well.

Figure 2.26 Softwood stockpile site.

Hardwood storage sites (Figure 2.27) have been far less common in FML #3 than softwood storage sites. Hardwood storage sites have been established within cut blocks that have all weather access with wood being skidded to roadside and processed later. In some cases, processed wood has been left within the cut block as a result of early thaws causing roads to deteriorate and trucks being unable to haul the wood.

Figure 2.27 Hardwood stockpile site at block JFL-010

2.6.3. Storage, handling, and disposal of hazardous, non-hazardous, domestic, and recyclable solid and liquid waste

Fuel, diesel or gasoline, was stored in an approved fuel storage tank (steel tank). Oil or hydraulic fluid was stored in the original container, typically a 20-litre plastic pail with a sealed lid.

Fuel was dispensed from the storage tank to a machine. A fuel hose runs from the tank to a fuel nozzle at the end of the hose. Typically, a large spill kit is present at the camp or by the fuel tank. A small spill kit was present with any vehicle equipped with fuel slip tank (*e.g.* pick-up trucks).

Manufacture's WHMIS labels were on the containers of all hazardous materials. Each contractor had a binder of Material Safety Data Sheets (MSDSs) from the product supplier. The MSDS sheets provided detailed information about product composition, reactivity, health effects, protective equipment and procedures, and emergency procedures.

All waste was removed from the site. As per the Work Instructions, all contractors contained all waste and remove waste from the work site regularly (*e.g.*, waste oil, waste oil filters, grease tubes, oil containers, chains, wedges, files, jugs, unused fuel and oil, skidder chokers, mainline, haul truck wrappers/binders, cigarette packages, pop cans, lunch bags, *etc.*).

Transport of Dangerous Goods - The Dangerous Goods Handling and Transportation Act sets out requirements for the handling and transportation of dangerous goods and hazardous waste. This Act enabled the provincial government to establish standards pertaining to the generation, storage, transportation and disposal of hazardous waste.

Recyclables were also removed from the logging site. Small local towns have recycle collection, which is later transported to a larger processing facility. Swan River, Roblin, and Dauphin have recycling processing facilities.

2.6.4. Logging camps included associated water supplies and wastewater storage and disposal

Most loggers in FML #3 commuted to the harvesting site and did not use logging camps. The minority of loggers that used logging camps for overnight accommodations were very small scale (*i.e.* 2 to 10-person camps). Furthermore, these camps are temporary. Logging camps typically consisted of one or two trailers on wheels.

The water supply for these temporary camps is potable water that is hauled in to supply the camp. Potable water is held in a storage tank. No wells of any sort are dug. Waste water from the camp was temporarily stored in containers. The wastewater was then removed from camp for disposal.

2.7. Forest Renewal

Forest renewal and stand management were an integral part of responsible forest stewardship and forest management. Louisiana-Pacific Canada Ltd. was assigned all forest renewal and stand management obligations and responsibilities within the area of Forest Management Licence # 3 (Forest Management Units 10, 11 and 13). Even though LP only uses hardwood, this licence responsibility includes all Quota Holders softwood harvest and hardwood harvest.

The FML Agreement (dated Sept. 21, 1994) states in section 22 (D):

> *"The Company acknowledges its primary forest management and renewal responsibility by ensuring that all harvested areas within FML 3 are regenerated to approved Provincial Standards."*

This commitment to forest renewal shall ensure:

- A perpetual sustained timber yield from the productive forest lands harvested; and
- The maintenance of forested ecosystems within FML #3.

On Jan. 1st, 2007 the Mountain Forest Section Renewal Company (MFSRC) took responsibility for all softwood renewal in the Mountain Forest Section (Duck and Porcupine Mountain Provincial Forests, as well as FMUs 10, 11, and 13). Louisiana-Pacific Canada Ltd. remained responsible for all hardwood renewal, including hardwood Quota Holders.

The MFSRC and Louisiana-Pacific Canada Ltd. managed and maintained forest ecosystems on a landscape-level basis. One hundred percent (100%) of areas harvested were regenerated by either planting softwood seedlings, natural regeneration of hardwood, or natural regeneration of softwood. Hardwood, mixedwood, and softwood ecosystems were maintained through a variety of silvicultural systems and treatments, such as: variable retention harvesting; leaving conifer seed trees with wildlife clumps; softwood understory protection; hardwood natural regeneration, and planting conifer seedlings.

2.7.1. Cone Collection

A summary of the cone collection efforts are shown in Table 2.18. The cones and extracted seeds were stored at Pineland Forest Nursery in Hadashville, Manitoba until 2018. In early 2019 the seeds were moved to a private nursery in Prince Albert, Saskatchewan. The seeds were used to grow softwood seedlings to reforest cut blocks.

Table 2.18 Summary of cone collection and number of extracted seeds, by species and year.

Year	Type	black spruce (hecto litres)	white spruce (hecto litres)	jack pine (hecto litres)	Total (hecto litres)
2006	White Spruce (seed orchard)		8.2		**8.2**
2007					**0.0**
2008					**0.0**
2009					**0.0**
2010					**0.0**
2011					**0.0**
2012					**0.0**
2013					**0.0**
2014					**0.0**
2015	black spruce (wild)	1.5			**1.5**
2016	black spruce (wild)	1.1			**1.1**
2017	black spruce (wild)	9.8		0.5	**10.3**
2018					**0.0**
2019					**0.0**
	Totals	**12.4**	**8.2**	**0.5**	**21.1**

2.7.2. *Scarification and Site Preparation Practices*

Scarification of a site involves preparing the ground for planting by creating microsites suitable for seedling establishment. Scarification was only utilized on softwood sites that were deemed necessary to mechanically create planting micro-sites. Although different site preparation and scarification techniques exist (*e.g.* ripper tooth plow, Bracke scalping, disc trenching, shark fin barrels and anchor chains) only the shark fin barrels and anchor chains (Table 2.19 and Figure 2.28) have been used since 2006.The other scarification and site preparation methods were discontinued due to:

- high cost
- promoted and increased competition (*e.g.* grass) on the sites
- damaged aspen roots, thereby creating a vector for pathogen entry
- not necessary on many sites due to hot planting (*i.e.* planting the same year as harvest)
- access constraints associated with winter harvest areas

In addition, scarification was only applied where necessary. Many areas did not require this treatment since larger seedlings can overcome much of the understory competition.

Table 2.19 Summary of annual scarification.

Year	Scarification Type	Annual Total Area (ha)
2006	Shark fin barrels and anchor chains	139
2007	Shark fin barrels and anchor chains	86
2008	Shark fin barrels and anchor chains	147
2009	Shark fin barrels and anchor chains	100
2010	Shark fin barrels and anchor chains	103
2011	none	0
2012	Shark fin barrels and anchor chains	126
2013	Shark fin barrels and anchor chains	99
2014	Shark fin barrels and anchor chains	81
2015	none	0
2016	none	0
2017	none	0
2018	Shark fin barrels and anchor chains	96
2019		0
	Total	**881**

Figure 2.28 Scarification with barrels and chains

2.7.3. Snow Cache

Winter-only accessible areas that needed to be planted utilized snow caches as an over-winter storage method for seedlings (Table 2.20 and Figure 2.29). This ensured that seedlings would be on-site for planting in the spring. Boxes of seedlings were stored in strategically located areas and were stacked on pallets and wrapped in poly prior to being buried with one metre of clean snow. An insulating layer of sawdust was then placed over the snow to insulate the seedlings and regulate their temperature. Trees were removed from snow caches and planted in the spring. Snow caches have been replaced by the use of a helicopter to transport boxes of trees and tree planters onto the site.

Table 2.20 Annual summary of snow-cached trees by species.

Year	Black Spruce	White Spruce	Jack Pine	Total # of Seedlings
2006-2007	284,160	390,600	5,400	**680,160**
2007-2008	208,500	326,100	22,000	**556,600**
2008-2009	141,000	272,760	90,600	**504,360**
2009-2010	157,200	297,720	25,200	**480,120**
2010-2011	267,000	239,760	36,600	**543,360**
2011-2012	419,040	278,640	55,800	**753,480**
2012-2013	165,580	156,160	11,400	**333,140**
2013-2014	233,791	218,880	0	**452,671**
2014-2015	150,900	217,080	0	**367,980**
2015-2016	0	0	0	**0**
2016-2017	0	0	0	**0**
2017-2018	0	0	0	**0**
2018-2019	0	0	0	**0**
Totals	**2,027,171**	**2,397,700**	**247,000**	**4,671,871**

Figure 2.29 Boxes of softwood seedlings were snow cached by covering them with snow and then insulating sawdust.

2.7.4. Forest Renewal Methods

There are three main methods of forest renewal described below: leave-for-natural regeneration; tree planting; and natural regeneration from seed.

2.7.4.1. *Leave-For-Natural*

Hardwood natural regeneration was dependent upon suckering from the tree roots. Buds on both aspen and black poplar tree roots must be stimulated by sunlight warming the soil. Removal of the tree canopy allowed more sunlight to reach the ground and warm the soil. Excessive slash (*i.e.* tree tops and limbs) intercepted sunlight, keeping soils cool, and potentially inhibited natural regeneration. Soil compaction could reduce natural regeneration by reducing soil pore space, which impeded infiltration of air and moisture to the roots.

Coppicing or stump-suckers are a common natural regeneration method of birch trees. A disturbed tree, whether burnt from fire or harvested, will produce 10 to 50 stump suckers per tree. The suckers utilized the large existing adult root system, allowing the suckers to grow quickly and vigorously.

All local hardwood trees produced seeds, which assisted in naturally regenerating areas. Poplar regeneration from seed is far less common that root suckering, due the very small seed size of poplar. White birch regenerates more readily from seed and has a much larger and vigorous seed than the poplars. Less abundant hardwoods, such as green ash, Manitoba maple, and American elm, have large seeds which are typically produced in abundance each year. Bur oak has the largest seed, an acorn, but produces less seed.

2.7.4.2. *Planting*

Planting softwood seedlings was a preferred method of reforestation for softwood cut blocks and clumps of softwood within hardwood blocks. Large high-quality softwood seedlings were planted each spring, immediately following harvest for prompt reforestation. Table 2.21 and Figure 2.30 summarize the species and numbers of trees planted from 2006 to 2019.

Table 2.21 Annual number of trees planted by species.

Year	black spruce	white spruce	jack pine	Total # of trees	area planted (ha)
2006	657,620	582,660	108,520	**1,348,800**	969.4
2007	599,925	660,465	123,900	**1,384,290**	1,070.5
2008	588,916	681,664	101,282	**1,371,862**	943.7
2009	364,366	412,611	144,730	**921,707**	616.6
2010	270,660	526,704	51,000	**848,364**	557.1
2011	802,965	556,635	57,600	**1,417,200**	887.2
2012	501,572	479,017	55,800	**1,036,389**	782.4
2013	422,409	689,031	11,400	**1,122,840**	782.5
2014	275,640	585,600	0	**861,240**	573.4
2015	403,200	603,720	0	**1,006,920**	738.1
2016	216,000	680,760	10,100	**906,860**	658.6
2017	226,560	706,320	0	**932,880**	702.8
2018	552,480	602,280	0	**1,154,760**	787.6
2019	622,080	515,040	0	**1,137,120**	773.0
			Totals	**13,159,352**	**9,282.2**
			averages	***1,096,613***	***773.5***

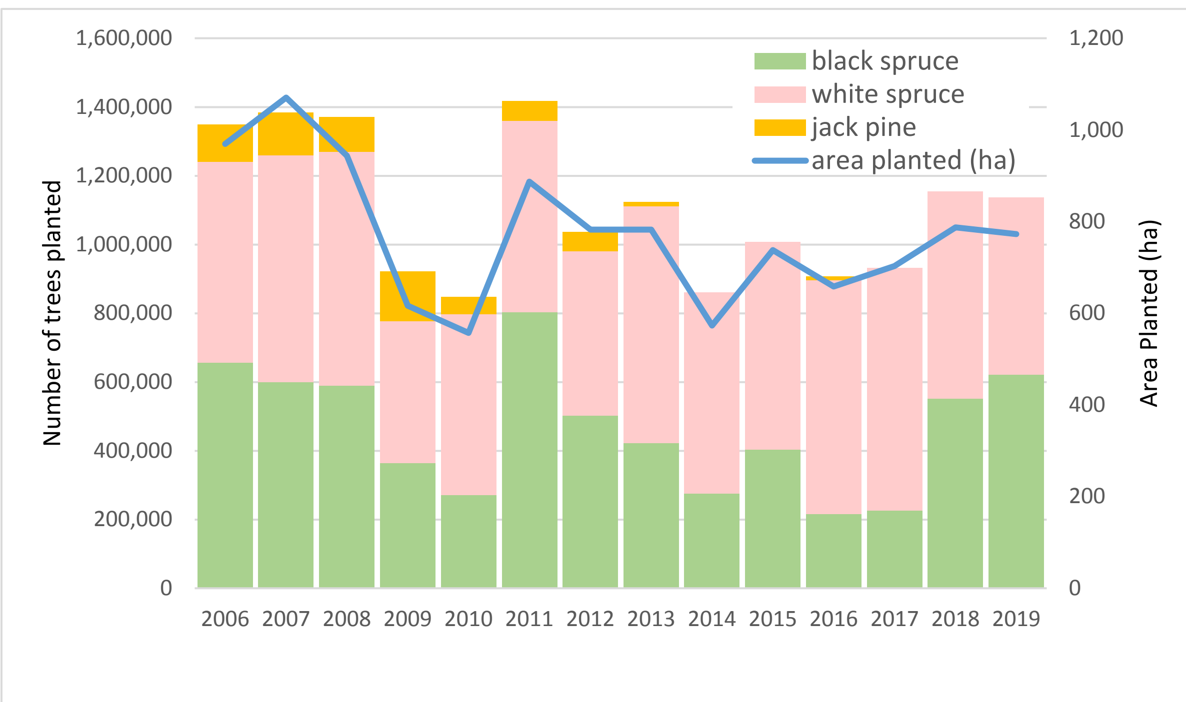


Figure 2.30 Area planted and number of trees planted by species.

