Type 4 Silviculture Strategy

Tactical Plan – 100 Mile House TSA

Version 2.0

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1 Introduction

1.1 Context

This document is the fifth of five documents that make up a Type 4 Silviculture Strategy (Silviculture Strategy), the documents are:

1. Situation Analysis – describes in general terms the situation for the unit. The Situational Analysis (draft) forms the starting point for the initial meeting to identify opportunities.
2. Data Package - describes the information that is material to the analysis including data inputs and assumptions.
3. Modeling and Analysis report –provides modeling outputs and rationale for choosing a preferred scenario.
4. Silviculture Strategy –provides treatment options, associated targets, timeframes and benefits.
5. **Tactical Plan – provides direction to silviculture practitioners for developing operational plans that identify specific stands for treatment**.

The tactical plan describes the suggested actions required to achieve some of the goals, objectives and targets described in the Silviculture Strategy for the 100 Mile House Natural Resource District. The tactical plan includes maps and georeferenced data that identify spatially-explicit target and candidate treatment areas for specific treatments at a given funding level. The funding levels used in this plan are consistent with those identified in the Silviculture Strategy. However, the plan identifies substantially larger eligible areas than budgeted in the Silviculture Strategy; many of the model identified areas may not be operationally appropriate for treatments due to data inconsistencies and, as such, contingency areas provide choice for operational silviculture planners. Further, significant changes in the inventory, as described below, reduced the relevance of the treatment schedules and locations produced by the timber supply model.

2 Project Objectives

The Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) initiated a Type 4 silviculture strategy for the 100 Mile House Timber Supply Area (TSA). The strategy will help MFLNRO work towards the government's strategic objectives such as:

- Best return from investments and activities on the forest and range land base;
- Encourage investments to benefit forest and range resources;
- Manage the pest, disease and wildfire impacts;
- Mitigate mid-term timber supply shortage caused by the MPB;
- Maximize timber growth in the provincial forests.

This silviculture strategy is a result of collaboration and sharing of ideas involving MFLNRO Victoria staff, MFLNRO local staff, other government and industry stakeholders, and other professionals.

The ultimate goal is a realistic strategy that will be owned and championed by district staff and licensees. In particular, this silviculture strategy will present:

- A fully rationalized plan to guide the expenditure of public silviculture funds to improve the future timber supply and habitat supply;
- A plan with a consistent format and content so that expanding it to regional and provincial levels is feasible and facilitates comparisons between management units;
- A plan containing the right information in the right format so that it can be utilized by government and industry for resource management related decision making;
- Silviculture regimes and associated standards that may potentially be adopted in forest stewardship plans as required standards for basic silviculture operations.
- An introduction of climate change into future management decision making.

3 Approach

3.1 Data

The modelling output from the Silviculture Strategy – particularly the preferred composite scenario – provided the starting point for this project. The scenario results were tentatively linked to generate spatial treatments locations for 10 years. Only rehabilitation and fertilization treatments are included in this plan.

3.2 Inventory Changes

The Silviculture Strategy and the related scenario analysis employed a 2011 version of the Vegetation Resource Inventory (VRI). The 2011 VRI consisted of approximately 20% true VRI, where the land base had been inventoried to the contemporary VRI standard. The remaining 80% of the inventory was made up of the old Forest Cover Inventory (FC1), which had been converted or "rolled over" to the VRI format.

A new version of the forest inventory was compiled in 2014 for the 100-Mile House Natural Resource District. This inventory is now 100% true VRI; the 80% of the land base that was still based on the old FC1 in 2011 was photo-interpreted and re-inventoried. The updated VRI was found to be substantially different from the old inventory; polygon boundaries changed significantly as did the inventory attributes. Given these changes, it was not longer feasible to use the Silviculture Strategy model output as the basis for this tactical plan, except in those cases where the inventories matched.

GIS analysis was used to help delineate candidate stands for rehabilitation as described under section 3.4. The identification of candidate fertilization stands was augmented using a fertilization plan as described under section 3.5.

3.3 Targets

The treatment targets for the tactical plan are shown in Table 1.

