



Range Plan for Woodland Caribou in Saskatchewan – APPENDICES

Boreal Plain Ecozone – SK2 Central Caribou Administration Unit

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Executive Summary

This appendix to the *Range Plan for Woodland Caribou in Saskatchewan Boreal Plain Ecozone (SK2 Central Caribou Administration Unit)* provides an overview of the efforts taken in the SK2 Central range plan to map disturbance and identify important caribou habitat management areas (CHMAs), as well as the process used to select them. It also provides information on land-use simulations that were done to assess how different management options might influence caribou habitat in the future.

Dominant land uses in the SK2 Central range include forestry and associated road networks, recreational road networks, communities and permanent highways. In addition to human land uses, wildfire is a natural disturbance process that shapes much of the SK2 Central landscape and maintains a healthy forest.

The federal recovery strategy for woodland caribou identifies 65 per cent undisturbed habitat in a range as the disturbance management threshold. When combining human-caused and wildfire disturbances using the Environment and Climate Change Canada woodland caribou disturbance mapping process, the SK2 Central range in 2015 was approximately 57.2 per cent undisturbed. Human-caused and wildfire disturbance accounted for approximately 28 per cent and 14.8 per cent of SK2 Central disturbances, respectively. Information presented may vary from previous periods or sources depending on the origin of datasets, date of available data, processing improvements, rounding and other factors.

Twenty-three CHMAs were identified in the SK2 Central range, covering a total of approximately 31,557 km². Tier 1 areas are primarily comprised of high and moderate habitat potential. Tier 2 areas are primarily comprised of upland ecosites with moderate habitat potential. Tier 3 CHMAs, provincial conservation areas (parks and ecological reserves) and federal lands, have the highest proportion of low habitat potential in SK2 Central.

Various land-use strategies were examined in simulation/sensitivity analyses to understand how different actions and activities influence our ability to manage the human footprint in SK2 Central. Disturbance levels were consistent with forest harvest changes. For example, a large increase in the amount of human-caused disturbance in SK2 Central could be expected with increased forest harvest, whereas, if the forest harvest rate were to decrease from current levels, disturbance reductions in SK2 Central could be expected. Furthermore, increasing the minimum harvest patch size that can be harvested could help reduce disturbance from forestry-related activities in SK2 Central.

Introduction to Appendices

These appendices provide background information, supporting evidence, contributory facts and additional technical figures and tables that were produced and analyzed in the development of the *Range Plan for Woodland Caribou in Saskatchewan Boreal Plain Ecozone (SK2 Central Caribou Administration Unit)* (the range plan). While these appendices provide examples and illustrations of the types of analyses conducted, they do not represent every set of analyses or every permutation of modelling explored. The intent is to provide further detail and more thorough explanation of some of the concepts, applications and evaluations described in the range plan.

The appendices are separated from the range plan to provide a better focus on the actions and management strategies designed to maintain and enhance woodland caribou habitat and to allow the range plan to be more concise.

APPENDIX A: SK2 Central Disturbance Mapping

Purpose

The Environment Canada (2011) caribou population risk assessment methodology is based on the amount of cumulative human and natural disturbance within a defined caribou range. This appendix describes disturbance mapping methods and results used to support the SK2 Central range plan.

Methods

The disturbance mapping used to support the national [*Recovery strategy for the Woodland Caribou \(Rangifer tarandus caribou\), Boreal population in Canada*](#) (Environment Canada, 2012) assessment used satellite imagery, and captured visible human disturbances mapped at a scale of approximately 1:50,000 (Figure 1). Based on available Government of Saskatchewan data sources, the Saskatchewan Ministry of Environment created an updated human disturbance layer that was equivalent to the 1:50,000 scale of mapping used by Environment Canada for their assessment, current to 2015. Wildfire perimeters were also updated to 2015.

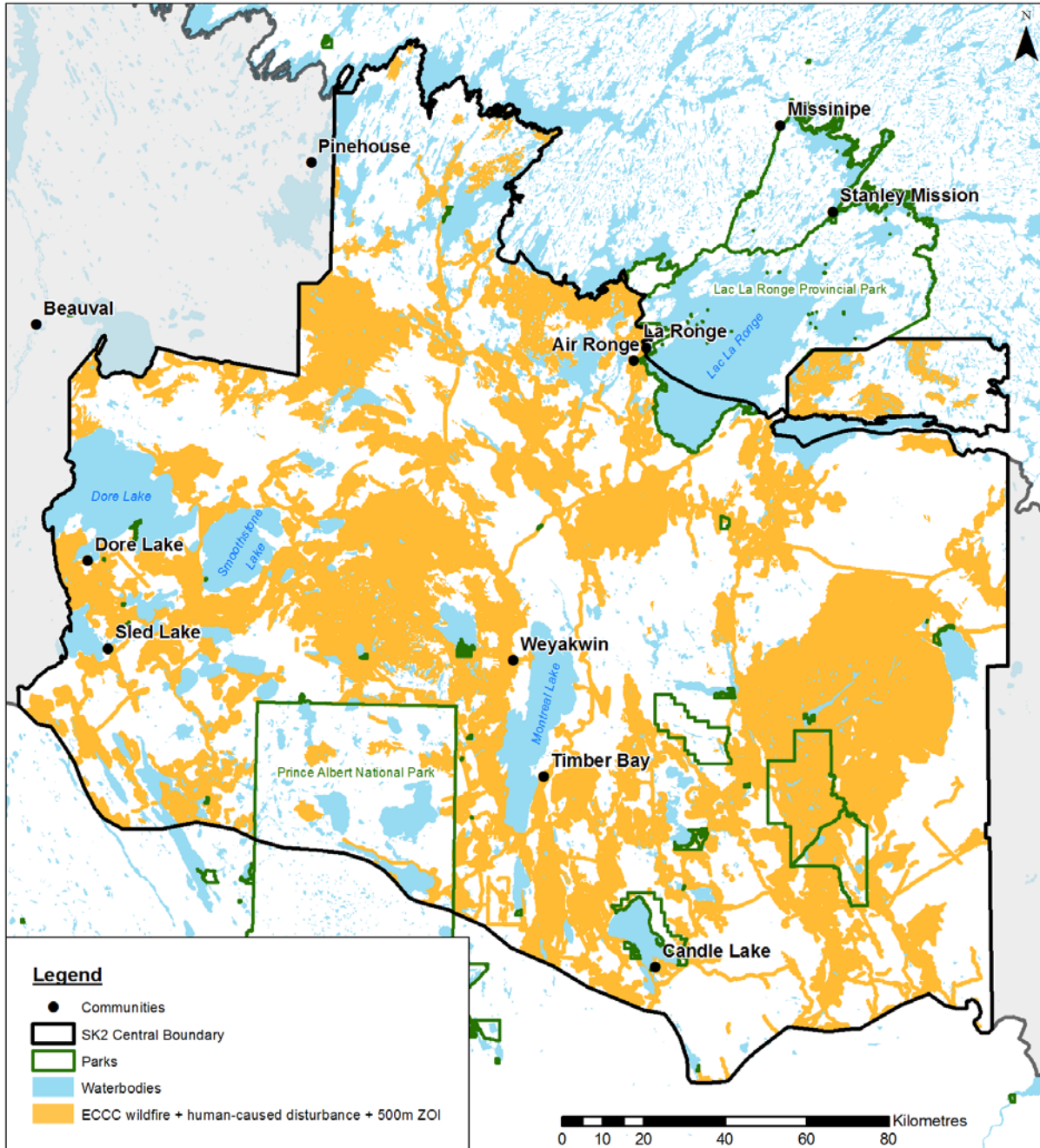


Figure 1. SK2 Central total disturbance map resulting from the Environment and Climate Change Canada (2015) scientific assessment¹.

¹ Total disturbance is calculated as total human-caused disturbance (i.e., direct footprint buffered by 500 metres to account for a zone of influence) plus disturbance from 1970 to 2010 wildfires.

Saskatchewan Data Sources

Human and wildfire disturbance mapping data sources used to create the Saskatchewan Ministry of Environment SK2 Central disturbance map are listed in Table 1.