2.7.4.3. *Natural Regeneration from Seed*

Although hardwoods can regenerate from seed, this section is limited to the regeneration of softwood species from seed. Jack pine seeds need mineral soil to successfully germinate. Black spruce seeds also germinate in mineral soil (Figure 2.31).

Figure 2.31 Jack pine and black spruce germinants from seed.

White spruce seeds can germinate on mineral soil, but are often found successfully growing on moist, rotting wood on the forest floor (Figure 2.32).

Figure 2.32 White spruce germinating on a rotting log.

2.7.5. *Regeneration Success*

One hundred percent (100%) of areas harvested were successfully regenerated by either planting softwood seedlings, natural regeneration of hardwood, or natural regeneration of softwood (Table 2.22 and Figure 2.33).

Table 2.22 Regeneration of all harvested areas.

Operating Year	FML 3 Area Harvested (ha)	Hwd Natural Regeneration (ha)	Planted Area (ha)	Swd Natural regeneration (ha)	*silvic exemption* (ha)*	REGENERATED TOTAL AREA (ha)	% harvested area regenerated (%)
2006-2007	2,364.2	1,394.1	969.4	0.7		2,364.2	100%
2007-2008	2,706.4	1,631.9	1,070.5	4.0		2,706.4	100%
2008-2009	1,130.5	186.2	943.7	0.6		1,130.5	100%
2009-2010	1,085.7	465.3	616.6	3.8		1,085.7	100%
2010-2011	1,814.1	1,248.0	557.1	9.0		1,814.1	100%
2011-2012	1,581.8	693.2	887.2	1.4		1,581.8	100%
2012-2013	1,242.3	458.0	782.4	1.9		1,242.3	100%
2013-2014	1,815.7	1,032.0	782.5	1.2	*184.1*	1,815.7	100%
2014-2015	2,655.5	2,081.8	573.4	0.3		2,655.5	100%
2015-2016	1,333.2	595.2	738.1	0.0	*24.0*	1,333.2	100%
2016-2017	1,640.5	981.3	658.6	0.6		1,640.5	100%
2017-2018	2,348.9	1647.0	701.9	0.0		2,348.9	100%
2018-2019	2,180.6	1,393.0	787.6	0.0		2,180.6	100%
Totals	**19,370**	**10,767**	**8,579**	**24**	***208***	**19,370**	

*silviculture exemption due to beaver flooding, cattle grazing, new cabins, fence line clearing *etc.*

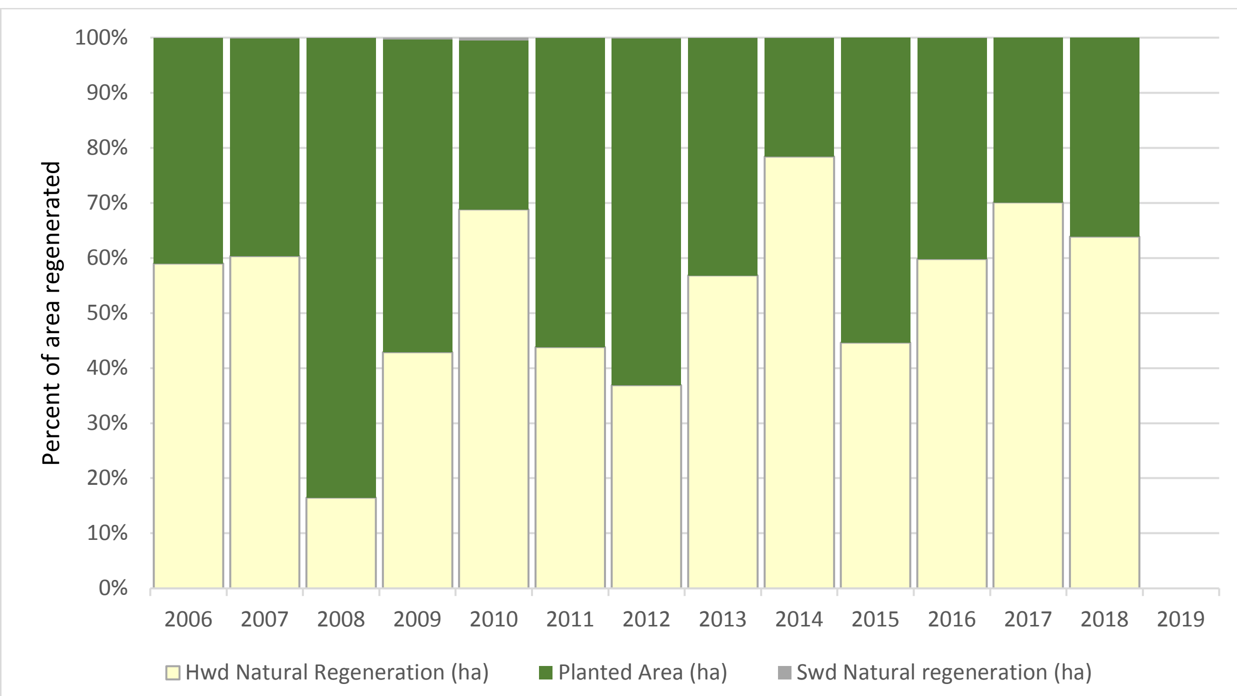


Figure 2.33 Regeneration of all harvested areas by natural regeneration or planting.

2.7.5.1. *Regeneration Summary*

Regeneration of harvested areas to approved Provincial standards depended upon original cover type (*e.g.* hardwood or softwood) and stand age. Hardwood regeneration surveys measured forest renewal success by assessing stocking (presence or absence of suitable crop trees), in addition to density, tree height, and competition measures. Naturally regenerating hardwood blocks required 80% or higher stocking to pass the survey and meet the requirement for 'Sufficiently Regenerated'. The Province of Manitoba forest regeneration survey manual (Forestry Branch 2014a) outlined procedures and regeneration standards. All surveyors performing regeneration surveys were certified by the Province of Manitoba. The regeneration surveys were check-surveyed by the provincial government.

Softwood regeneration surveys at age 7 years were discontinued in 2015 in favour of softwood Free To Grow surveys. In addition, the year of softwood survey changed from 14 years after planting, to 10 years after planting. The field procedures follow the provincial survey manual (Forestry Branch 2014b) and are check surveyed by the provincial government.

Table 2.23 summarizes all harvested blocks that have received either a 'Certificate of Reforestation' or Free To Grow certification.

Table 2.23 Number of harvest blocks issued Certificate of Reforestation or Free To Grow.

	Hwd regeneration		Swd regeneration		14 year Free To Grow			
Year of Survey	Hwd Area (ha)	# hwd blocks (H & N)	Swd Area (ha)	# swd blocks (M & S)	FTG area (ha)	# FTG blocks (M & S)	Total area surveyed (ha)	Total # surveyed blocks
2006	1,058	30	452	10			1,510	40
2007	1,196	47	810	24			2,006	71
2008*	0	0	202	8			202	8
2009	1,471	51	676	13			2,147	64
2010	1,996	31	1,180	33			3,176	64
2011	2,884	81	151	3	1,247	30	4,281	114
2012	2,235	90	932	24	503	13	3,669	127
2013	2,068	65	432	11	1,034	24	3,534	100
2014	516	29	255	6	714	24	1,485	59
2015	1,939	60			496	13	2,435	73
2016	2,833	89					2,833	89
2017	2,273	84					2,273	84
2018	1,878	72	1,077	26			2,955	98
2019	1,937	62	1,817	62			3,754	124
Totals	**24,284**	**791**	**7,982**	**220**	**3,993**	**104**	**36,259**	**1,115**

*in 2008 LP changed from surveying in the fall to surveying in the spring of the following year
**includes blocks from FMUs 12 & 14 (outside FML #3)
7 year swd regeneration surveys were discontinued by the Manitoba government
note that 14 year FTG surveys could not start until 2011
also note that 14 year FTG changed to 10 year FTG in 2013
FTG was discontinued in 2018 in favour of softwood regeneration survey

2.7.5.2. *Regeneration Surveys*

Sustainable Forest Management was a goal for the management of Forest Management Licence #3. A significant portion of sustainability was successful regeneration of harvested sites, producing goods and ecological services in the present and for future generations. The regeneration success of both naturally-regenerated hardwoods and planted softwoods was consistently excellent.

Regeneration surveys were measured five years post-harvest for hardwood, and seven years post-harvest for softwood. A summary of all regeneration surveys, both hardwood and softwood, is presented in Table 2.24, for all sites surveyed from the year 2000 to 2017. Provincial hardwood regeneration standards are a minimum of 80% stocking to pass (*i.e.* Sufficiently Regenerated). Hardwood sites averaged 97%, 95%, and 97% stocking for H-hardwood, H-hardwood leased land, and N-hardwood-softwood mixedwood sites, respectively. Softwood regeneration surveys measured between 2000 and 2014 averaged 95% stocking.

Table 2.24 Regeneration survey summary of both hardwood and softwood.

			STOCKING %			Density (trees per ha)				
Pre Harvest cover group	**# harvest blocks**	**Area Surveyed (ha)**	**Swd**	Hwd	**Total**	**Swd**	Hwd	**Total**	Hwd Avg Ht (m)	**Swd Avg Ht (m)**
H - hardwood	751	21,482	11	96	**97**	382	20,246	**20,621**	2	
H - hardwood leased land	83	1,720	3	95	**95**	111	19,438	**19,548**	2.5	
N - hardwood-softwood mixed	142	4,419	28	95	**97**	787	19,203	**19,991**	1.9	
*M - softwood-hardwood mixed & S - softwood	308	11,399	72	80	**95**	2,458	12,836	**15,294**	1.7	0.5
totals	1284	39,020								
averages			28.5	92	96	935	17,931	18,864	2.0	0.5

**softwood regeneration surveys were discontinued in 2014 in favour of free-to-grow surveys*
H and N - hardwood surveyed (2000 to 2017)
softwood surveyed (2000 to 2014)

Treatment and response percentages were calculated by the Provincial government and Louisiana-Pacific Canada Ltd., based on previous silviculture surveys. The Leave-For-Natural silviculture summary is shown in Table 2.25.

Table 2.25 Responses to Leave-For-Natural silviculture.

	post S	post M	post N	post H	Area (ha)	data sources:
pre-S	**51%**	34%	10%	5%	**663**	all historical survey data collected from FMU 13 (survey years: 1986 to 1995)
pre-M	28%	**56%**	8%	8%	**967**	all historical survey data collected from FMU 13 (survey years: 1986 to 1995)
pre-N	1%	6%	**19%**	74%	**2,003**	data collected from blocks at harvest year of 1996 and above from FML-3
pre-H	1%	2%	6%	**91%**	**14,148**	data collected from blocks at harvest year of 1996 and above from FML-3

2.7.5.3. ***Free-To-Grow Surveys***

Free-To-Grow surveys are measured on softwood plantations at age 14 years. No plantations were old enough to measure until the year 2011.3,393 ha (104 blocks) of softwood plantations were surveyed between 2011 and 2015 (Table 2.26).