Table 1: Targets for silviculture treatments

Year	Rehabilitation			Fertilization		
	Area (ha/yr)	Cost ($/ha)	Annual Cost	Area (ha/yr)	Cost ($/ha)	Annual Cost
1 to 5	0	n/a	0	600	$500	$300,000
6 to 10	750	$2,000	$1,500,000	1,000	$500	$500,000

3.4 Rehabilitation

Rehabilitation of MPB killed pine stands is a potential opportunity to mitigate the late mid-term timber supply and reduce fire risk at the landscape and local levels. Rehabilitation treatment is assumed to consist of the removal of standing and fallen trees, with no recovery of merchantable volume, followed by planting with suitable tree species.

In the scenario analysis approximately 65,000 ha of MPB attacked stands were not harvested within the first 20 years; these stands had lost most of their merchantable sawlog volume due to decay and were assumed to break up in the timber supply model. This population was the basis for the rehabilitation scenarios. The area was reduced by excluding all stands within UWR's and those stands that in the timber supply model were assumed to have high densities of advanced regeneration. The remaining area of 23,000 ha was considered to be the maximum treatable area.

During the preparation of the Silviculture Strategy, the TSA licensees and the government staff were convinced that the scenario analysis overestimated the candidate rehabilitation area. They believed that most of the dead pine dominated stands in the TSA will be harvested and little rehabilitation is required. As a result, the Silviculture Strategy proposes a modest rehabilitation program of 750 ha per year over a 5-year period starting in the 6th year of the strategy for a total of 3,750 ha. Analysis shows that this program is projected to have a modest late mid-term impact; however, it may provide more mid-term harvest than indicated in the modelling results, should the rehabilitated stands contain any significant merchantable volume.

In early 2015 the TSA licensees and government staff still believe that most of the forest killed by the MPB will be salvaged and subsequently reforested. Records indicate that in January of 2015, stands containing less than 60 m^3 per ha were being laid out for harvesting indicating a continued harvesting of small volume dead stands (Personal Communication with Ian Hamilton, RFP, December 2014).

The stands with no merchantable volume are the first priority for rehabilitation, while stands that may still contain merchantable volume even after the salvage period is over should be rehabilitated during the mid term when a timber shortage is projected to exist.

The theoretical spatial locations of the treated stands were used only as a coarse starting point for the tactical rehabilitation plan. It was not considered feasible to use the model generated rehabilitation populations due to the inventory changes described above. Also, the model results are theoretical and appear overestimated in the opinion of the TSA stakeholders.

Stands selected as rehabilitation candidates are larger than 1ha but smaller than 25ha; the population excludes the larger dead stands as these might still be appropriate candidates for salvage operations. The candidate rehabilitation population of small isolated dead pine stands was chosen through GIS analysis using the latest VRI (compiled in 2014 and published in January 2015) and the latest depletion coverage,

3.4.1 Stand Selection Methodology

The new VRI for the 100-Mile House Natural Resource District is projected to January 1 of 2014 and updated for depletions to the end of 2013. We updated this 2014 VRI with the most recent RESULTS depletion data, thus capturing harvest and natural disturbance events to the end of 2014. We then compared the new inventory to the previously version of the inventory (2011) – the one used for the Type 4 Silviculture Analysis. Our intent was to base the rehabilitation plan on the new inventory while understanding the changes between the two inventories. As discussed under section 3.2, the inventory had changed significantly. The 2014 VRI listed a large number of stands that were characterized by high mortality but where the new leading species was not pine.

3.4.1.1 Primary and Secondary Criteria

The following primary criteria were set for selecting the candidate stands for rehabilitation:

- Stands must be at least 61 years old;
- Stands must be pine leading stands or used to be pine leading stands before serious mortality;
- Stands must be characterized by high mortality (>50% of sph listed as dead);
- Stands must have little remaining merchantable volume (<150 m^3/ha);
- Stands should be small and isolated (>1ha and <25ha).