Table 1. SK2 Central Saskatchewan disturbance mapping data sources.

Disturbance Features	Data Source
HUMAN DISTURBANCE	
Linear Features *	
Roads	<p>Saskatchewan Forest Road Network (SFRN) road features**:</p> <ul style="list-style-type: none"> Classified into permanent and non-permanent features.² Permanent roads include primary and secondary highways (SFRN Class 0), municipal roads (SFRN Class 7-8) and major improved bush roads (SFRN Class 1). Non-permanent roads consist of minor improved bush roads (SFRN Class 2), bush/winter roads (SFRN Class 3), in-block roads (SFRN Class 4), public roads (SFRN Class 5-6) and unknown roads (SFRN Class -1). SFRN also identifies and maps a class of linear features called “trails” (e.g., a linear route suitable for travel by mobile equipment, but not necessarily regular on-road vehicle uses). Trails were typically not mapped as a human-caused disturbance in the ECCC disturbance assessment in SK2 Central and so were not included in the SK2 Central Saskatchewan disturbance mapping or calculations. The removal of trails in this assessment for SK2 Central does not necessarily indicate that trails will be removed in disturbance assessments in other Caribou Administration Units.
Area-based Features	
Forest Harvest Blocks***	Saskatchewan Ministry of Environment, Forest Service Branch harvest block mapping: 40-year forest harvest history, 1975-76 to 2014-15.
Settlements	Saskatchewan Ministry of Environment, Technical Resources Branch human disturbance mapping.
Other Area-based Disturbances	Same as settlements.

² Permanent: features unlikely to be reclaimed or to naturally revegetate (e.g., highways and communities).
 Non-permanent: features likely to be reclaimed or naturally revegetate (e.g., harvest blocks, in-block roads, etc.).

Table 1. SK2 Central Saskatchewan disturbance mapping data sources (Continued).

WILDFIRE DISTURBANCE	
Wildfire Perimeters	Saskatchewan Ministry of Environment, Wildfire Management Branch: <ul style="list-style-type: none"> • 40-year wildfire boundaries, 1975 to 2015. • Waterbodies, as identified in the CanVec 1:50,000 shapefile, were erased from the wildfire polygons and did not contribute to the overall disturbance calculation attributed to wildfire.

Notes:

* Power lines were not included in the linear feature data set. In SK2 Central, all power lines follow road corridors.

**SFRN polylines (valid as of April, 2016) were used but reclassified according to Sakaw Askiy Management Inc. interactive map.

***At the time of data assembly 2015-16 forest harvest block mapping was not available.

Data Compilation

Three key geographic information system (GIS) data layers were used in the SK2 Central disturbance analysis:

1. The permanent human-caused disturbance layer includes linear and area-based disturbances that are likely to remain indefinitely on the landscape. Examples of these disturbances include, but are not limited to, highways, major improved bush roads and settlements.
2. The non-permanent human-caused disturbance layer includes features that have the potential to be removed from the landscape through reclamation or natural revegetation. Examples of non-permanent disturbances include, but are not limited to, recent forest harvest cut blocks (1975 to 2014) and bush roads.
3. The wildfire layer includes all wildfire perimeters for the time period 1975 to 2015. Wildfires are non-permanent natural disturbances. Waterbodies were removed from the wildfire disturbance calculations.

These three GIS files were merged together and dissolved in ArcGIS 10.3, to create the total disturbance layer for SK2 Central.

For the purpose of reporting individual feature type contributions to total disturbance calculations, priority was assigned to different feature classes. Permanent human disturbance features were assigned the highest priority, non-permanent human features next and wildfires the lowest³. A detailed breakdown of the human-caused disturbance hierarchy is provided in Table 4.

³ Disturbance mapping hierarchy: any human-caused disturbance that overlaps a wildfire polygon is assigned to the human-caused disturbance category and removed from the wildfire disturbance.

Results

Human Disturbance

Based on the available mapping, the total amount of non-overlapping human disturbance (direct footprint plus 500 m buffer) is approximately 10,084 km² (i.e., 28 per cent of SK2 Central) (Figure 2). Permanent features (settlements, highways and other major roads) account for 2,753 km² (i.e., 27 per cent of the total human disturbance). Non-permanent human disturbances (e.g., largely forest harvest blocks less than 40-years old) account for the remaining 7,332 km² (i.e., 73 per cent of the total human disturbance). Detailed results for linear and area-based features are reported in Tables 2 and 3, respectively. The purpose of these tables is to indicate the footprint of the different human-caused disturbances on the landscape.

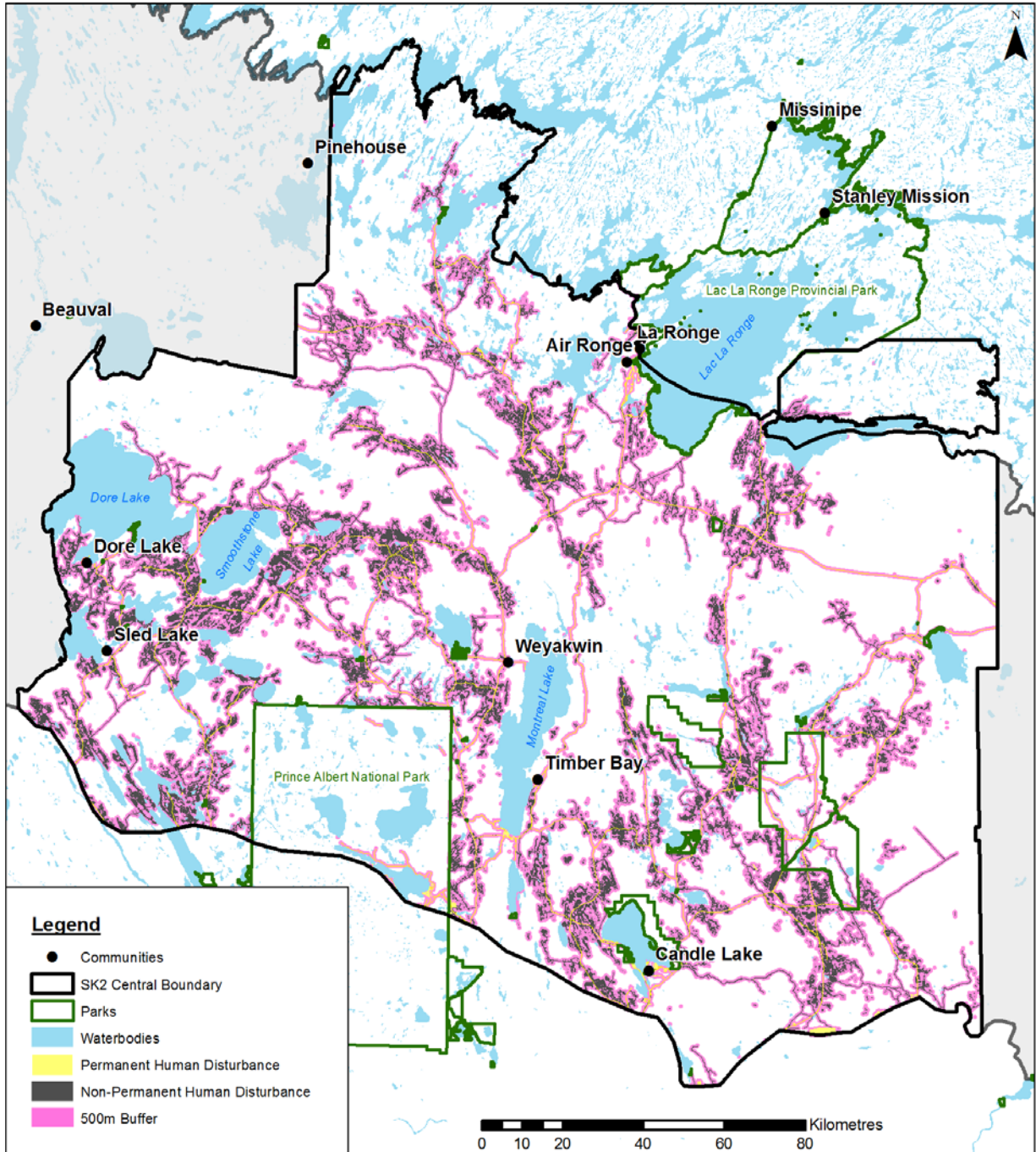


Figure 2. Current human disturbance in the SK2 Central.