Table 2.26 Free To Grow softwood plantation summary.

	Density (trees/ ha)			Well-Spaced (trees/ ha)			Free-To-Grow (trees/ ha)					
	Swd	Hwd	Total	Swd	Hwd	Total	WS	BS	JP	BF	TL	Total FTG
avgs	**3,334**	**4,215**	**7,550**	**1,292**	**367**	**1,495**	**213**	**367**	**388**	**45**	**80**	**785**
min	250	0	1,477	125	0	563	0	17	13	0	0	63
max	42,917	10,042	43,084	2,524	1,250	2,524	1,000	1,143	1,571	300	1,250	2,393
Std. dev	4,401	2,324	4,366	454	306	379	195	268	317	70	232	478

The Free To Grow survey system classifies surveyed sites into categories:

- FTG (Free-To-Grow)
- NFTG (Not Free To Grow) sufficient softwood trees, but hardwood trees are present and assumed to be significant competitors
- Mixed – mixedwood rather than softwood dominated site
- Hardwood – mostly hardwood trees

Furthermore, these categories are sub-divided into S – softwood and M – softwood mixedwood. Further subdivision based on softwood species (*e.g.* white spruce, back, spruce, jack pine) exist, but are not shown for this summary. The pie graph (Figure 2.34) shows that the majority of softwood plantations were Free-To-Grow softwood (FTG-S) or mixedwood (FTG-M).

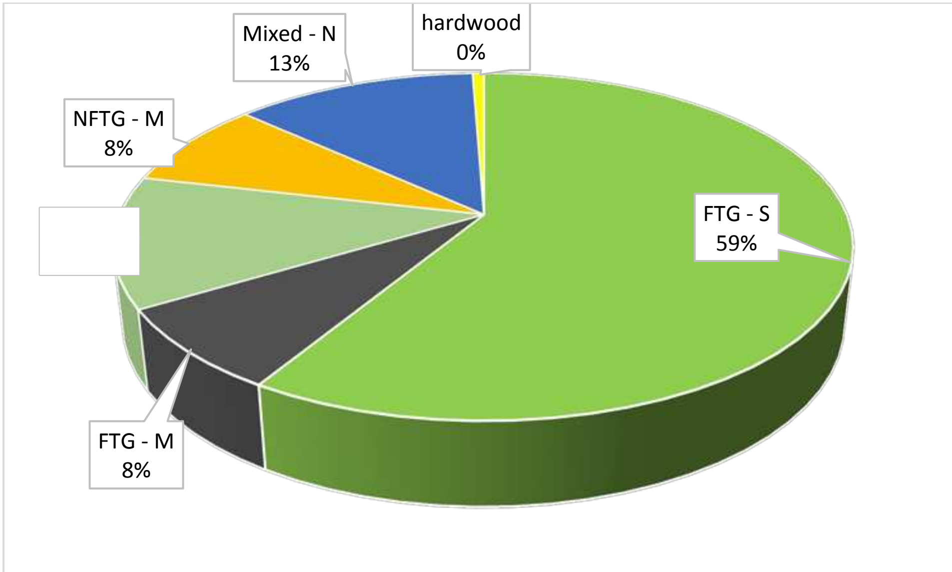


Figure 2.34 Free To Grow standards summary.

Free-To-Grow surveys are being discontinued in favour of a less complicated renewal assessment procedure. Softwood plantations are surveyed using the regeneration survey procedure from the 2018 field season and into the future.

Treatment and response percentages were calculated by the Provincial and Louisiana-Pacific Canada Ltd., based on plantation silviculture from existing surveys (Table 2.27).

Table 2.27 Responses to plantation silviculture.

PLANTED: Based on data collected from blocks at harvest year of 1996 and above from FML # 3					
	post-S	**post-M**	**post-N**	**post-H**	**Area (ha)**
pre-S	**62%**	29%	8%	1%	**2,436**
pre-M	31%	**44%**	21%	4%	**3,095**
pre-N	24%	48%	**23%**	5%	**8,020**
pre-H	8%	40%	33%	**19%**	**5,013**

2.7.6. *Stand Tending*

Stand tending refers to mechanical or chemical release of softwood trees from competition (*e.g.* grass, shrubs, or hardwoods). There have only been two years (Table 2.28) where stand tending was performed, 2006 and 2010. The chemical used was Vision® Silvicultural Herbicide (glyphosate).

Since the initial implementation of the herbicide program, serious effort has been put into adopting techniques which reduce the amount of area to be treated. Techniques used to accomplish this include: planting immediately after harvest, the use of larger planting stock, and planting a higher density of trees. These various techniques all help to reduce the need for herbicides for plantations and other harvested areas to reach Free-To-Grow status.

Table 2.28 Stand tending in FML #3 (2006 to 2019).

Year	Tending Description	Area (ha)
2006	Aerial tending (helicopter) fall 2006	689
2007	none	0
2008	none	0
2009	none	0
2010	back pack spray	487
2011	none	0
2012	none	0
2013	none	0
2014	none	0
2015	none	0
2016	none	0
2017	none	0
2018	none	0
2019	none	0
totals		**1,176**

2.7.6.1. *Type of Herbicide Used*

Aerial spray 2006 – used Vision and VisionMax, both have the active ingredient glyphosate.

Backpack spray 2010 – used VisionMax with the active ingredient glyphosate. VisionMax is improved from Vision because can use ½ hour before rain. VisionMax can also be used later in the season, even when the competition vegetation's leaves are a little yellow. Mixes with water.

2.7.6.2. *Volume of Herbicide*

Aerial spray 2006 – used 3,487 litres of Vision and 128 litres of VisionMax for a combined total of 3,615 litres. Actual area sprayed was 689 ha. An average of 5.2 litres per ha of herbicide was used.

Backpack spray 2010 - actual sprayed area: 487.23 ha, 908.1 litres chemical used. 1.84 L/ha used on average at approximately 2% concentrations.

2.7.6.3. *Methods of Application*

Aerial spray in 2006 was with a helicopter. Aircraft used AgNav (GPS) guidance systems. Pilots and operators were provided cutover photography indicating "no spray" zones, as well GIS block shape files.

Backpack spray 2010 was ground spray with workers who had a spray backpack and wand. Backpack spray is more labour-intensive but allows for very precise spray application around conifer crop trees.

2.7.6.4. *Measures to Protect Human Health*

Aerial Spray 2006 – 15 metre no spray zone adjacent to the harvest blocks edges in order to avoid drift into adjacent forest edge. There is virtually zero drift. Aerial spraying must cease if the wind speeds exceed 10 km per hour.

Back pack spray 2010 - All recommended safety equipment was worn while performing all applications duties. This included chemical resistant CSA boots, long sleeve shirts or coveralls, hardhats, high visibility vests, and goggles or glasses.

Signs are posted while blocks are being sprayed (one-week pre and post-spray).

2.7.6.5. *Measures to protect Non-Target Species*

Aerial spray 2006 - 30 m no spray buffer around all water bodies.30 m buffer on the Duck Mountain Provincial Park boundary.15 m spray buffer on both the block boundary and residual tree patches with in the cutblock. Aerial spraying must cease if wind speeds exceed 10 km per hour.

Back pack spray 2010 started on August 20 and was completed by September 15, 2010.The blocks were mapped and flagged. Only sprayed in favorable weather conditions, and stop spraying when local wind speed exceeds 10 km/hr.

2.7.6.6. *Measures to protect the Environment*

Leave areas include:

- Sections of the block that has 3 m or taller poplar was left.
- Any residuals in the block was left especially poplar.
- Areas with no to little competition was left unsprayed.

Spray Buffers include:

- 5 m buffers on wetlands, beaver ponds, and in-block streams.
- 5 m buffer on main access roads.
- 5 m buffer on in-block roads if road is used by ATV's.

A map depicting all forest renewal activities from 2006 to present is shown in Figure 2.35.

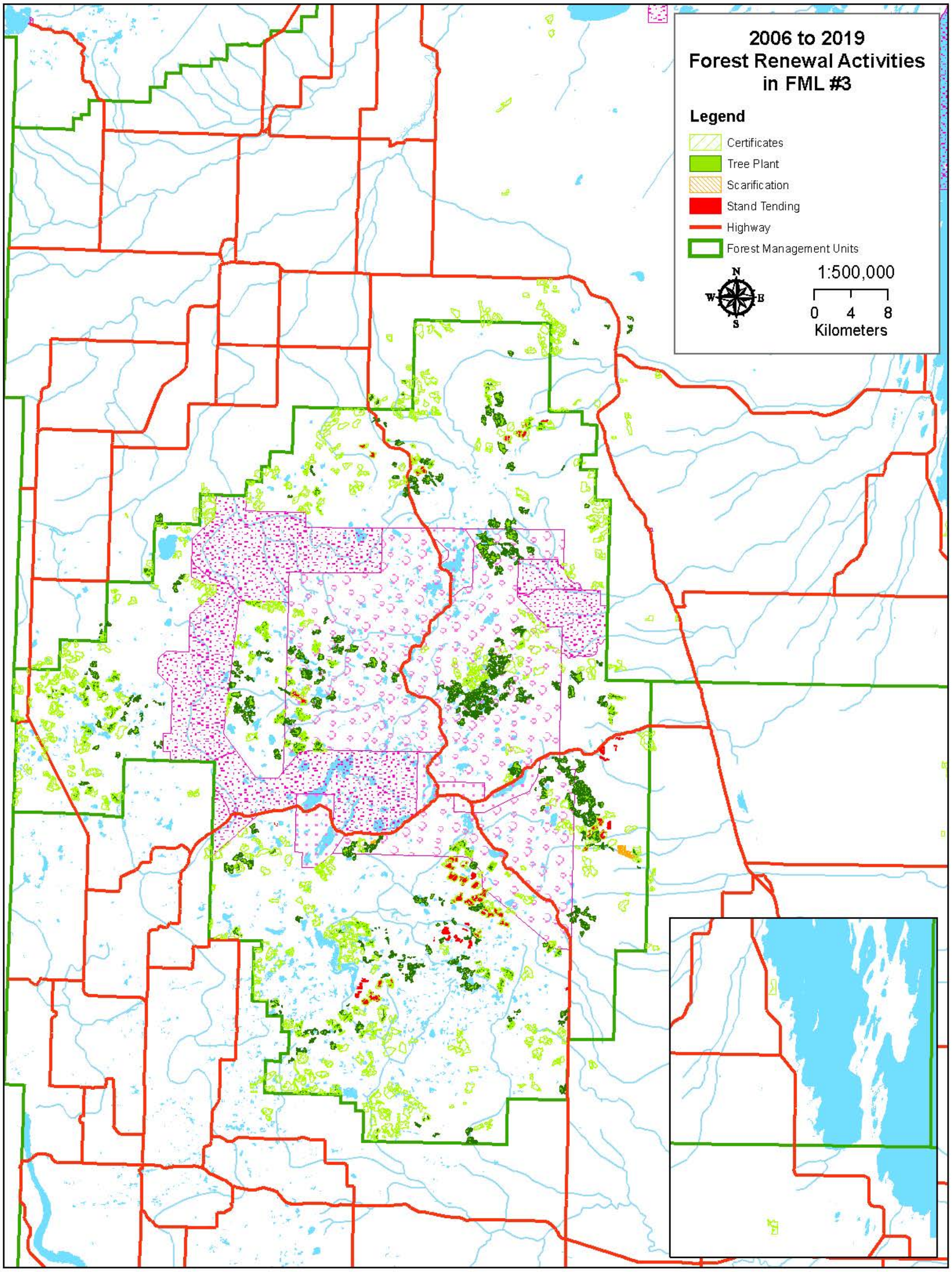


Figure 2.35 Renewal activities in Forest Management Licence # 3 (2006 to 2019)

*note a second copy of this map with a much larger scale and detail exists in Appendix 3.

2.8. Research & Monitoring

Louisiana-Pacific Canada Ltd. was actively engaged in the development and implementation of research and monitoring in support of Sustainable Forest Management. Multi-scale, integrated management approaches increased our understanding of boreal ecosystems function and processes. The research and monitoring program addressed data and knowledge gaps, and acquired new knowledge related to terrestrial and aquatic ecosystems. Planning and operational practices were continuously improved, utilizing the research and monitoring knowledge.