In addition, the following secondary criteria were also employed:

- The stands must be located in the THLB as defined in the resultant dataset of the Type 4 Silviculture Strategy;
- The stands must be outside OGMAs;
- The stands must be outside the Clinton Community Watershed;
- The stands may not be located in preservation or retention VQOs;
- The stands may not be in a known ungulate winter range area;
- The stands are outside wildlife habitat areas;

The above criteria yielded a population of 10,595 ha of stands that were considered potential rehabilitation candidates.

3.4.1.2 Ranking of Stands

The potential rehabilitation stands were further ranked as per the following criteria:

Rank =1:

- Age >60
- Percent dead > 80%
- Pine percent > 80%
- Total Stand Volume (dead and alive) < 100m^3/ha

Rank =2:

- Age >60
- Percent dead > 70%
- Pine percent > 70%
- Total Stand Volume (dead and alive) < 150m^3/ha

Rank =3:

- Age >60
- Percent dead 50 to 70%
- Total Stand Volume (dead and alive) < 150m^3/ha

3.4.1.3 Spatial Criteria (GIS Processing) and Selection Process

All stands in rank 1, 2 or 3 were spatially identified through linkages between the new VRI and the resultant dataset used for the Silviculture Strategy. In total, 784 individual stands were selected accounting for 4,946 ha. Stands selected as rehabilitation candidates are larger than 1ha but smaller than 25ha. The remaining stands that were not selected (5,649 ha) form a population of potential candidates that should be assessed as well.

The Type 4 Silviculture Strategy recommends a rehabilitation target of 750 ha per year for years 6 to 10 or 3,750 ha in total. This tactical plan identifies a larger population of potential stands as it is expected that the operational checks will eliminate several candidate stands. Table 2 shows the candidate areas by rank and Figure 1 illustrates the dead stands and the selected candidate stands.

Table 2: Candidate areas by rank

SELECTED	Area (ha)			
	Rank = 1	Rank = 2	Rank = 3	Total
No (Potential)	553	1,407	3,689	5,649
Yes	167	939	3,840	**4,946**
Total	**720**	**2,347**	**7,529**	**10,595**