Linear Features

Linear features (Table 2) comprise a large proportion (i.e., 58.8 per cent) of the total human disturbance present in SK2 Central. Permanent roads (e.g., primary highways, secondary highways, municipal roads and major improved bush roads) total 2,746 km in length, and they account for 29.4 per cent of the total linear disturbance. Non-permanent roads account for 70.6 per cent of the total linear disturbance and are further separated into in-block forest harvest roads and other roads. Of these features, in-block forest harvest roads account for the highest amount of linear disturbance totaling 4,206 km in length, which accounts for 41.4 per cent of the total linear disturbance. There are 2,294 km of other roads (i.e., improved bush roads, bush and winter roads, unknown roads and public roads). These features contribute 29.2 per cent of the total linear feature disturbance, approximately the same amount as all permanent roads combined.

Table 2. SK2 Central human disturbance mapping summary for linear features⁴.

Linear Features	Length (km)	Area of Direct Footprint + 500 m buffer (km ²)	Per cent of Total Linear Disturbance
Permanent Roads			
Sub-Total	2,746	2,369	29.4
Non-permanent Roads			
In-Block Roads	4,206	3,338	41.4
Other Roads	2,294	2,348	29.2
Sub-Total	6,500	5,685	70.6
TOTAL	9,246	8,054	100.0

Area-based Features

Area-based features (Table 3) account for 41.2 per cent of the total human-caused disturbance in SK2 Central. Permanent area-based features (e.g., settlements, recreation areas and airports) constitute only 9.1 per cent of the total area-based disturbance. Non-permanent features (e.g., forest harvest blocks less than 40 years of age) account for more than 90 per cent (8,166 km²) of the total amount of area-based disturbance, which is nearly equivalent to all linear features combined.

⁴ See Table 4 for percentage of total non-overlapping human-caused disturbance.

Table 3. SK2 Central human disturbance mapping summary for area-based features ⁴.

Area-based Features	Area of Direct Footprint (km ²)	Area of Direct Footprint + 500 m buffer (km ²)	Per cent of Total Area-based Disturbance
Permanent			
Settlements	19	149	1.7
Other	48	668	7.4
Sub-Total	67	817	9.1
Non-permanent			
Forest Harvest Blocks < 40 years old	2,300	8,166	90.9
Sub-Total	2,300	8,166	90.9
TOTAL	2,367	8,983	100.0

Non-overlapping Human Disturbance

As previously described in the data compilation section of this report, a disturbance hierarchy was established to avoid duplication in disturbance calculations. Table 4 shows the hierarchy of the data layers. Although permanent area-based features are the highest ranking human-caused disturbance, they only account for eight per cent of the total SK2 Central human-caused disturbance. However, non-permanent roads, which fall in the middle of the human-caused disturbance ranking, amount to the highest proportion (39.5 per cent) of disturbance. Forest harvest blocks are the other major contributor to total human-caused disturbance, accounting for 33.2 per cent of the non-overlapping area.

Table 4. SK2 Central non-overlapping human-caused disturbance features and mapping hierarchy.

Disturbance Features and Mapping Hierarchy	Non-Overlapping Area of Direct Footprint + 500 m buffer (km ²)	Per cent of Total Non-overlapping Human-caused Disturbance
1. Permanent Area-based		
a. Settlements	149	1.5
b. Other	660	6.5
Sub-Total	809	8.0
2. Permanent Roads		
Sub-Total	1,944	19.3
3. Non-permanent Roads		
a. In-block roads	2,163	21.5
b. Other Roads	1,824	18.1
Sub-Total	3,987	39.5
4. Non-permanent Area-based		
Forest Harvest Blocks < 40 years old	3,345	33.2
Sub-Total	3,345	33.2
TOTAL	10,084	100.0

Wildfire Disturbance

The total area of wildfire disturbance in SK2 Central calculated from provincial wildfire perimeter mapping, with waterbodies removed, for the period 1975 to 2015 is 8,502 km² (i.e., 23.6 per cent of SK2 Central). Figure 3 shows wildfires by decade with the wildfire area summarized in Table 5. Fire cycles based on the past 40 years of fire mapping suggests time periods which may be longer than the historical fire cycle, potentially as a result of fire suppression efforts.

There is considerable overlap between human and wildfire disturbance. The extent of wildfire as measured between 1975 to 2015 that does not overlap with human disturbance is 5,356 km² (i.e., 63 per cent of total wildfire area), or 0.37 per cent per year (i.e., 134 km²/year).

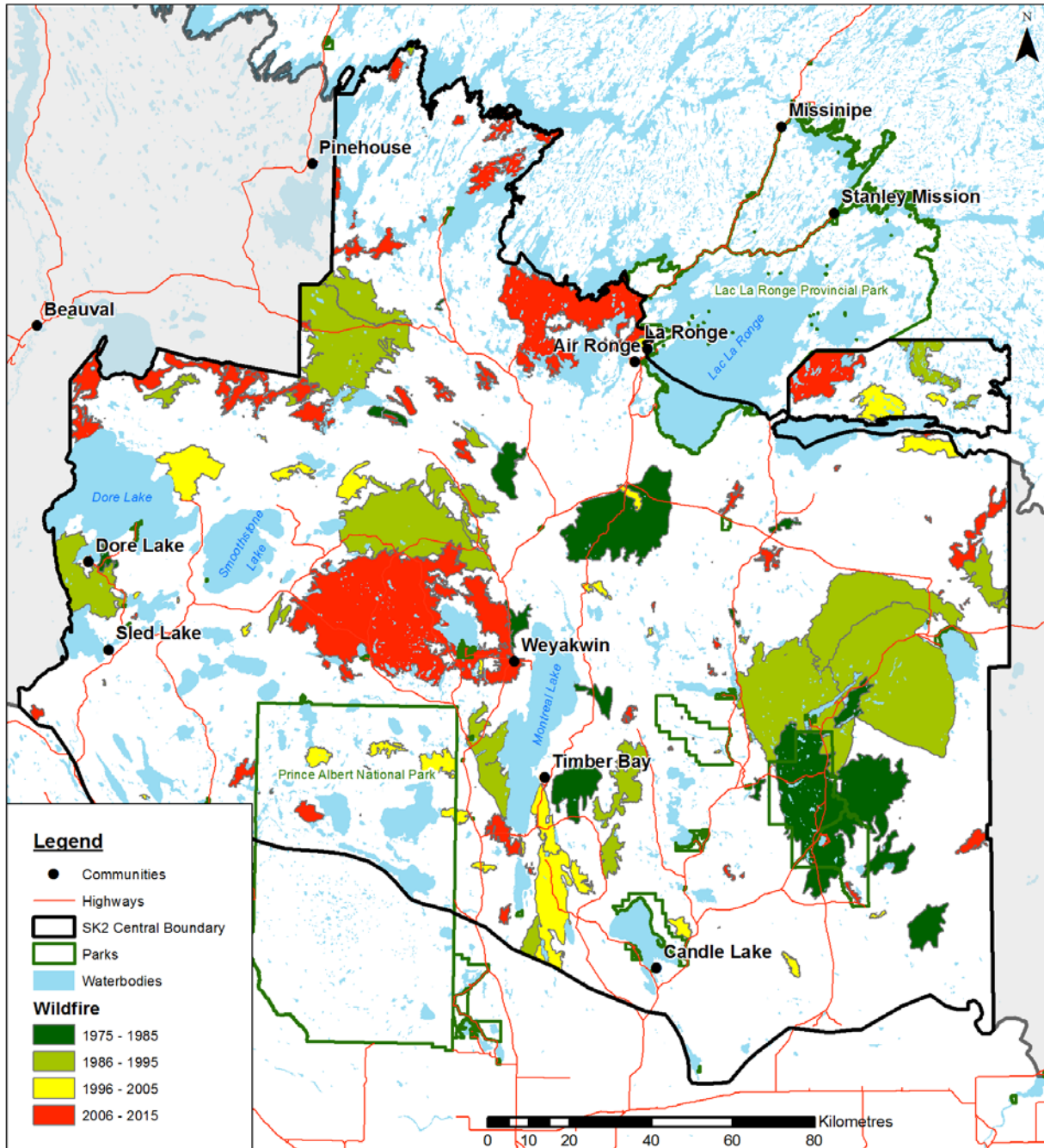


Figure 3. Wildfire disturbance in SK2 central for the period 1975 to 2015, shown by decade.