A list and summary of research and monitoring projects from 2006 to present were presented in the following sections. Collaborative research partnership projects, research organization affiliations, and company-sponsored research projects were described. Results and data collected from these projects have been incorporated where possible into this Forest Management Plan.

2.8.1. Collaborative Research Projects

This section describes multi-agency collaborative research projects that Louisiana-Pacific Canada Ltd. has participated in. The agencies include conservation groups, universities, research organizations, provincial and federal government departments (Table 2.29). These collaborative research projects were supported by Louisiana-Pacific Canada Ltd. and other partners in various ways, depending on project requirements. Support by Louisiana-Pacific Canada Ltd. and Spruce Products Ltd. included direct research funds and in-kind contributions such as spatial data, aerial imagery, and forest management professional staff time.

Table 2.29 Collaborative research projects 2006 to present.

Year(s)	Principal Investigator	Project Description
2007	Kevin Smith (Ducks Unlimited Canada)	Wetlands mapping and classification across western Canada from LANDSAT 30 m pixels (DUC publication)
2007	Mike Bokalo, Philip G. Comeau and Stephen J. Titus (University of Alberta)	Early development of tended mixtures of aspen and spruce in western Canadian boreal forests. (published in Forest Ecology and Management)
2007	Theresa L. Mundell, Simon M. Landhausser, Victor J. Lieffers (University of Alberta)	Effects of Corylus cornuda stem density on root suckering and rooting depth of Populus tremuloides. The regeneration capabilities of over-aged aspen stands containing heavy hazel competition. (published in Can. J. Bot.)
2008	Theresa L. Mundell, Simon M. Landhausser, Victor J. Lieffers (University of Alberta)	Impacts of season of harvest on aspen regeneration. (published in Forest Ecology and Management)
2008	Iain Edye, M.Sc. candidate, Department of Biological Sciences, University of Alberta.	White-tailed deer movement, habitat use, and potential for disease transmission in the greater Riding Mountain and Duck Mountain ecosystems. (M. Sc. Thesis, University of Alberta)
2009	Kevin J. Kardynal, Keith A. Hobson, Steven L. Van Wilgenburg, Julienne L. Morissette	Moving riparian management guidelines towards a natural disturbance model: An example using boreal riparian and shoreline forest bird communities (published in Forest Ecology and Management)
2009	Dan Chranowski	Cow elk ecology, movements and habitat use in the Duck Mountains of Manitoba. (M.Env. thesis, University of Manitoba)

Year(s)	Principal Investigator	Project Description
2009	Comeau, P., V. Reyes-Hernandez, H. Chen, N. Kenkel, M. Bokalo, C. Hawkins, K. Greenway, A. Velazquez-Martinez. (U of A)	Influence of relative density and composition on growth and understory in the boreal mixed-woods. SFMN project report.
2010	Triin Hart, Han Chen, Anthony Taylor, Paul LeBlanc, Steve Watson	Management Implications of Disturbance and Aging on Forest Stand Composition (Sustainable Forest Management Network)
2010	Julienne Morissette and Margaret Donnelly	Riparian Areas - Challenges and Opportunities for Conservation and Sustainable Forest Management (Sustainable Forest Management Network)
2010	Robert S. Rempel (CNFER) and Margaret Donnelly (LP)	A Spatial Landscape Assessment Modeling Framework for Forest Management and Biodiversity Conservation (Sustainable Forest Management Network)
2010	Jeff Renton (University of Manitoba), Andrew Park, and Richard Westwood (University of Winnipeg, Centre for Forest Interdisciplinary Research)	The Impact of Cattle Grazing on Aspen regeneration on Crown Lands in Western Manitoba. (U of Manitoba thesis)
2010 & 2015	Manitoba Agriculture and Food	Garland Grazing Trial (1997 - 2015). Draft report – Province of Manitoba
2011	Irena Creed, Gabor Sass, Fred Beall, Jim Buttle, Dan Moore, Margaret Donnelly	Hydrological principles for conservation of water resources within a changing forested landscape (SFMN: A State of Knowledge Report)
2011	K.J. Kardynal, J.L. Morissette, S.L. Van Wilgenburg, E.M. Bayne, and K.A. Hobson	Avian responses to experimental harvest in southern boreal mixedwood shoreline forests: Implications for riparian buffer management (published in Cdn. J. Forest Res.)
2013	Mike Bokalo, Kenneth J. Stadt, Philip G. Comeau, and Stephen J. Titus (University of Alberta)	The Validation of the Mixedwood Growth Model (MGM) for Use in Forest Management Decision Making. (published in Forests)
2013	J. L. Morissette & K. J. Kardynal & E. M. Bayne & K. A. Hobson	Comparing Bird Community Composition Among Boreal Wetlands: Was Wetland Classification a Missing Piece of the Habitat Puzzle? (published in Wetlands)
2014	Ducks Unlimited Canada	Forest Road Wetland Crossings. (DUC publication)
2015	Ducks Unlimited Canada	Field Guide Boreal Wetland Classes in the Boreal Plains Ecozone of Canada. (DUC publication)
2016-2019	Saskatchewan Research Council, Ducks Unlimited Canada, Louisiana-Pacific Canada Ltd., Spruce Products Ltd., University of Brandon, University of Saskatchewan	Carbon in Wetlands Project (2016-2019). Sampling wetlands for peat depth, peat samples, wetland type, vegetation, shrubs, and trees (if any). Quantifying carbon stocks by wetland type and across the landscape.
2017 (3-year project in progress)	Han Chen (Lakehead University), U of Wpg, U of A, CFS-Atlantic Forest Centre, provincial forestry branches of Ontario, Manitoba, and Saskatchewan, Resolute Forest Products, and Louisiana-Pacific Canada Ltd.	Assessing climate change impacts on timber resource availability in western-central Canada: Economic implications and mitigation. (NSERC funded)

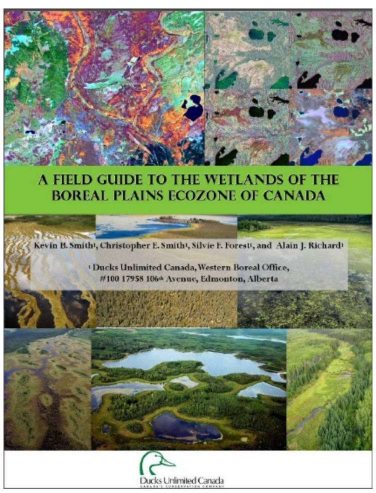
Year(s)	Principal Investigator	Project Description
2018 to 2020	Mark Johnston (Saskatchewan Research Council) and Dana Collins (Canadian Institute of Forestry) 13 project partners	Northern Prairie Forests Integrated Regional Assessment (NPFIRA) - climate change vulnerability assessment
2018 and 2019	Nicole Barker (University of Alberta) 17 project partners, including the Central and Western Canada SFI committees	BAM – Boreal Avian Modeling http://www.borealbirds.ca/ Applying data-driven measures to evaluate and improve the conservation value of managed forests for birds.

The following sub-sections provide a short summary for each of the projects listed in the table above, grouped by organization instead of chronologically.

2.8.1.1. *Ducks Unlimited Canada Collaborative Projects*

Ducks Unlimited Canada (DUC) has a long and productive history with Louisiana-Pacific Canada Ltd. Many mutually-beneficial projects were completed in the Duck Mountain area.

Smith, K., C.E. Smith, S.F. Forest, and A.J. Richard. 2007. A field guide to the wetlands of the boreal plains ecozone of Canada. Ducks Unlimited Canada publication.



The field guide to the wetlands of the Boreal Plains Ecozone of Canada provides a remote sensing-based wetland classification system. The Boreal Plains ecozone covers 740,632 square kilometers of the 2.6 million square kilometers of the Western Boreal Forest and extends across portions of British Columbia, Alberta, Saskatchewan and Manitoba.

This wetlands inventory utilizes 30 m resolution LANDSAT satellite imagery to outline an approach that incorporates information at various observation levels (ground, aerial, and satellite) into a comprehensive wetland classification system that can be used for field identification as well as for mapping purposes. The general wetland classes determined in the field guide were applicable at a national scale (bog, fen, marsh, swamp, open/shallow water) but designed to be interchangeable at a regional scale with the more detailed wetland classes (to compensate for regional scale differences in vegetation/climate/wetland type/distribution) with the more detailed wetland classes.

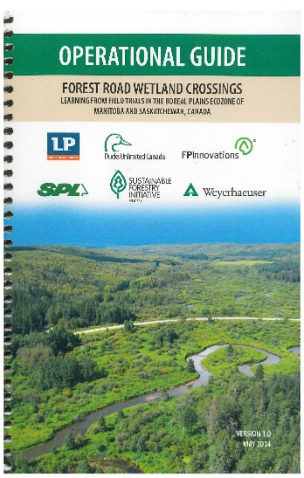
Morissette, J.L. & K. J. Kardynal & E. M. Bayne & K. A. Hobson. 2013. Comparing Bird Community Composition Among Boreal Wetlands: Was Wetland Classification a Missing Piece of the Habitat Puzzle? (published in Wetlands (2013) 33:653–665)


ARTICLE

Comparing Bird Community Composition Among Boreal Wetlands: Is Wetland Classification a Missing Piece of the Habitat Puzzle?

Despite making up 20–60% of the North American boreal landscape, wetlands and their associated bird communities remain poorly understood. In the context of forest management and avian conservation, wetland classification presents an opportunity to classify and investigate wetland bird communities. We compared bird communities among a suite of eight wetland classes in the southern Boreal Plains ecozone of Manitoba and tested whether wetland classification was a useful tool for delineating habitat for birds. To provide context for how wetlands fit into a managed forest setting, we compared wetland classes with structurally similar harvested deciduous and mixedwood stands early in succession (5–7 years) to assess potential overlap in community composition. We conducted fixed radius (100 m) point counts across 83 sites and used a combination of multivariate techniques to determine whether individual wetland classes supported characteristic bird assemblages and species. Our study suggests using established approaches to classifying wetlands will be helpful for documenting the full breadth of habitats used by boreal birds. Given ongoing industrial development, particularly in the boreal plains ecozone, further research was needed to determine effects of human disturbance and support the conservation of a full spectrum of wetland classes in the boreal landscape.

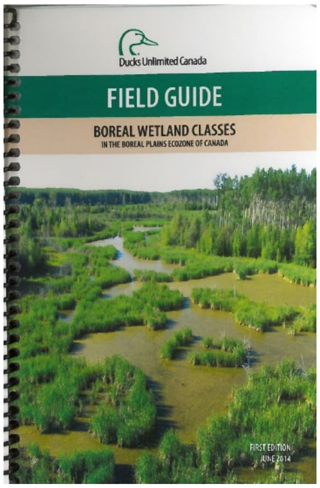
2014 Operational Guide - Forest Road Wetland Crossings (with Sustainable Forestry Initiative funding). Within FML #3, there were three test sites in the Porcupine Mountain and one in the Duck Mountains. The operational guide was developed for western Canada and led to a national guide being developed by FP Innovations.



Knowing where wetlands are located and understanding how water flows through them can help ensure a successful road project, while minimizing impacts to wetland ecosystems.

Many boreal wetlands are highly connected systems that move water and nutrients slowly across the landscape making them vulnerable to road development that can potentially block water flow. This impedance of flow may result in the die off of trees or other long-term vegetation changes. This can be a very gradual process depending on the extent of damming and can sometimes take decades to see the full effects of these hydrologic changes.

2015 Field Guide Boreal Wetland Classes in the Boreal Plains Ecozone of Canada



The wetland classes were a companion guide to the 2014 Forest Road Wetland Crossings. This guide was intended for resource managers to help them identify wetlands while in the field. This guide was based on the Enhanced Wetland Classification system developed by Ducks Unlimited Canada (DUC) for the Boreal Plains Ecozone of Western Canada and conforms to the Canadian Wetland Classification System. It will help identify five major wetland classes: marsh, swamp, fen, bog, open water. Furthermore, the user can then key and identify which of nineteen additional minor classes the wetland belongs to. It was intended to be useful at the planning and operational levels of business.