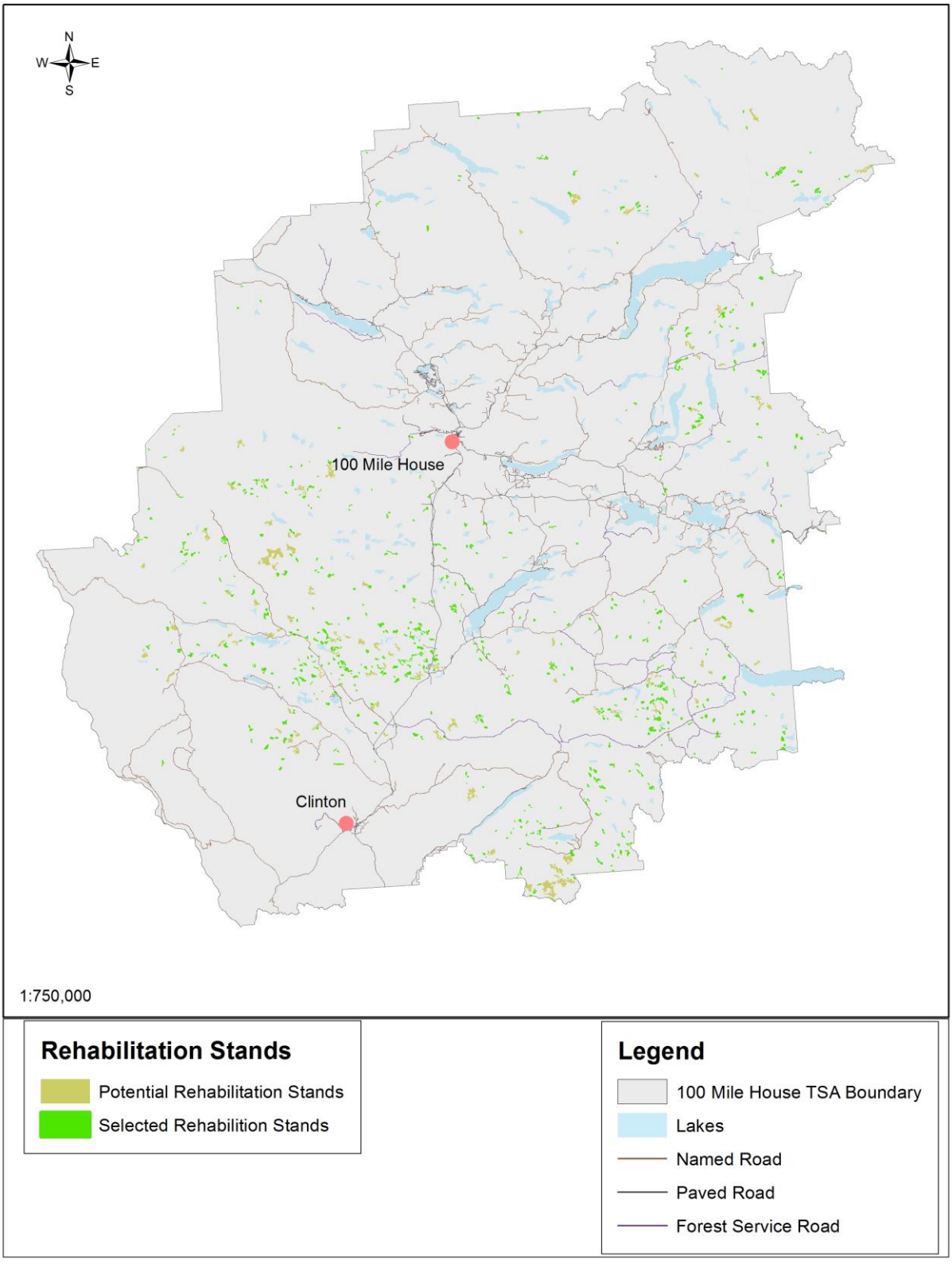

Figure 1: Candidate areas for rehabilitation

3.5 Fertilization

Due to concerns regarding the efficacy of fertilization in the 100 Mile House TSA, the Silviculture Strategy set a rather modest target at 600 ha per year for the first 5 years and 1,000 ha per year for years 6 to 10.

The best financial return in fertilization is achieved by fertilizing healthy, well stocked stands - dominated by Douglas fir, spruce and pine - younger than 80 years of age once, approximately 10 to 20 years before harvest. The fertilization should take place on mesic, medium to poor sites in SBS, ICH, SBPS and lower portions of the ESSF. According to the 2011 inventory this population was limited in the TSA; however, the 2015 VRI contains substantially more potentially suitable area for these older stands.

As noted previously, because of significant changes in the forest inventory it was not feasible to use model created treatment locations and schedules for this plan. Instead, fertilization potential was assessed based on the 2015 version of the VRI and updated depletions. This assessment produced a set of eligible fertilization stands. Model output was used only where the eligible population overlapped with the model output.

3.5.1 Eligible Stands

The current FLNRO Stand Selection Guidelines (April, 2014) and the following criteria were used to develop ranking algorithms to identify stands where fertilization would generate a biological response and may be financially viable assuming current costs and values:

Fdi and Sx Stands:

- Age: 25 to 80 years old;
- Fdi/Sx %: 50 to 100% with >80% preferred;
- BEC Subzone / Variant: SBS and ICH (all subzones and variants), SBPSmk and ESSFwk1 and wc3;
- Site Index: 17-25.

Pli Stands:

- Age: 25 to 35 years old;
- Pli %: 50 to 100% with >70% preferred;
- BEC Subzone/ Variant: SBS and ICH (all subzones and variants), SBPSmk and ESSFwk1 and wc3;
- Site Index: 17-25.