Table 5. SK2 Central wildfire disturbance summary, reported by decade.

Decade	Area Burned (km ²)	Area Burned (Per cent of Total Area Burned)	Area Burned (Per cent of SK2 Central)
1975 to 1985	1,593	18.7	4.4
1986 to 1995	3,678	43.3	10.2
1996 to 2005	760	8.9	2.1
2006 to 2015	2,470	29.1	6.9
TOTALS	8,502	100	23.6

* Extent of wildfire that does not overlap with human disturbance is 5,356 km².

Total Non-overlapping Disturbance

Figure 4 shows the extent of total non-overlapping disturbance resulting from human and wildfire sources. Results are summarized in Table 6. As of 2015, approximately 42.8 per cent (i.e., 15,442 km²) of the SK2 Central area was disturbed by humans and wildfire. Of the 15,442km² disturbed area, human-caused disturbance accounts for approximately 65 per cent (i.e., 10,086 km²) of this area. Approximately 57.2 per cent (i.e., 20,610 km²) of SK2 Central remains in an undisturbed condition.

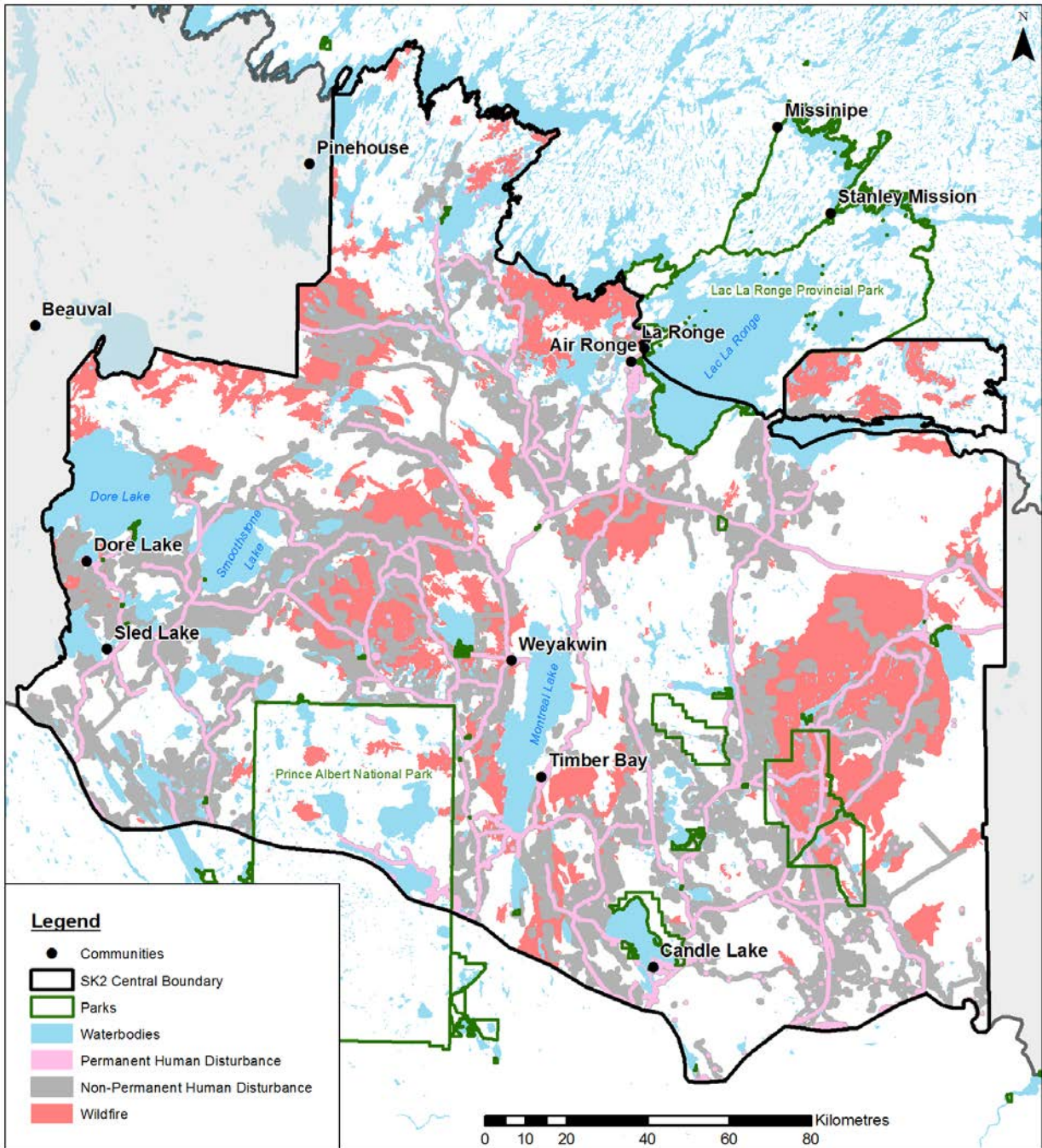


Figure 4. Current extent of non-overlapping human and wildfire disturbance in SK2 Central⁵.

⁵ Permanent and non-permanent human disturbance and wildfire disturbance is shown separately.

Table 6. SK2 Central disturbance mapping summary.

Disturbance Source	Non-overlapping Area (km ²)	Per cent of Total Non-overlapping Area
Human Disturbance*		
Permanent	2,753	7.6
Non-Permanent	7,332	20.4
Total Human Disturbance	10,084	28.0
Wildfire Disturbance**		
Total Wildfire	5,356	14.8
Disturbance Summary		
Total Disturbed Area	15,442	42.8
Total Undisturbed Area	20,610	57.2

Notes:

* Human disturbance is calculated as direct footprint plus 500-metre buffer.

** Wildfire disturbance is calculated based on wildfire perimeter mapping for 1975 to 2015 fire record.

Waterbodies, as identified in the CanVec 1:50,000 shapefile, have been erased from the wildfire polygons and do not contribute to the disturbance calculations.

Summary

Human-caused Disturbance

Based on the Saskatchewan Ministry of Environment disturbance assessment, the total amount of human disturbance (i.e., direct footprint plus 500 m buffer) in SK2 Central is approximately 10,084 km² (i.e., 28.0 per cent of SK2 Central). These mapping products represent the best available information at the time of the development of the range plan, but could over or under-estimate disturbance due to uncertainties regarding the re-vegetation status of disturbed areas. Other considerations regarding human-caused disturbance are as follows:

- Re-vegetation status of current linear features is not well documented, but given that most are readily visible at a scale of approximately 1:50,000, many features are assumed to be in an un-vegetated state or early-stage of re-vegetation, and that many of the linear features represented in the SK2 Central human disturbance mapping may be actively used by people.
- The length of time required for a human feature to be considered restored (i.e., no longer has a negative effect on caribou, and/or has reverted to suitable caribou habitat), is not well understood. The ECCC (2011) methodology currently assumes a time of 40 years is required for the human or natural disturbance feature to no longer be considered in a disturbed condition.

Natural Disturbance

Following ECCC (2011) methodology, wildfire disturbance is calculated based on fire perimeter mapping with waterbodies removed. Based on provincial wildfire perimeter mapping for the period 1975 to 2015,

the total area affected by recent wildfire in SK2 Central is approximately 8,502 km² (23.6 per cent of SK2 Central). Other considerations regarding natural disturbance are as follows:

- Fire severity mapping which identifies unburned remnant patches within fire polygons is now available for the Boreal Plain for the period 1988 to 2015, and in future assessments could be used to identify fine-scale unburned forest patches within wildfires that may be used by caribou. However, at this time, the methodology used in the ECCC disturbance assessment only considers wildfire perimeter boundaries and not more detailed mapping.
- Other natural disturbances (e.g., forest insects, wind throw) affect the Boreal Plain but as per ECCC (2011) methodology have not been considered in the disturbance calculations.