2.8.1.2. *Manitoba Agriculture and Food*

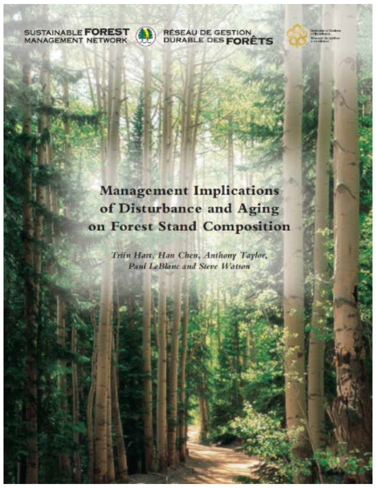
Garland Grazing Trial (GGT)
Manitoba Agriculture and Food established the Garland Grazing Trial in cooperation with LP in 1997.Manitoba Conservation–Forestry Branch (now Sustainable Development) established temporary regeneration plots. Five-year results in 2001 showed all regeneration plots being classified as Sufficiently Regenerated with stocking levels of 89% to 100%.

LP established Permanent Sample Plots (PSPs) within the various grazing (low and medium grazing levels) and harvest (summer and winter) treatments (Figure 2.36). The regenerating aspen PSPs were established in 2000, remeasured in 2005, 2010, and 2015.These PSPs quantify the aspen's growth rates, which have no significant difference in height growth rates between grazed and ungrazed plots.

Figure 2.36 Map of the Garland grazing trial (2008 imagery).

2.8.1.3. *Sustainable Forest Management Network*

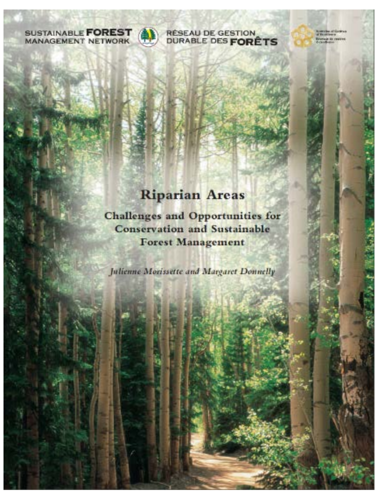
Hart, T., H. Chen, A. Taylor, P. LeBlanc, and S. Watson. 2010. Management Implications of Disturbance and Aging on Forest Stand Composition. SFMN synthesis report.



To meet sustainable forest management targets, there was a need for reliable succession models that would assist managers in predicting forest composition and structural development at both the stand and landscape levels. Future species composition and structure of forest stands are the key elements affecting future benefits of the forest, including biodiversity, timber supply, productivity, carbon dynamics, ungulate, fur-bearer, bird habitats, recreational opportunities, and non-timber forest products.

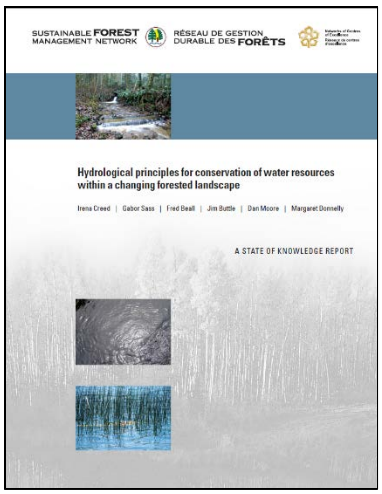
There was a strong correlation between pre- and post-disturbance species composition for shade intolerant tree species. In the prolonged absence of stand-replacing fire, compositionally similar stands undergo multiple succession pathways, depending on time since fire, soil conditions, intermediate disturbances, presence of advanced regeneration, and seed availability. This report demonstrated that succession rules should be applied to wood supply and habitat modeling analyses to get realistic future forest projections.

Morissette, J. and M. Donnelly. 2010. Riparian Areas Challenges and Opportunities for Conservation and Sustainable Forest Management. SFMN publication.



Generally riparian areas are described as the "…interface between aquatic and terrestrial systems." However, definitions pertaining to riparian areas range from simple to complex and can be ecologically-based or defined in terms of management applications. Regardless of the definition, the management of these highly productive, complex components of the landscape was a challenge to forest managers and policy makers. The planning and application of riparian guidelines and buffer retention strategies was further complicated since approval for forest management plans for these areas falls under the jurisdiction of both federal and provincial regulatory agencies. Management guidelines provided by these agencies are generally updated infrequently and thus do not incorporate new knowledge or new approaches easily. They are also developed in isolation of other values and resource sectors (*e.g.* private vs. crown land, forestry vs. fisheries concerns) leading to problems with integrated management of multiple resources and values. In recent years, there has been increased interest in developing alternate management strategies for riparian areas to more fully integrate their management with the rest of the forest. In several jurisdictions, there was interest in applying natural disturbance-based approaches to manage these systems, and potentially integrate landscape-level strategies to minimize cumulative effects to both terrestrial and aquatic components of the forest ecosystem. This has resulted in considerable debate among scientists, policy makers and resource managers regarding the long- term consequences of current methods and policies, as well as the development of new policies and practices for managing and conserving riparian areas and water resources. Related to the interest in alternative management practices, a series of questions regarding the management of riparian areas in the boreal forest were developed through consultation with several SFM Network industrial partners in western Canada. These questions are addressed in this synthesis document through the use of case studies, as well as a review of the literature and guidelines pertaining to riparian systems. Ultimately, we hope to stimulate dialogue and knowledge exchange among forestry companies, governments and other stakeholders to build a stronger riparian management framework for decision making. The challenges faced during the riparian guidelines development, review and implementation process are also discussed as well as some of the potential solutions for the sustainable management of riparian areas.

Creed, I., G. Sass, F. Beall, J. Buttle, D. Moore, and M. Donnelly. 2011. Hydrological principles for conservation of water resources within a changing forested landscape (SFMN: A State of Knowledge Report)



This report presents a set of hydrological principles that can be used to inform forest policies and practices and be translated into actions for sustainable forest management in Canada. These principles were developed as part of a backcasting-from-principles approach to planning that envisions a desired future constrained a set of principles, and then considers the policy and practical steps necessary to arrive there. Many of the concepts underlying the hydrological principles are currently represented in some provinces and territories. However, these principles should serve as the first step in opening a dialogue between forest hydrologists, managers and policy makers. This will help to establish a unified framework for sustainable forest management across the country.

The way forward for scientists, managers, and policy makers to implement our suggested backcasting-from-principles approach was to:

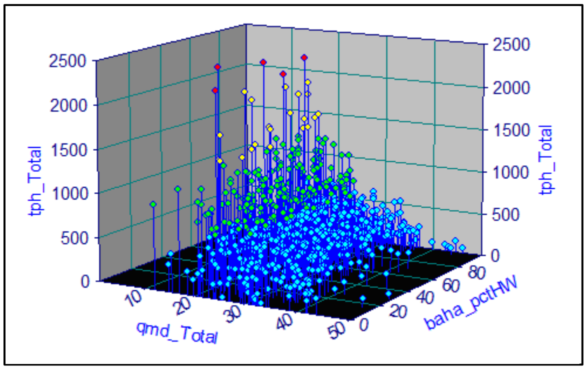
1) Reach consensus on hydrological principles through open dialogue;

2) Embed the hydrological principles into a framework of principles, policies and practices;

3) Integrate the hydrological principles with social, economic and ecological principles; and

4) Develop a process for effective monitoring and adaptation of the backcasting-by-principles process.

Comeau, P., V. Reyes-Hernandez, H. Chen, N. Kenkel, M. Bokalo, C. Hawkins, K. Greenway, A. Velazquez-Martinez. 2009. Influence of relative density and composition on growth and understory in the boreal mixed-woods. SFMN project report.



Sustainable forest management requires the ability to estimate or predict the potential outcomes (in terms of forest structure, habitat and other ecological services, timber production, economics, and social implications) of forest management practices. There was a need for research which will improve knowledge about "whether young stands arising from forest management practices today will develop into the stands which we predict" and better knowledge of successional pathways in managed and unmanaged mixedwood forests. Results reported here indicate that species composition may play a significant role in the maximum density – size relationships in boreal mixedwoods.

2.8.1.4. *Saskatchewan Research Council*

Carbon in Wetlands (2016-2019)

This project was awarded $150,000 funding through the Sustainable Forestry Initiative Conservation and Community Grant Program. LP contributed $50,000 cash plus in-kind contributions to complete the field work. Sustainable Development contributed student time to complete additional field work.

The carbon in wetlands project's objective was to:

> *Develop methodologies and estimates of carbon sequestration in upland forests and wetlands on SFI-certified boreal forest landscapes.*

Project partners include:

SFI (Sustainable Forestry Initiative) $150,000 in grant funds http://www.sfiprogram.org/
SRC (Saskatchewan Research Council) http://www.src.sk.ca
DUC (Ducks Unlimited Canada) http://www.ducks.ca/ - project used the DUC wetland inventory, many DUC staff for wetland expertise, and GIS staff for site selection
LPC (Louisiana-Pacific Canada Ltd.) $50,000 in cash for two years of field work (2016 and 2017), field procedure facilitation, field supervision, additional mapping support
SPL (Spruce Products Ltd.)
SD (Sustainable Development) Province of Manitoba – staff and student time
BU (Brandon University) - lab analyses and field expertise
University of Saskatchewan – advice on field procedures

Forests and forested wetlands provide critical carbon storage and may play an important role in mitigating climate change, but the quantification methods for boreal wetlands were poorly understood. To investigate these dynamics, the project partners developed practical methods for quantifying carbon sequestration in upland forests and wetlands.

The field protocol developed was efficient, based on international accepted methods, and applicable across other SFI-certified landscapes. SRC created tools to sample carbon in the field and to calculate carbon based on vegetation and soil field data. A case study on forestlands managed by SFI Program Participant Louisiana-Pacific Canada Ltd. was developed to ensure the accuracy of tools and protocol.

The carbon of the sampled wetlands will be calculated, based on peat depths and peat sample carbon density. These estimates will be used to quantify carbon estimates by wetland type as well as across all wetlands at the landscape level.

Northern Prairie Forests Integrated Regional Assessment (NPFIRA) - climate change vulnerability assessment

The objectives of the NPFIRA project are to:

1. Assist our partner organizations in understanding their vulnerability to climate change and variability;
2. Assist partners in identifying adaptation options that can be mainstreamed into planning and decision-making systems;
3. Integrate the results across companies, governments and a large multi-use landscape into a regional assessment of climate change vulnerability with real-world implementable adaptation options for the partner organizations;
4. Provide partners with tools for vulnerability assessment and adaptation planning that can be incorporated into their planning systems after project completion.

The project has two primary outputs:

1. An assessment of regional climate change vulnerability, integrated across the study area landscape and across partner organizations, including across multiple branches of the SK and MB governments. Components of the assessment will include an understanding of recent (CMIP5) projections of future climate (i.e. exposure), the sensitivity of these forest ecosystems to climatic variability and climatic change, and an assessment of each organization's adaptive capacity given the impacts identified.

2. In addition to the vulnerability assessment, we will work with each partner organization to identify adaptation options related to the vulnerabilities. The options will focus on those that are cost effective and that are within the capacity of the organizations given their levels of staff expertise, technology availability, and the policy environments within which they operate. Economic analysis will be included in the screening of adaptation options.

2.8.1.5. *U of Alberta*

The University of Alberta has done a lot of research in Manitoba, either as a specific study or as part of a larger group study.

Bokalo, M., P.G. Comeau and S.J. Titus. 2007. Early development of tended mixtures of aspen and spruce in western Canadian boreal forests. Published in: Forest Ecology and Management 242 (2007) 175–184.

In 1992, the Western Boreal Growth and Yield Association (WESBOGY) began a long-term study to evaluate the dynamics of regenerated aspen (*Populus tremuloides* Michx.) - white spruce (*Picea glauca* (Moench) Voss) mixedwood stands following manipulation of aspen to a range of densities. In this study six levels of aspen (0, 200, 500, 1500, 4000 stems per ha and natural) and three levels of spruce (0, 500 and 1000 stems per ha) densities have been created. Data from four locations demonstrate substantial variation in initial aspen densities following clearcutting of aspen dominated stands. After 9 years densities begin to converge with the highest rates of mortality associated with high starting densities. A model was developed that shows a significant relationship between the proportion of trees surviving to the end of a year and the density at the beginning of the year. Size-density relationships based on quadratic mean root collar diameter, mean tree volume and mean tree height are presented. Three to four years following spacing of aspen to densities ranging from 200 to 4000 stems per ha there were no significant effects of density on aspen size. In addition, spacing of the aspen had no significant effect on spruce height at year 9 (3–4 years after spacing), but spruce root collar diameter (RCD) was significantly smaller in the unspaced compared to the spaced plots. The ratio of height to root collar diameter (HDR) for white spruce showed a significant and clear response to aspen density and increased with increasing aspen density.