A review of the current VRI data showed that crown closure reflects the damage from the mountain pine beetle (MPB) infestation reasonably well. Crown closure also correlates well with fertilization potential. As a result, crown closure was used to exclude stands that were significantly damaged by MPB. It was also used to exclude stands growing on ecologically unsuitable sites for fertilization. The following crown closure criteria were used:

- >40% for stand ages of 51 to 80 years and >20% for stand ages of 25 to 50 years

Due to the different nutritional requirements of Pli and Fdi/Sx, different blends of fertilizer are commonly used for Pli and Fdi/Sx stands. For this reason, it is desirable to develop rankings that identify the fertilization opportunities by species group.

Fdi/Sx stands that are older than 40 years of age and contain significant components of Pli are rare, as most of the pine has been killed by the MPB. However there is a population of young mixed stands of Fdi, Sx and Pli. A separate algorithm was developed to consider these stands for treatment.

The ranking of Fdi/Sx and Pli and mixed Fdi/Sx/Pli stands is shown in Table 3, Table 4 and Table 5 respectively.

Table 3: Fdi/Sx fertlization ranking

Fertilization Rank	Age	% Fd and Sx	% Crown Closure	BEC Site
High: Mature Forest (FdSx_HMF)	51 to 100	>=70	>40	SBS and ICH (all variants) and SBPS mk and ESSF wk1 and wc3
Moderate: Mature Forest (FdSx_MMF)	51 to 100	>= 40% <= 69	>40	SBS and ICH (all variants) and SBPS mk and ESSF wk1 and wc3
Low: Mature Forest (FdSx_LMF)	51 to 100	>= 40	>40	MS xk2 and ESSFdc3
High: Young Forest (FdSx_HYF)	20 to 50	>=70	>20	SBS and ICH (all variants) and SBPS mk and ESSF wk1 and wc3
Medium: Young Forest (FdSx_MYF)	20 to 50	>= 40% <= 69	>20	SBS and ICH (all variants) and SBPS mk and ESSF wk1 and wc3
Low: Young Forest (FdSx_LYF)	20 to 50	>= 40	>20	MS xk2 and ESSFdc3

Table 4: Pli fertilization ranking

Fertilization Rank	Age	% Pli	% Crown Closure	BEC Site
High: Young Forest (Pli_HYF)	25 to 35	>=70	>20	SBS and ICH (all variants) and SBPS mk and ESSF wk1 and wc3
Medium: Young Forest (Pli_MYF)	25 to 35	>= 40% <= 69	>20	SBS and ICH (all variants) and SBPS mk and ESSF wk1 and wc3
Low: Young Forest (Pli_LYF)	25 to 35	>= 40	>20	MS xk2 and ESSFdc3

Table 5: Fdi/Sx/Pli fertilization ranking

Fertilization Rank	Age	% Fdi and Sx and Pli	% Crown Closure	BEC Site
Medium: Young Forest (Mixed MYF)	25 to 35	>= 40% <= 69	>20	SBS and ICH (all variants) and SBPS mk and ESSF wk1 and wc3
Low: Young Forest (Mixed LYF)	25 to 35	>= 40	>20	MS xk2 and ESSFdc3

The eligible areas are exclusive of the following;

- Recently logged areas;
- Planned harvest blocks;
- Existing WTP's, WTR's;
- Private land, Long term reserves, protected areas, parks etc;
- UWR, WHA (including Caribou habitat);
- OGMA;
- Community Watersheds.

The area of eligible Fdi/Sx and Pli-leading and mixed Fdi/Sx/Pli stands by ranking are displayed in geo-referenced PDF format on an overview 1:500,000 scale key map with hyperlinks to 44 1:50,000 maps (1 per mapsheet). In addition, these maps show the above listed land base exclusions. The following additional information is also displayed:

- Woodlots, TFL's, Community Forests;
- Domestic water licenses/intakes, buffers are required;
- Slopes >50%, increases harvest costs and therefore reduced financial returns from treatment;
- VQO= Retention, potentially reduces future harvest efficiency/potential;
- PSPs/research installations, may not be treatable and buffers may be required;
- Areas previously aerially fertilized, separate theme for 2009 to 2014 and before 2008;

The PDF maps and the GIS resultant for this project have been delivered separately from this report.

Table 4 summarizes the areas for the different groups of eligible fertilization populations in the 100 Mile House TSA.