Total Disturbance

The total extent of non-overlapping human (i.e., direct footprint plus 500 m buffer) and wildfire disturbance in SK2 Central is 15,442 km² (i.e., 42.8 per cent of SK2 Central). Human-caused disturbance accounts for 10,084 km² (i.e., 65 per cent) of the total non-overlapping disturbance, with wildfire accounting for the remaining 5,356 km² (i.e., 35 per cent).

APPENDIX B: Overview of SK2 Central Caribou Habitat Management Areas on Provincial Crown Lands

Introduction

This appendix describes the rationale and management considerations for the caribou habitat management areas (CHMAs) on provincial Crown lands in the SK2 Central caribou administration unit. Map overlays demonstrate how three important factors—habitat potential, human-caused disturbance and recent wildfire disturbance—guided the identification and boundaries of the CHMAs. A summary table describes the area, rationale and management considerations for each CHMA.

Overview of the Caribou Habitat Management Areas

Section 5.3.1 of the range plan describes the proposed CHMA framework. Provincial Crown lands within the SK2 Central area have been divided into three types of CHMAs—Tier 1, 2 and 3 (Figure 5)—based on their relative importance to caribou, habitat conditions and potential risks. Different management objectives and strategies were developed for each tier. Tier 1 represents areas of high importance, where caribou habitat retention is the primary objective. Tier 2 areas are of importance to caribou, but have higher levels of habitat disturbance and have an objective of habitat restoration. Tier 3 areas represent general matrix caribou habitat where maintaining connectivity is an important objective.

The following factors were considered when determining the appropriate tier classification and boundaries:

- habitat potential based on ecosite-habitat relationships and Indigenous traditional knowledge;
- the level of human-caused disturbance;
- the level of recent wildfire disturbance;
- caribou occupancy/utilization;
- connectivity; and
- risks of northwards range retraction.

Map overlays of the CHMAs and habitat potential, human-caused disturbance and recent wildfire (1975-2015) are shown in Figures 6, 7, and 8, respectively. Table 7 lists the areas and describes the rationale and potential management concerns for each of the CHMAs.

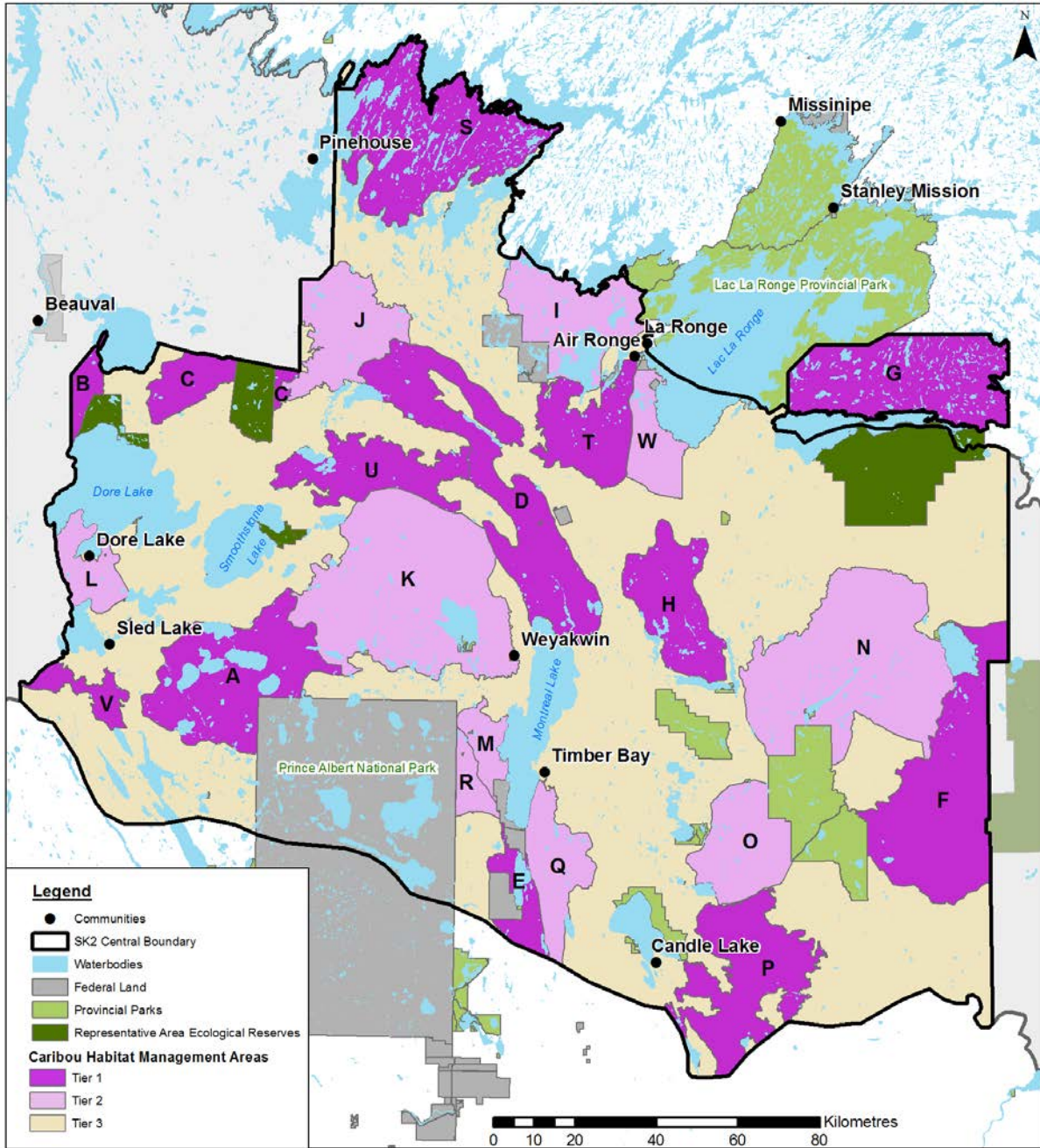


Figure 5. SK2 Central caribou habitat management areas on provincial Crown lands.