Mundell, T.L., S.M. Landhausser, and V.J. Lieffers. 2007. Effects of Corylus cornuda stem density on root suckering and rooting depth of Populus tremuloides. The regeneration capabilities of over-aged aspen stands containing heavy hazel competition. Published in: Canadian Journal of Botany. 85: 1041-1045 (2007).

Aspen stands with a high density of understory hazel (>45,000 stems per hectare) and a low density of hazel (<5,000 stems per hectare) were harvested in the fall of 2005.After one growing season, aspen sucker density, height and leaf area were assessed. Soil trenches were excavated to examine the root density and rooting depth of both aspen and hazel. Aspen sucker regeneration was 68,200 stems per hectare in areas with low hazel density, and 43,600 stems per hectare in areas with high hazel density. The cross-sectional surface area of aspen roots in shallow soil layers (0-10 cm) was significantly lower under high densities of hazel. As aspen usually produces most of its' root suckers from shallow roots, the reduction of roots in the upper 10 cm of soil was the likely cause of lowering sucker densities. Height growth of the suckers was not influenced by pre-harvest hazel density, possibly owing to high light transmission as a result of the reduced leaf area of the hazel after the harvest.

T.L. Mundell, S.M. Landhausser, and V.J. Lieffers. 2008. Root carbohydrates and aspen regeneration in relation to season of harvest and machine traffic. Published in: Forest Ecology and Management 255 (2008) 68–74.

Season of harvest has often been suggested as a driver for the erratic success of aspen (Populus tremuloides) sucker regeneration, partially due to root carbohydrate reserves and soil conditions at the time of harvest. A field experiment in western Manitoba, Canada, assessed root suckering and root carbohydrates of aspen in response to season of harvest and machine traffic. Six sites (120 m X 120 m) were selected within two large mature aspen stands slated for summer harvest. Plots (50 m X 50 m) were hand-felled (without machine traffic) in mid-summer, late summer, winter, and one plot was left uncut as a control. Season of cut with no traffic had no effect on sucker density, height or leaf dry mass per sucker. During the dormant season, root starch reserves were highest in the winter cut plots, however, just prior to suckering, this difference in carbohydrate reserves among the three seasons of harvest disappeared and by the end of the first growing season root reserves in all three seasons of cut had recovered to near control levels. Adjacent plots that were conventionally harvested in the summer and impacted by logging traffic had similar sucker densities but had 19% less height growth of suckers and 29% less leaf dry mass per sucker compared to suckers in plots harvested at the same time without traffic. After one growing season, root carbohydrate levels were similar whether or not machine traffic was used; however, the reduction in leaf dry mass in plots with machine traffic could have negative implications for carbohydrate accumulation and growth. The study suggests that the phenological state of the mature aspen plays a very small role in aspen regeneration and that harvesting practices and site conditions are likely the main drivers of aspen regeneration success.

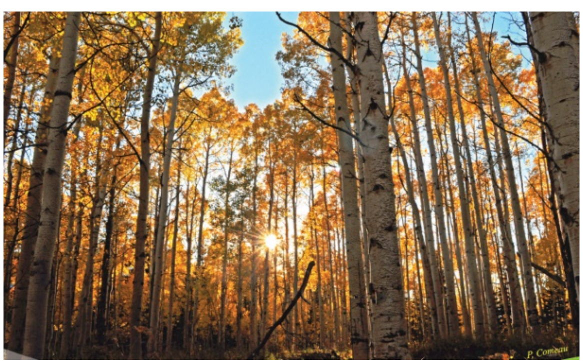
Edye, I. and E. Bayne. 2008. White-tailed deer movement, habitat use, and potential for disease transmission in the greater Riding Mountain and Duck Mountain ecosystems. M.Sc. thesis, Department of Biological Sciences, University of Alberta.

Very little information exists in regards to deer home range size, movement and dispersal as well as information about sub-populations and degrees of interaction among them within the greater RMNP and Duck Mountain ecosystems. The project wanted to gain an understanding of the potential spread of bovine Tuberculosis by deer within and out of the RMNP area, and to develop appropriate deer disease management strategies.

The detailed objectives of this project were:

- Document seasonal home range, inter-seasonal movements, philopatry, and dispersal of deer in the study area;
- Determine the effect of landscape/habitat values on resource use by deer, and produce predictive maps illustrating the relative probability of deer use of space.
- Use molecular methods to delineate any existing subpopulations and determine genetic structure, in order to identify long-term trends in deer movement over the landscape in the greater Riding and Duck Mountain ecosystems.

Bokalo, M., K.J. Stadt, P.G. Comeau, and S.J. Titus. 2013. The Validation of the Mixedwood Growth Model (MGM) for Use in Forest Management Decision Making. Published in: Forests 2013, 4, 1-27



We evaluated the Mixedwood Growth Model (MGM) at a whole model scale for pure and mixed species stands of aspen and white spruce in the western boreal forest. MGM was an individual tree-based, distance-independent growth model, designed to evaluate growth and yield implications relating to the management of white spruce, black spruce, aspen, lodgepole pine, and mixedwood stands in Alberta, British Columbia, Saskatchewan, and Manitoba. Our validation compared stand-level model predictions against re-measured data (volume, basal area, diameter at breast height (DBH), average and top height and density) from permanent sample plots using combined analysis of residual plots, bias statistics, efficiency and an innovative application of the equivalence test. For state variables, the model effectively simulated juvenile and mature stages of stand development for both pure and mixed species stands of aspen and white spruce in Alberta. MGM overestimates increment in older stands likely due to age-related pathology and weather-related stand damage. We identified underestimates of deciduous density and volume in Saskatchewan. MGM performs well for increment in postharvest stands less than 30 years of age. These results illustrate the comprehensive application of validation metrics to evaluate a complex model and provide support for the use of MGM in management planning.

BAM – Boreal Avian Modeling

Applying data-driven measures to evaluate and improve the conservation value of managed forests for birds. The Boreal Avian Modelling Project (BAM) is a biome-scale program providing data-driven scientific information for conservation and management of boreal birds.

This project addresses Objective 4 in SFI's Standard: "Protection of Biological Diversity" by developing methods for measuring and improving sustainability of forest management using birds as bio-indicators. Models will evaluate the conservation value of sustainable forest management for bird biodiversity and inform sampling recommendations. Where possible, existing bird models will be enhanced with new data provided by partners. This grant will facilitate further engagement with industry partners interested in enhancing conservation value of managed forests. http://www.borealbirds.ca/

2.8.1.6. *U of Manitoba*

Chranowski, D. 2009. Cow elk ecology, movements and habitat use in the Duck Mountains of Manitoba. M.Env. thesis, University of Manitoba.

This study conducted baseline research to determine home range, movements and habitat selection of Manitoban elk (*Cervus elaphus manitobensis*) in the Duck Mountain of west-central Manitoba. Cow elk (n=22) were captured by helicopter net-gun and GPS radio-collared in 2005/06.Data was analyzed with ArcView 3.3 for Windows (ESRI). Duck Mountain elk show selection for deciduous forest and avoidance of roads. Mean 100% MCP home ranges were 127.85 km^2 with 95% and 50% adaptive kernel home range sizes of 58.24 km^2 and 7.29 km^2, respectively. Home range overlap occurs at all times of the year with many elk using farmland. Elk moved the least in late winter. Movements increased in the spring, declined in June with a gradual increase from July to October. Elk had generalized movement in southerly directions. No cow elk dispersed from the study area. Mean estimated calving date was June 3rd and mean estimated breeding date was September 27th. Duck Mountain elk were found in mature deciduous/mixed-wood forest and shrub/grassland/prairie savannah ecosites, but not found within 200 m of a road or water feature more often than expected by random. Elk were found in areas with <10% and <81% crown closure, on middle slopes and variable aspects. Elk displaced from forestry cut-blocks. Only 149 of 79,284 elk locations were within 100 m of a winter cattle operation. Recommendations to mitigate forestry and BTB impacts focus on riparian areas, road management, farming practices and hunting.

Renton, J., A. Park, and R. Westwood. 2010. The Impact of Cattle Grazing on Aspen regeneration on Crown Lands in Western Manitoba. (University of Manitoba thesis)

In western Manitoba there has been an increasing appreciation for the value of trembling aspen (*Populus tremuloides* Michx) as a source of timber. Moreover, aspen stands and the understory vegetation that they support also provide valuable forage for livestock and wildlife. Timber harvesting and cattle grazing are often done on the same area of land, though not simultaneously. The purpose of this project was to investigate the effects cattle grazing have on commercial tree regeneration, forest health and understory species diversity in post-harvest aspen stands. Tree density; tree health; and understory herbaceous and shrub diversity were compared in nine grazed and nine ungrazed sites across a 10-year harvesting chronosequence, consisting of three stand age classes (2-3 years, 5-8 years and 9-11 years-old). Environmental data were collected to establish supplementary correlates of species performance. These variables included soil compaction, soil texture, drainage class and an index of grazing pressure. Ungrazed 9 to 11-year old stands had a significantly higher stem density and stem height for aspen and all other commercial species ($p < 0.1$). Tree health was not found to differ significantly between grazed and ungrazed treatments within any stand age.

2.8.1.7. *U of Saskatchewan*

Kardynal, K.J., K.A. Hobson, S.L. Van Wilgenburg, and J. Morissette. 2009. Moving riparian management guidelines towards a natural disturbance model: An example using boreal riparian and shoreline forest bird communities. Published in: Forest Ecology and Management.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Moving riparian management guidelines towards a natural disturbance model: An example using boreal riparian and shoreline forest bird communities

Kevin J. Kardynal, Keith A. Hobson, Steven L. Van Wilgenburg, Julienne L. Morissette

Forest harvesting strategies that approximate natural disturbances have been proposed as a means of maintaining natural species' diversity and richness in the boreal forests of North America. Natural disturbances impact shoreline forests and upland areas at similar rates. However, shoreline forests are generally protected from harvest through the retention of treed buffer strips. We examined bird community responses to forest management guidelines intended to approximate shoreline forest fires by comparing bird community structure in early (1–4 years) post-burned and harvested boreal riparian habitats and the adjacent shoreline forest. We sampled riparian areas with adjacent: (1) burned merchantable shoreline forest (n = 21), (2) burned non-merchantable shoreline forest (n = 29), (3) 10 m treed buffer with 25% retention in the next 30 m (n = 18), and (4) 30 m treed buffer (n = 21). Only minor differences were detected in riparian species' abundance and bird community composition between treatments with greater differences in these parameters occurring between post-fire and post-harvest upland bird communities. Indicators of all merchantable treatments were dominated by upland species with open-habitat species and habitat generalists being typical upland indicator species of burned merchantable habitats and forest specialists typical upland indicators of harvested treatments. Riparian species indicative of burned riparian habitats were Common Yellowthroat (*Geothlypis trichas*), Le Conte's Sparrow (*Ammodramus leconteii*) and Eastern Kingbird (*Tyrannus tyrannus*) and indicators of 30 m buffers were Alder Flycatcher (*Empidonax alnorum*) and Wilson's Warbler (*Wilsonia pusilla*). Multivariate Redundancy Analysis (RDA) of the overall (riparian and upland birds) community showed greater divergence than RDA with only riparian species suggesting less effect of fire and forestry on riparian birds than on upland birds. Higher natural range of variability (NRV) of overall post-fire bird communities compared to post-harvest communities emphasizes that harvesting guidelines currently do not achieve this level of variability. However, lack of a large negative effect on common riparian species in the first 4 years post-disturbance allows for the exploration of alternative shoreline forest management that better incorporates bird community composition of post-fire riparian areas and shoreline forests.

2.8.2. Forest Research Organization Affiliations

Forest research organizations (Table 2.30) in this section are agencies that include conservation groups, universities, research organizations, or government departments. These organizations were supported by LP and other partners in various ways, depending on project requirements. The partnerships have been established to pursue research and monitoring related projects in order to enhance sustainable forest management planning and operational practices on crown and private lands. These joint ventures demonstrate the ability to apply a holistic approach in managing the forest land base for all values (biological, social and economic) in order to achieve an effective model of forest sustainability.