Table 6: Eligible fertilization stands, 100 Mile House TSA

Species Group	Age Category	Ranking	Gross Area (ha)
Fir/Spruce	Mature	High	19,655
		Moderate	9,098
		Low	681
	Young	High	7,514
		Moderate	7,658
		Low	632
	SUBTOTAL		45,238
Pine	Young	High	7,870
		Moderate	3,396
		Low	2,003
	SUBTOTAL		13,268
Fir/Spruce/Pine	Young	Moderate	1,392
		Low	132
	SUBTOTAL		1,524
GRAND TOTAL			**60,030**

3.5.2 Stand Selection for Tactical Plan

The Type 4 Silviculture Strategy recommends 3,000 ha of fertilization for the first five-year-period and 5,000 ha for the second five-year-period for a total of 8,000 ha over 10 years. In this plan a population of 8,920 ha is presented for operational consideration and prioritization.

The stands that were scheduled for fertilization in the forest estate model and also matched the high and moderate eligible stands as identified above in section 3.5.1 were given the first priority in the tactical plan. These stands comprised of 43%, or 3,791 ha of all the selected stands. The balance of the fertilization candidates (5,128 ha) were chosen from the high ranked young Fdi/Sx population based on their proximity to the previously selected stands. The candidate population for fertilization is presented in Table 7 and Figure 2.

Table 7: Candidate stands for fertilization (ha)

Fertilization Class	Model Output	Priority	Fert Period		Total
			1	2	
Fir/Spruce, Mature, High	Yes	1	297	301	**598**
Fir/Spruce, Young, High	Yes	1	376	1,092	**1,467**
Fir/Spruce, Mature, Medium	Yes	1	74	50	**124**
Fir/Spruce, Young, Medium	Yes	1	295	553	**848**
Pine, Young, High	Yes	1	448	62	**510**
Pine, Young, Medium	Yes	1	236	8	**244**
Fir/Spruce, Young, High	No	2	1,362	3,766	**5,128**
Total			**3,088**	**5,832**	**8,920**