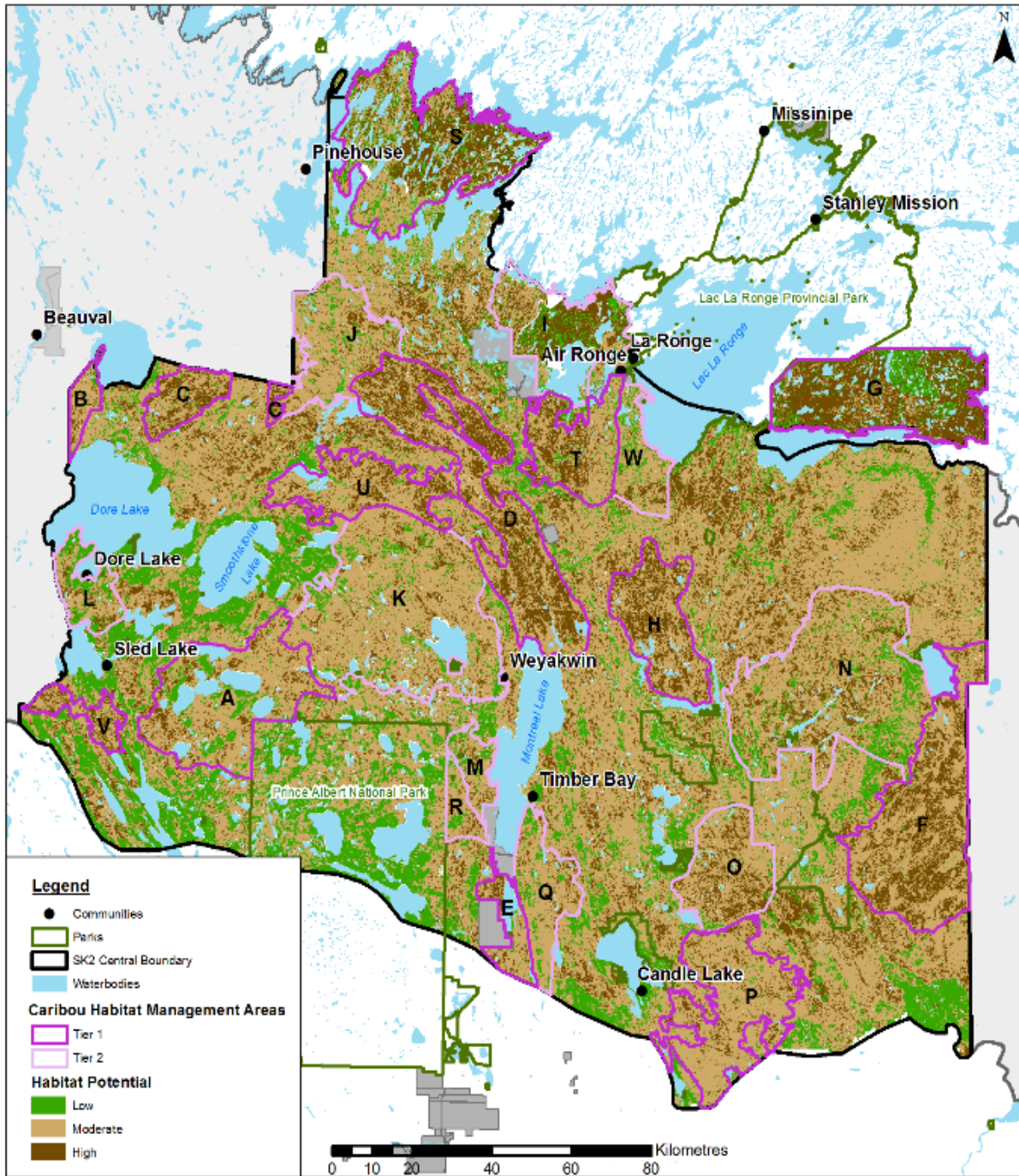


Figure 6. Map overlay of Tier 1 and Tier 2 caribou habitat management areas with caribou habitat potential.

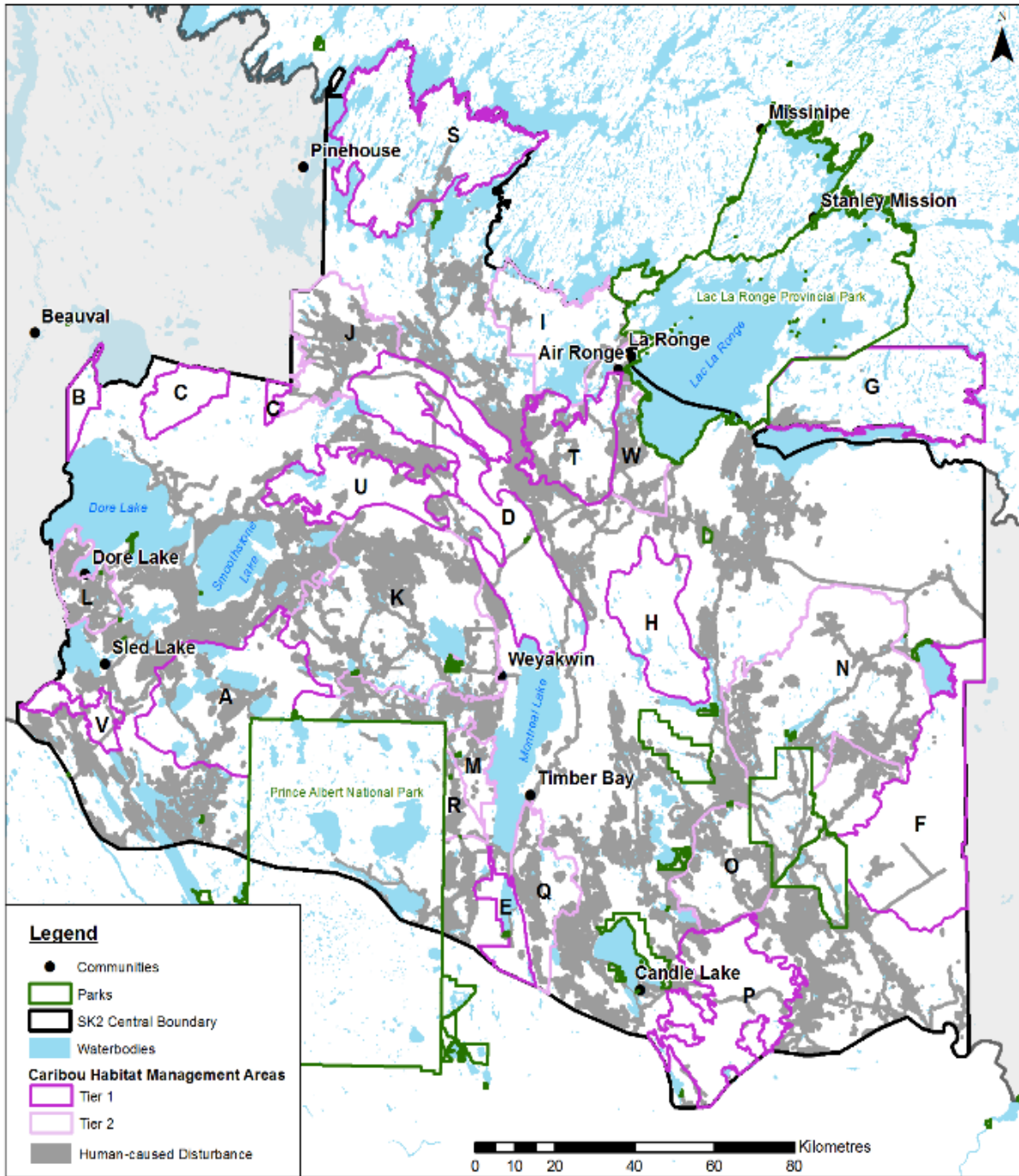


Figure 7. Map overlay of Tier 1 and Tier 2 caribou habitat management areas with total human-caused disturbance.