Table 2.30 Forest research organization affiliations 2006 to present (in alphabetical order)

Forest research organizations
Assiniboine Community College (ACC)
Canadian Forest Service (CFS) - Northern Forestry Centre (NoFC) in Edmonton, AB
Ducks Unlimited Canada (DUC)
Intermountain Conservation District (IMCD)
Manitoba Agriculture and Food
Manitoba Feasibility Assessment of Afforestation for Carbon Sequestration (FAACS)
Manitoba Model Forest (MMF) shut down in 2007
National Council for Air and Stream Improvement (NCASI)
Natural Sciences and Engineering Research Council (NSERC)
Nature Conservancy Canada (NCC)
Poplar Council of Canada (PCC)
Swan Lake Watershed Conservation District
Sustainable Forest Management Network (SFMN)
University of Alberta (U of A)
University of Manitoba (U of M)
University of Winnipeg (U of W)
Western Boreal Growth and Yield association (WESBOGY)

Assiniboine Community College (ACC)
http://public.assiniboine.net

Assiniboine Community College (ACC) was a progressive post-secondary institution that provides individuals with knowledge, skills and credentials that are highly valued in the workforce. ACC was committed to be a college that was the first choice of students. LP contributes to the Geographic Information Systems (GIS) advisory committee and has assisted with joint GIS student projects.

Canadian Forest Service (CFS) - Northern Forestry Centre (NoFC)
http://www.nrcan.gc.ca/forests/research-centres/nofc/13485

The Northern Forestry Centre was one of five research centres operated by the Canadian Forest Service. It was located in Edmonton, Alberta. The work underway at the centre supports Natural Resources Canada's national research priorities, and addresses forestry issues in Alberta, Saskatchewan, Manitoba, and the Northwest Territories.

The centre's program includes four main areas of research:

Boreal ecosystem ecology
Sound management of Canada's largest forest ecosystem depends on sound knowledge of the structure, composition, and function of boreal forests and of how they respond to natural and human-made disturbances. Current projects at the centre include studying the response of the boreal to novel pest invasions; assessing and predicting forest ecosystem responses to harvesting and fire; and transferring new knowledge to forest managers to promote better management of resources. The flagship EMEND project was one example of the work underway to develop better forest practices.

Climate change and forests research
In this research area, the focus was on mitigating and adapting the effects of climate change on Canada's forests. Work includes modelling forests as carbon sinks or sources; tracking and assessing the impacts of climate change on forest ecosystems; and developing tools and strategies to facilitate adaptive sustainable forest management. The centre also leads outreach activities related to the CFS Carbon Budget Model and was an active member of the Canadian Council of Forest Ministers' Climate Change Task Force.

Land reclamation
This area was a relatively new initiative within the CFS. Work was underway with a wide range of stakeholders and collaborators to develop innovative approaches to: minimizing resource development impacts on forest land, and accelerating reclamation of forest ecosystems on oil sands mining and *in situ* sites. Research activities focus on developing baseline conditions and reclamation technologies, establishing indicators of ecosystem recovery, and engaging industry, academia and other sectors in increasing CFS contributions to land reclamation issues.

Wildland fire
The centre works with partners across the country to increase knowledge about wildland fires. It also provides national-level information on current and forecasted fire conditions. Its fire research, information systems and decision support tools—among them, Canada's Wildland Fire Information System—improve the ability of Canada's fire management agencies to predict and manage the risks and benefits associated with wildland fire. Other research activities include developing new techniques to reduce the impacts of fire on communities, and creating tools to undertake risk analysis, projections and modelling related to wildland fire behaviour, smoke distribution and burn probability.

Ducks Unlimited Canada
http://www.ducks.ca/

Ducks Unlimited Canada (DUC) and Louisiana-Pacific Canada Ltd., Swan Valley Forest Resources Division, signed a Memorandum of Understanding (MOU) 2005-2010 that outlined a commitment to effective watershed-based conservation within Forest Management License Area #3. This MOU identifies several strategic priorities that will guide the partnership including:

- The development of forest management strategies to promote sustainable management of aquatic resources through appropriate watershed-based management planning and operations;

- Collaborate on the development and implementation of research and monitoring projects and share information and research results related to water, wetlands, riparian and watersheds;
- Development and promotion of Best Management Practices that protect the integrity of watersheds, riparian habitats, water and wetlands;
- Develop and participate in an implementation project in the Duck Mountains to test the effects and effectiveness of new planning and management approaches;
- Promote sustainable private land forestry that maintains long-term forest cover and protects the integrity of watersheds, riparian habitats, water and wetlands, and
- Communication and Knowledge Exchange

The MOU was followed by a five-year Contribution Agreement which outlines the commitment by both agencies to financial and other resources required to facilitate program development. A key component to the Contribution Agreement was the development of activities and work plan to accomplish the objectives identified in the MOU. Various activities, such as the continued monitoring of the boreal riparian bird project sites, refinement of the DUC Enhanced Wetland Classification System for the Boreal Plains Ecozone, and the development of a knowledge exchange workshop on watershed and riparian management were carried out over the five-year time-frame.

Inter Mountain Conservation District
www.intermountaincd.com

Both LP and the Inter Mountain Conservation District (IMCD) have worked on new approaches to achieve improved environmental outcomes, including working with others to establish a long-term vision, implementing a watershed-based planning approach, sharing the awareness for environmental quality, establishing a comprehensive database of water management objectives, and working continuously to monitor and improve watershed-based standards, practices and outcomes. LP and the IMCD have jointly discussed common concerns and many areas of mutual interest.

Manitoba Agriculture and Food
Manitoba Agriculture and Food established the Garland Grazing Trial in cooperation with LP. LP has established permanent sample plots within the various grazing (low and medium grazing levels) and harvest (summer and winter) treatments. The regenerating aspen PSPs were established in 2000, and remeasured in 2005, 2010, and 2015.

Manitoba Feasibility Assessment of Afforestation for Carbon Sequestration (FAACS)

The objective of FAACS was to determine if a large-scale national tree planting program for the purposes of carbon sequestration was feasible to help Canada achieve its greenhouse gas emission reduction targets. LP was a member of FAACS and contributed to advising potential research projects and trials.

Manitoba Model Forest

The Manitoba Model Forest (MMF) officially ended on March 31st, 2007.LP was an active participant with the Forest Communities Program (FCP), which was the successor to the MMF.LP was funding and actively participating in the FCP.LP contributed to the formal proposal "Sustaining Manitoba's Forests and Forest-Based Communities", submitted in October 2006 to the Canadian Forest Service and the Forest Communities Program. FCP provided outdoor educational programming geared towards elementary, junior and intermediate school levels. The Forest Communities Program has received federal funding and significant financial contributions and leveraging from the many FCP partners.

The Forest Communities Program five-year program and broad objectives were:

- Capacity Building of Communities;
- Integrated Landscape Management;
- Forest-based Opportunities; and
- Projects with International Model Forests.

National Council for Air and Stream Improvement (NCASI)

http://www.ncasi.org/

The National Council for Air and Stream Improvement (NCASI) was an independent, non-profit research organization that conducts technical studies on environmental topics or issues facing the forest products industry in the United States and in Canada. NCASI maintains a technical staff of approximately 80 scientists and engineers with expertise in areas such as chemistry, chemical engineering, environmental engineering, pulp and paper science, forestry, toxicology, aquatic biology, wildlife biology, forest biology and computer science. NCASI distributes a number of publications used within industry but are also used among academic researchers, regulatory agencies and within other organizations. LP was a corporate member of NCASI and was represented on the NCASI Canadian Steering Committee, NCASI Environmental Task Group and on the Forestry Task Group.

Natural Sciences and Engineering Research Council (NSERC)

http://www.nserc-crsng.gc.ca/index_eng.asp

NSERC's role was to make investments in people, discovery and innovation for the benefit of all Canadians. We invest in people by supporting more than 9,000 students in their advanced studies. We promote discovery by funding more than 8,700 researchers every year. And we help make innovation happen by encouraging more than 1,000 Canadian companies to invest in university research.

NSERC (the Natural Sciences and Engineering Research Council of Canada) was the national instrument for making strategic investments in Canada's capability in science and technology.

NSERC supports both basic university research through research grants and project research through partnerships of universities with industry, as well as the advanced training of highly qualified people in both areas.

NSERC was a separate employer of the Government of Canada, reporting to Parliament through the Minister of Industry. NSERC was governed by a Council of 22 members selected from private sectors, public sectors, and universities.

Nature Conservancy Canada (NCC)
http://www.natureconservancy.ca/en/

The Nature Conservancy of Canada (NCC) was Canada's leading national land conservation organization. NCC was a private, non-profit group that partners with corporate and individual landowners to achieve the direct protection of our most important natural treasures through property securement (donation, purchase, conservation easement and the relinquishment of other legal interests in land) and long-term stewardship of our portfolio of properties.

VISION - The Nature Conservancy of Canada will protect areas of biological diversity for their intrinsic value and for the benefit of future generations.

MISSION - A Nature Legacy Through Partnership. To accomplish this mission, the Nature Conservancy of Canada will lead, innovate and use creativity in the conservation of Canada's natural heritage by securing ecologically significant natural areas through purchases, donations, conservation agreements or other mechanisms, and by achieving long-term stewardship through management plans and monitoring arrangements.

VALUES - The earth's biological diversity was being lost at a rate that impoverishes our quality of life and threatens our future. NCC's work was guided by the belief that our society will be judged by what it creates in the present and what it conserves for the future. Wherever we work across Canada, we share and apply values that reflect this philosophy:

- We are guided by the best available conservation science;
- We work in a non-confrontational manner;
- We manage lands and waters for their intrinsic, natural values;
- We respect and promote nature's own processes of growth, succession and interaction;
- We recognize the need to create avenues for people to sustain themselves and live productively while conserving biological diversity.

Poplar Council of Canada (PCC)
http://www.poplar.ca/

PCC undertakes studies and review of poplar resources, management and utilization and has an excellent base of information and expertise in our members' and data sources. PCC also assists in the process of research on poplar issues through contract administration, lobbying for funding, member contacts, and technological committees to evaluate projects and knowledge gaps. Although not a research agency, the PCC regularly publishes current information from research for its members.

PCC, as Canada's national 'poplar commission', was involved with the International Poplar Commission (IPC), which was a Statutory Body of the Food and Agriculture Organization (FAO) of the United Nations. Through IPC, PCC has links with poplar and willow scientists throughout the world. PCC has copies available of the IPC Directory of Poplar and Willow Scientists. Several PCC members are actively involved in the work of the Executive Committee and Working Parties of IPC.

Swan Lake Watershed Conservation District
http://www.mcda.ca/swan-lake-watershed-conservation-district/

The Swan Lake Watershed conservation district delivers incentive-based programming to address land and water issues, including stream bank stabilization, grassed waterway construction and repair, abandoned well sealing, well head protection, private well water testing, tree planting, and fisheries and riparian enhancement. The SLWCD plays an important role in environmental education initiatives; it works closely with its local schools and Envirothon team. The conservation district has completed its integrated watershed management plan for the Swan Lake Watershed.

Sustainable Forest Management Network
http://sfmn.ualberta.ca/

LP was very active in the Sustainable Forest Management Network (SFMN) Centres of Excellence, until the SFMN shut down in 2010.Based out of the University of Alberta, the SFMN was a unique national organization of university, forest industry, First Nations and government agencies, and conservation organizations conducting research on various components of sustainable forest management. LP had a representative on the Board of Directors and the Industry Partners Committee and was been active in formulating research priorities for research funding. The SFMN conducted approximately $6.5 million of research annually related to natural disturbance regimes, harvesting effects on forest ecosystems, biodiversity assessment and monitoring, modeling approaches and social and economic issues related to forest management.
LP was a collaborating partner on several multi-year research proposals. The SFMN had a very strong emphasis on collaborative research, partnerships, and Knowledge Exchange and Technology Extension.

Western Boreal Growth and Yield association (WESBOGY)
http://www.ales.ualberta.ca/rr/Research/WESBOGY.aspx

LP is a member of the Western Boreal Growth and Yield (WESBOGY) association based out of the University of Alberta. The association works to:

- develop and disseminate natural and managed growth and yield information;
- develop and improve modeling technology (*i.e.* MGM - Mixedwood Growth Model);
- encourage member agencies work in a coordinated fashion to improve the efficiency of their research and development efforts;
- facilitate data sharing; and
- provide a forum for communication between professionals.

WESBOGY members collaborated on the development and dissemination of growth and yield modeling technology and information. Research, development, extension activities, and growth and yield data sharing were completed. Current membership in the association includes seven forest companies, three provincial/territorial governments (Alberta, Saskatchewan and the Northwest Territories) and the federal government.