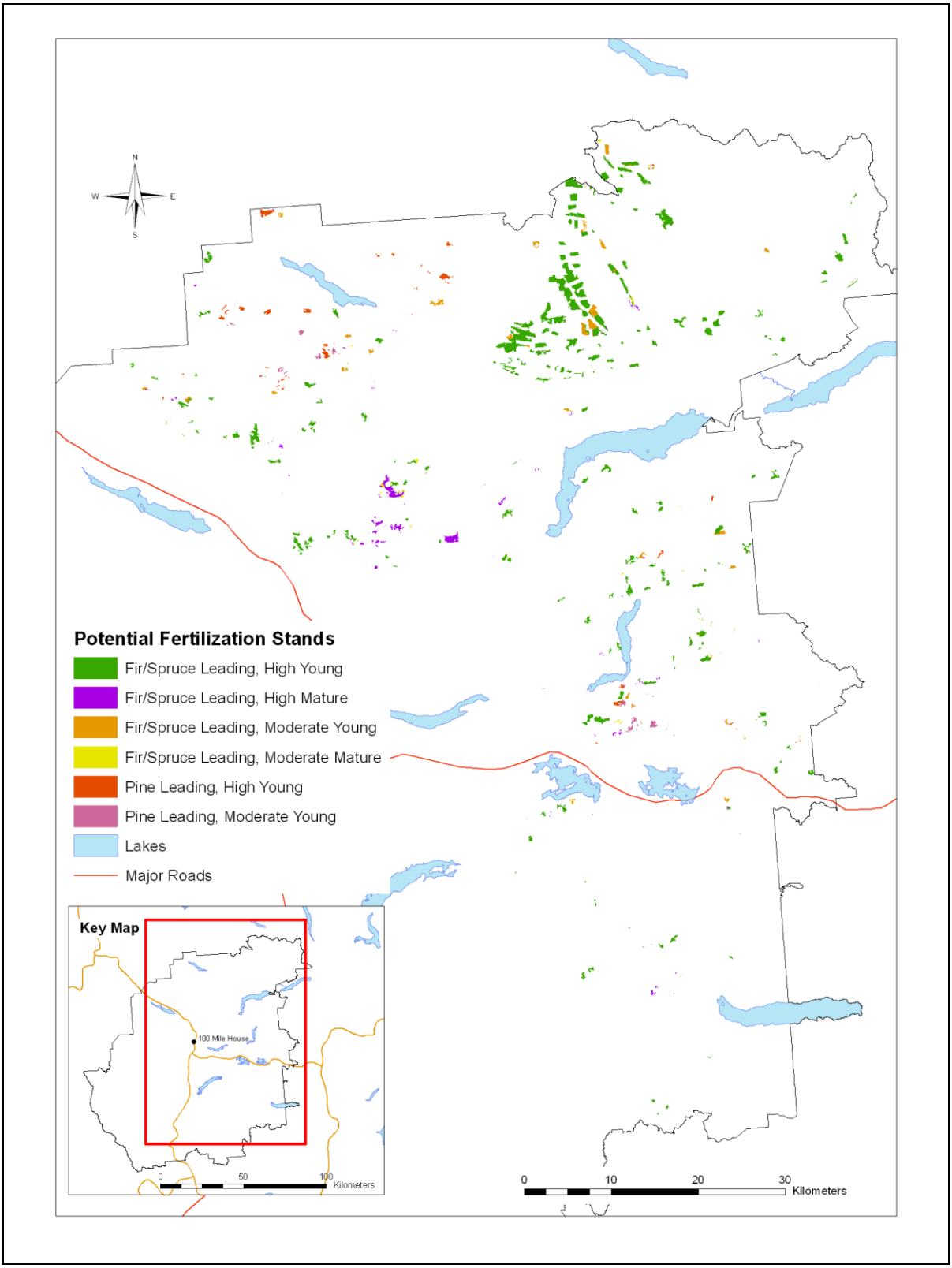

Figure 2: Candidate stands for fertilization

3.6 Mapping

Candidate rehabilitation stands and fertilization stands were mapped; four 1:125,000 scale maps were prepared for both treatment types (8 maps in total). The maps and shapefiles were delivered in conjunction with this report.

The suggested treatment periods were not shown on the maps as we felt that an operational review is required before any treatment decisions regarding the suitability of the treatment itself or its timing can be made. No operational constraints were considered when selecting the stands, aside from those already outlined in this report.

4 Discussion

The intent of this project was to create two tactical plans: one for the rehabilitation of MPB killed pine leading stands and the other for fertilization. The original, model-created rehabilitation candidate population was based on the harvest schedule of the forest estate model. The forest estate model neglected to harvest stands that had lost most of their merchantable volume as per the shelf life assumptions employed in the model. This un-harvested population of stands was originally considered the rehabilitation candidate population. The perusal of the new VRI revealed that many of the dead pine stands that were expected to remain un-harvested had in fact been harvested between the inventory updates. Using the model output to identify the candidate rehabilitation stands was not feasible. A population of dead un-harvested pine stands was identified in the updated inventory and is presented in this plan as the point of commencement for operational review.

The chosen fertilization population was originally based on the forest estate model output. Due to the significant changes in the forest inventory, the model based fertilization schedule was used only partially. A fertilization plan, based on the new inventory, was constructed. This fertilization plan presents a population of stands eligible for fertilization. The stands that were scheduled for fertilization in the timber supply model and also matched the eligible stands identified in the fertilization plan were included in the tactical plan. The balance of the fertilization candidates were chosen from the high ranked young Fdi/Sx population based on their proximity to the model selected stands.

The population of eligible stands is large (60,030 ha) as discussed above in section 3.5.1. This large eligible population provides substantial opportunities for substitution, should the stands identified in the tactical plan not be operationally feasible.

The large population of eligible stands also suggest that there may be an opportunity to increase the size of the fertilization program. It is also important to note that the eligible stands identified in this plan are considered the maximum treatable area and factors such as access and forest health were not considered in this plan.

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