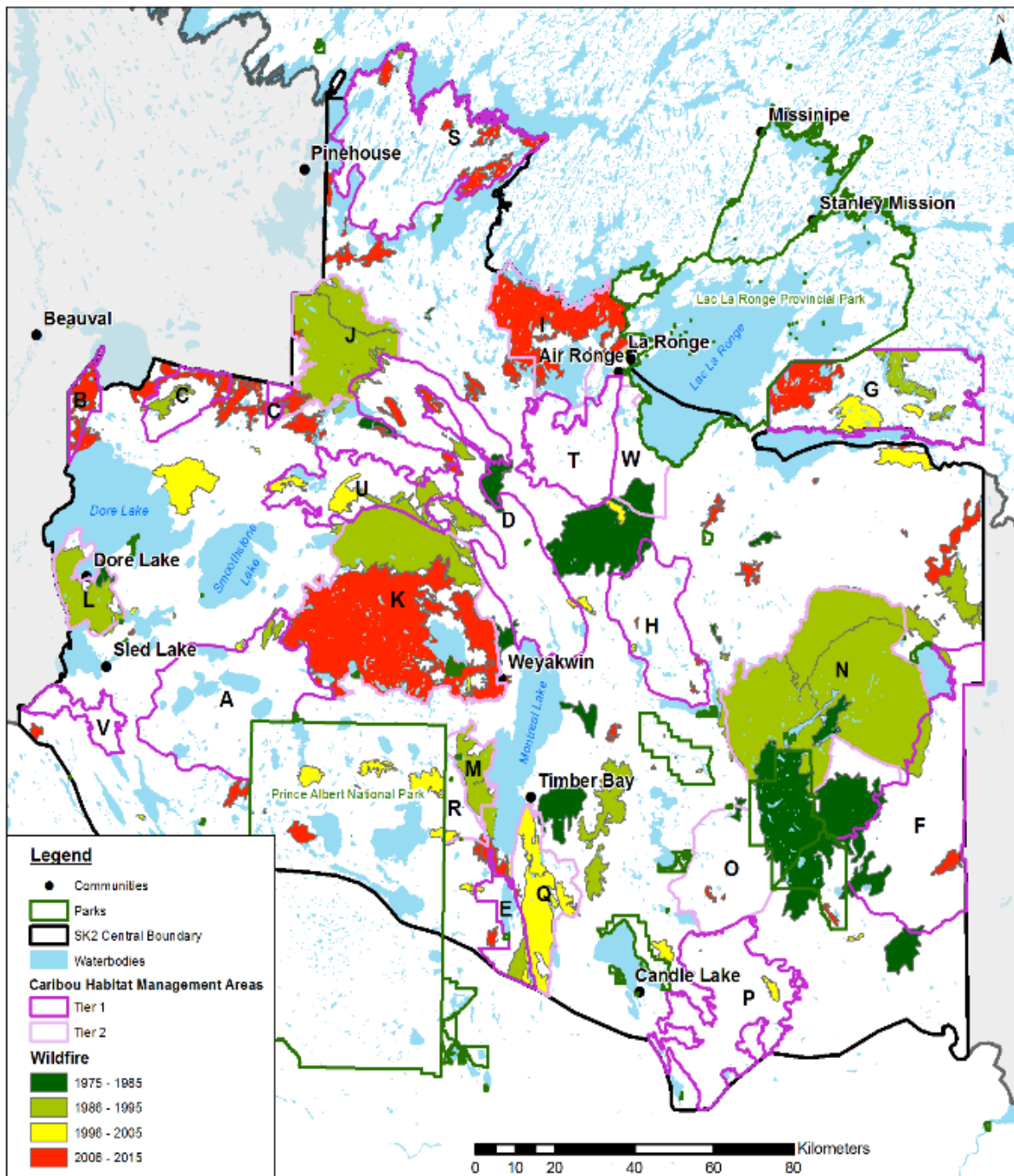


Figure 8. Map overlay of Tier 1 and Tier 2 caribou habitat management areas with recent wildfire by decade (1975 to 2015).

Table 7. Summary of SK2 Central CHMAs on Provincial Crown lands.

CHMA	Area (km ²)	Area (Per cent of SK2 Central)	Rationale for Selection	Potential Management Concerns
TIER 1 AREAS				
A	1,002	2.8	The Clarke Lakes area has long-term documented caribou use centred on high-value peatlands. The area contains some roads and historical forest harvesting, but much of the area remains relatively undisturbed from human activities.	Additional human disturbance may result in abandonment by caribou, contributing to incremental northward range retraction. <u>Potential Land Use Concerns:</u> <ul style="list-style-type: none"> • Future peat harvesting. • Historical forest harvesting and associated roads.
B	108	0.3	Dore-La Plonge muskeg is mostly intact black spruce lowland with caribou presence along the western edge of SK2 Central that matches a similar area in SK2 West. Habitat is a mix of high- and moderate-value to caribou.	There has been some historic winter travel through the area but is otherwise not disturbed and meets an ecological reserve at the north end of Dore Lake. <u>Potential Land Use Concerns</u> <ul style="list-style-type: none"> • Some forestry expansion and seasonal road development. • Potential cottage development on Dore Lake and Lac La Plonge after road development. • Recreational use/fishing.
C	261	0.7	McLurg Creek headwaters contains high-value habitat and provides important connectivity with habitat in SK2 West and between the Ecological Reserves north of Dore Lake and west of Emmeline Lake. Small parts of this area were affected by 1995 and 2015 wildfires.	Past and proposed forest harvesting and wildfire could restrict movement between Dore Lake and Lac La Plonge.

Table 7. (continued) Summary of SK2 Central CHMAs on Provincial Crown lands.

CHMA	Area (km ²)	Area (Per cent of SK2 Central)	Rationale for Selection	Potential Management Concerns
TIER 1 AREAS				
D	1,143	3.2	The Montreal Lake lowland is the largest peatland complex in SK2 Central. It has intact high-value habitat with long-term documented caribou use.	<p>Future human disturbance would reduce the value of this important central area for caribou.</p> <p><u>Potential Land Use Concerns:</u></p> <ul style="list-style-type: none"> • Future peat harvesting. • Forest harvesting and associated roads adjacent to peatland.
E	193	0.5	The Bittern Lake area contains high-value habitat and has long term occupancy of caribou. This area is at the southern edge of the range and provides important connectivity with areas to the north and east and west of the lake. A small part was affected by wildfire in 1989.	<p>Additional human disturbance may result in abandonment by caribou, contributing to incremental northward range retraction.</p> <p><u>Potential Land Use Concerns:</u></p> <ul style="list-style-type: none"> • Forest harvest in mature pine-lichen stands. • General transportation and access. • Summer and winter recreation. • Agricultural expansion northward.
F	1,206	3.3	Mossy-Big Sandy lowlands is a large undisturbed peatland with high-value habitat and long-term documented caribou use. Area F is on the western edge of the extensive Suggi Lake-Mossy River peatland complex and adjacent to the Seager Wheeler Lake Ecological Reserve in SK2 East.	<p>Future human disturbance would reduce the value of this important central area for caribou.</p> <p><u>Potential Land Use Concerns:</u></p> <ul style="list-style-type: none"> • Some forest harvesting and roads into peatland. • Future peat harvesting. • Mineral exploration.

Table 7. (continued) Summary of SK2 Central CHMAs on Provincial Crown lands.

CHMA	Area (km ²)	Area (Per cent of SK2 Central)	Rationale for Selection	Potential Management Concerns
TIER 1 AREAS				
G	994	2.8	Wapawekka North contains high-value habitat on the Boreal Shield and provides a connection to caribou habitat in Lac La Ronge Provincial Park and Wapawekka Lake Uplands Ecological Reserve. This area has long-term occupancy of a large concentration of caribou. Parts of the area have been affected by at least four separate wildfires in 1964, 1995, 2005 and 2015.	<p>The western part of the area burned in 2015, and further expansion of logging east of the burn may threaten the long-term viability of the area for caribou.</p> <p><u>Potential Land Use Concerns:</u></p> <ul style="list-style-type: none"> • Pulpwood and post-harvest in high-value caribou habitat. • Forestry road expansion. • Mineral exploration and development.
H	556	1.5	Meeyomoot River lowland is a large relatively undisturbed peatland with high-value habitat and long-term documented caribou use.	<p>Area H is surrounded by forest harvesting and roads that threaten to isolate caribou in this area.</p> <p><u>Potential Land Use Concerns:</u></p> <ul style="list-style-type: none"> • Trail development - snowmobile tourism. • Adjacent forest harvesting and roads. • Roads to fishing lakes.

Table 7. (continued) Summary of SK2 Central CHMAs on Provincial Crown lands.

CHMA	Area (km ²)	Area (Per cent of SK2 Central)	Rationale for Selection	Potential Management Concerns
TIER 1 AREAS				
P	833	2.3	Candle Lake southeast is predominately lowland muskeg interspersed with sandy jackpine/lichen ridges and some upland mixed forest ridges along the Torch River, Gull Creek and the east side of Birchbark Lake. Much of the interior lowland is undisturbed. The area is predominately high-value caribou habitat with a long history of significant caribou occupancy part of which is locally known as the Bacon Bog.	<p>The area is bounded on the west, north and east by highways and farmland on the south. Seasonal forestry trails exist as intrusions into the outer fringes of the area from highway and farmland boundaries. A seasonal trail follows the Torch River through much of the center part of the area, and a portion of the Trans-Canada snowmobile trail cuts through the eastern quarter from south to north.</p> <p><u>Potential Land Use Concerns</u></p> <ul style="list-style-type: none"> • Forestry activity and seasonal forest road development. • Trail development – snowmobile tourism. • Local resource extraction and associated disturbance pushing the southern edge of the range northward.

Table 7. (continued) Summary of SK2 Central CHMAs on Provincial Crown lands.