University of Alberta
www.ualberta.ca

The University of Alberta has a faculty of Forest Science and Management. U of Alberta faculty and their students have conducted forest research projects in west-central Manitoba. U of Alberta's research aim is to provide a scientific basis for improvements to forest management practices which aim to ensure economic and ecological sustainability now and in the future.

University of Manitoba
http://www.umanitoba.ca/institutes/natural_resources/

The University of Manitoba has the Natural Resources Institute (NRI), which integrates knowledge gained from the natural and social sciences to develop holistic perspectives on environmental and natural resources management problems. Research conducted at the NRI may have an economic, social, or ecological perspective, or may integrate all three disciplines.

University of Winnipeg
Centre for Forest Interdisciplinary Research (C-FIR)
http://www.uwinnipeg.ca

Several research initiatives with the University of Winnipeg have been developed. LP has contributed funding towards the initial development of C-FIR at the University of Winnipeg. LP also participates on an advisory committee involved with setting research priorities, development of curricula, programs, and Centre administration. LP staff have participated in several forest research symposiums.

2.8.3. LP Research

The projects included within this section were solely funded by Louisiana-Pacific Canada Ltd., Swan Valley - Forest Resources Division. Project coordination, implementation, field work, and preliminary data analysis were conducted internally. Additional analyses were sometimes conducted by external researchers.

2.8.3.1. *Forest Bird Monitoring*

The Duck Mountain Forest Bird Monitoring Project was initiated in 1997 to 2002 and 2004, in order to gather baseline information on the distribution and habitat associations of neo-tropical, riparian, and resident bird species inhabiting the Duck Mountain Provincial Forest.

In 2007 the forest bird monitoring project focused on describing the local abundance and habitat requirements of Golden-Winged Warbler (GWWA), a migratory bird species designated as threatened under provincial and federal species at risk legislation.

In 2009 to present, LP continues to conduct bird surveys specifically to identify the presence of species at risk within proposed harvest areas. This information allows LP to support the conservation of priority species through the implementation of various planning strategies and specific Best Management Practices for migratory birds.

2.8.3.2. *Permanent Sample Plots*

Permanent Sample Plots (PSPs) are the primary source of forest change data (*e.g.* species composition, volume gain, ecological attributes, heights, diameters, mortality *etc.*). These data are extremely valuable for assessing sustainability, since PSP data quantifies the actual growth rate of the forest.

LP's Environment Act Licence 2191E states in Section 13 iii:

> *"The Licensee [LP Canada Ltd.] shall co-operate in the establishment of permanent monitoring and research sites within the no-harvest areas of the F.M.L. Area and in long-term ecological monitoring on those sites;"*

PSPs were established, due to uncertainty of growth rates of hardwoods in the Duck Mountains (Tetr*ES* consultants 1995). It was also recognized that PSPs were needed to develop habitat relationships for various stand type and age combinations for future long-term ecological monitoring.

From 2006 to present, the PSP network of 489 PSPs was improved through remeasurement and establishing new PSPs at research trials. In 2006, 69% of the PSP network had never been remeasured.112 PSPs were remeasured during the 2006 to 2016 period (Figure 2.37), decreasing the number of PSPs that had never been remeasured to 57%.

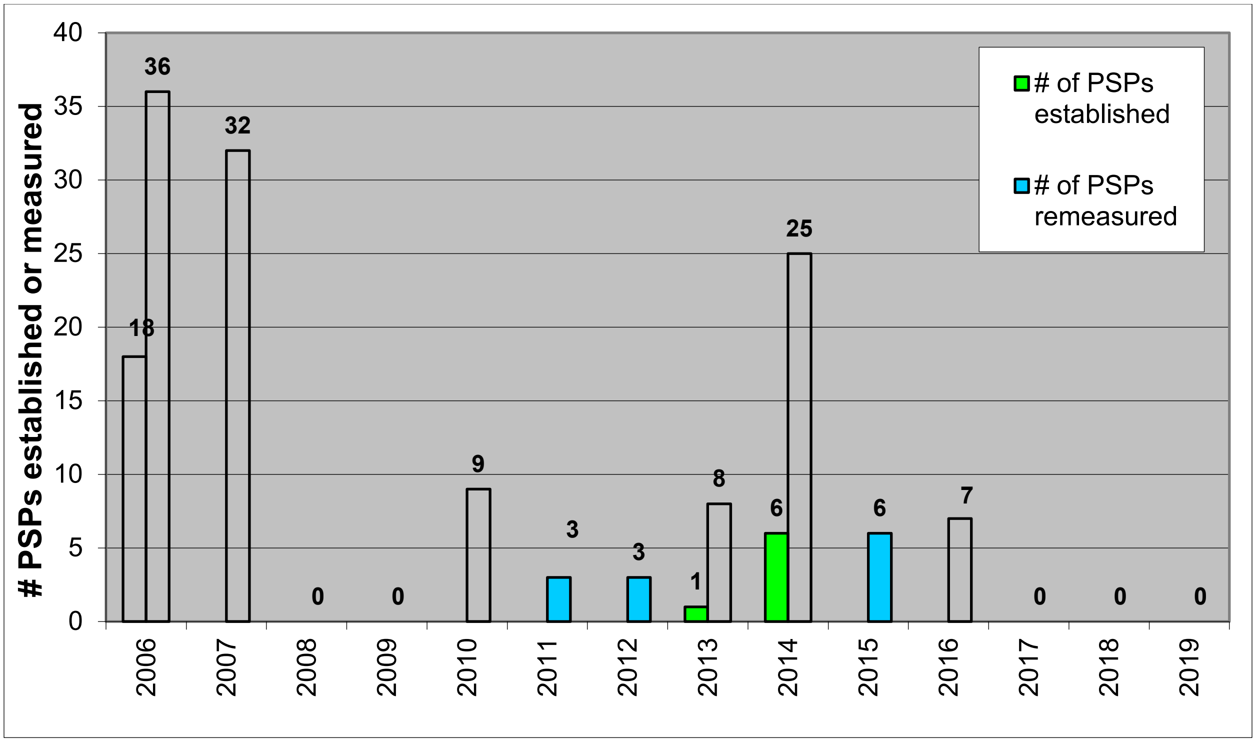

Figure 2.37 Permanent Sample Plot establishment and measurement 2006 to 2019.

In 2012 there was a significant blow down event which destroyed approximately 20 PSPs. From 2010 to 2019 there were 30 PSPs decommissioned due to harvesting, reducing the total PSP network.

2.8.3.3. *WESBOGY Mixedwood Density Experiment*

LP Swan River (Figure 2.39) has the eastern-most installation of 11 identical mixedwood density experimental installations across western Canada. Note that LP Dawson Creek, BC (LPDC) was the western-most installation. Membership in the WESBOGY association includes seven forest companies, three provincial/territorial governments (Alberta, Saskatchewan and the Northwest Territories) and the federal government of Canada.

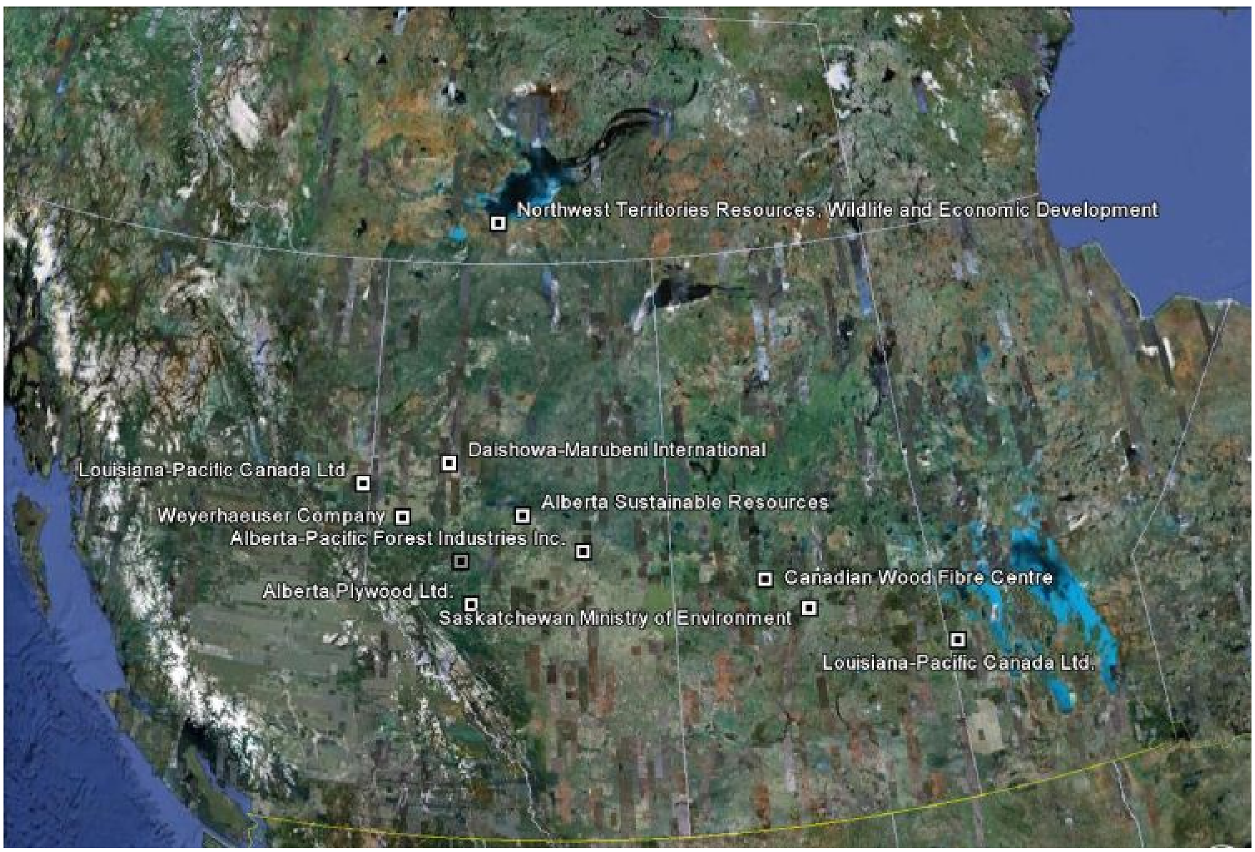

Figure 2.38 WESBOGY mixedwood experimental trials in western Canada.

LP established their mixedwood density installation in 1998 and has consistently maintained and remeasured these valuable aspen and white spruce permanent plots. There are 60 permanent plots on two sites; Alpine-high site quality, and Boggy Creek-medium site quality. The mixedwood plots range from pure white spruce to pure aspen, with four levels of mixed aspen-spruce densities.

Two of the WESBOGY association's main goals are:

- To evaluate the effect of spruce and aspen density levels on the development of plantations from establishment to final harvest (Bokalo *et. al.* 2007); and
- To develop and refine growth and mortality relationships and incorporate these new relationships into the Mixedwood Growth Model growth simulator (Bokalo *et. al.* 2013).

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2.10. APPENDICES

APPENDIX 1: **Roads and Water Crossings in Forest Management Licence #3** (1:150,000 scale map).

APPENDIX 2: **Area harvested in Forest Management Licence #3 (2006 to 2019)** (1:150,000 scale map).

APPENDIX 3: **Renewal activities in Forest Management Licence #3 (2006 to 2019)** (1:150,000 scale map).

Roads and Stream crossings that existed between 2006 and 2019 within FML #3
Legend
Existing Bridge
Existing Crossing
Existing Culvert
Rehab'd Bridge
Rehab'd Crossing
Rehab'd Culvert
Forest Management Units
Highway
Closed Roads
Existing All Season
Existing Seasonal
Rivers
Lakes
0 2.5 5 10 15
Kilometers
N
W E
S


Locations that were harvested between 2006 and 2019 in FML #3
Legend
Harvested Location
Forest Management Units
Backcountry
Heritage
Recreational Development
Resource Management
Rivers
Lakes
N
W
E
S
0
4.25
8.5
Kilometers
1:200,000
Eastern Portion of Forest Management License #3
1:825,000
0
3.25
6.5
13
Kilometers


2006 to 2019 Forest Renewal Activities
in FML #3
Legend
Certificates
Tree Plant
Scarification
Stand Tending
Highway
Forest Management Units
1:200,000
0
5
10
20
Kilometers
N
S
E
W