CHMA	Area (km ²)	Area (Per cent of SK2 Central)	Rationale for Selection	Potential Management Concerns
TIER 1 AREAS				
S	1,222	1.5	Besnard Lake Northwest area is a rugged Boreal Shield/Boreal Plain transition area with rocky/gravelly spruce-pine and birch ridges with openings carpeted in lichens and black spruce and open muskeg in the bottoms which constitute high-value caribou habitat. Very little disturbance has occurred in the area, and caribou are known to occupy the area.	<p>The area is at the current limit of commercial forestry with a low density of merchantable timber. The north end of a provincial highway extends slightly into the southern edge of the CHMA and could conceivably be extended up to the Churchill River.</p> <p><u>Potential Land Use Concerns</u></p> <ul style="list-style-type: none"> • Forestry expansion and road construction into and through to the Churchill River. • Roads to fishing lakes and rivers. • Remote cottage development.

Table 7. (continued) Summary of SK2 Central CHMAs on Provincial Crown lands.

CHMA	Area (km ²)	Area (Per cent of SK2 Central)	Rationale for Selection	Potential Management Concerns
TIER 1 AREAS				
T	487	1.4	Egg Lake-Bigstone lowland is an expansive area with little disturbance dominated by black spruce and tamarack muskeg and gravelly undulating terrain to the southwest. There is a long history of caribou occupancy in a mix of high- and moderate-value caribou habitat.	<p>The Egg Lake road cuts through the middle from south to north, but only about half is navigable at this time and only in summer. Large interior lowlands remain relatively undisturbed. There is some development pressure at the north end close to the tri-communities area of La Ronge, the Lac La Ronge Indian Band, and Air Ronge that would be mostly infrastructure (i.e., sawmill upgrade).</p> <p><u>Potential Land Use Concerns</u></p> <ul style="list-style-type: none"> • Future forest harvesting and roads. • Cabin access on the south side of Egg Lake. • Trail development – snowmobile tourism. • Silica sand extraction in the southeast.

Table 7. (continued) Summary of SK2 Central CHMAs on Provincial Crown lands.

CHMA	Area (km ²)	Area (Per cent of SK2 Central)	Rationale for Selection	Potential Management Concerns
TIER 1 AREAS				
U	509	1.4	Swan Lakes-Randall River lowlands begin with a plain receiving run-off from the Smoothstone hills to the south and forming the headwaters of the Randall River system. It represents high-value habitat with a long history of caribou occupancy up to the present and is only lightly disturbed.	<p>Caribou habitat is diverse and dispersed across this landscape. The distribution of dense stands of black spruce and mixed forests in this CHMA may result in forest harvesting that could fragment habitat, especially in the south and push caribou out of important upland habitat.</p> <p><u>Potential Land Use Concerns</u></p> <ul style="list-style-type: none"> • Future forest harvesting and road development. • Recreational access for hunting. • Snowmobile tourism.
V	150	0.4	The Cowan River-Cousin Lake area contains high- and moderate-value caribou habitat with caribou occupancy bounded by Cowan River and Taggart Creek on the south. The northwest half is part of a drainage basin leading to Cousin Lake. The area is not heavily disturbed.	<p>There are several winter trails and at least one forestry road in the area. Its small size, combined with extensive adjacent disturbance, makes it vulnerable to future disturbance.</p> <p><u>Potential Land Use Concerns</u></p> <ul style="list-style-type: none"> • Existing and future forestry activity, road and trail upgrade and expansion. • Recreational access for hunting.
Sub-total	8,664	24.0		

Table 7. (continued) Summary of SK2 Central CHMAs on Provincial Crown lands.

CHMA	Area (km ²)	Area (Per cent of SK2 Central)	Rationale for Selection	Potential Management Concerns
TIER 2 AREAS				
I	650	1.8	The Clam-Morin Lakes area contains high-value habitat in the Boreal Shield/Boreal Plain transition. It provides a connection between the Shield and Plain and has documented occupancy by caribou. Much of Area I was affected by the 2015 wildfires which reduces near-term caribou habitat suitability and forest harvesting potential.	<p>The 2015 burn has reduced caribou habitat suitability in the near-term. Maintaining the remaining unburned portions and surrounding habitat will be important for continued occupancy by caribou.</p> <p><u>Potential Land Use Concerns:</u></p> <ul style="list-style-type: none"> • Future forest harvesting and roads. • Mineral exploration and development. • Recreation and tourism.
J	569	1.6	The Emmeline-Smoothstone River area has a mix of high- and moderate-caribou habitat, connection to the Montreal River lowland and habitat in SK2 West. Area J has observed long-term occupancy of caribou. All of Area J was affected by a wildfire in 1995, resulting in reduced near-term forest harvesting potential and caribou habitat suitability.	<p>Historical and future potential forest harvesting, recent wildfire and existing and future roads could isolate caribou into unburned habitat less-attractive for logging with reduced connectivity.</p> <p><u>Potential Land Use Concerns:</u></p> <ul style="list-style-type: none"> • Forest harvesting and roads.

Table 7. (continued) Summary of SK2 Central CHMAs on Provincial Crown lands.

CHMA	Area (km ²)	Area (Per cent of SK2 Central)	Rationale for Selection	Potential Management Concerns
TIER 2 AREAS				
K	1,766	4.9	The Weyakwin/Rock Lakes complex contains several areas of historical and recent caribou occupancy. Most of Area K was affected by two separate wildfires wildfire in 1995 (northern part) and 2015 (southern and central part) reducing near-term forest harvesting potential and caribou habitat suitability.	<p>The impact of recent wildfires on caribou habitat could be magnified by salvage logging of burned and remaining unburned stands and related road development.</p> <p><u>Potential Land Use Concerns:</u></p> <ul style="list-style-type: none"> • Forest harvesting and roads. • Recreational access.
L	247	0.7	The Dore-Sled Lakes area contains a relatively undisturbed (from human activity) remnant of the Sled Lake lowlands that provided refuge for caribou surrounded by a diverse landscape supporting several ungulate species. Area L provides an important connection between SK2 Central and SK2 West. Most of area L was affected by wildfire in 1995, reducing near-term forest harvesting potential and caribou habitat suitability.	<p>Additional land use in or around Area L may further isolate a remnant cluster of caribou already bordered by past and ongoing human activity. Connectivity with SK2 West may also be affected.</p> <p><u>Potential Land Use Concerns:</u></p> <ul style="list-style-type: none"> • Multiple land uses including forest harvesting, roads, tourism and recreation.

Table 7. (continued) Summary of SK2 Central CHMAs on Provincial Crown lands.

CHMA	Area (km ²)	Area (Per cent of SK2 Central)	Rationale for Selection	Potential Management Concerns
TIER 2 AREAS				
M	157	0.4	The area west of Montreal Lake West contains moderate caribou habitat with periodic occupancy of caribou. It provides a connection between Montreal Lake and habitat in Prince Albert National Park and Bittern Lake to the south. Most of area M was affected by wildfire in 1989.	Extensive forest harvesting, temporary roads and Highway #2 create impediments to east-west caribou movement. <u>Potential Land Use Concerns:</u> <ul style="list-style-type: none"> • Forest harvesting and roads.
N	1,598	4.4	This large area north of Narrow Hills Provincial Park contains pockets of high-potential habitat within an extensive upland matrix of moderate- potential. The entire area was affected by three separate wildfires in 1987, 1988 and 1995. These regenerating burns will not be suitable for forest harvesting for many years. Area N has an extensive network of trails and some post-fire salvage logging.	Caribou use of this area could be affected as a result of high numbers of other ungulate species and road and trail access resulting from past forestry activity. As area N recovers from wildfire, it will have high forestry potential. <u>Potential Land Use Concerns:</u> <ul style="list-style-type: none"> • Forest harvesting and roads. • Recreational access.

Table 7. (continued) Summary of SK2 Central CHMAs on Provincial Crown lands.

CHMA	Area (km ²)	Area (Per cent of SK2 Central)	Rationale for Selection	Potential Management Concerns
TIER 2 AREAS				
O	514	1.4	The Lorenz Lake area contains a mix of high- and moderate- value caribou habitat with a long history of occupancy by caribou. It provides an important connection to Candle Lake South, and Narrow Hills Provincial Park and areas to the east. Roads and past forestry activity have affected a relatively large part of Area O.	<p>Caribou use of the area has been reduced to lowlands that are interspersed with uplands attractive to current and future forest harvesting. Recreation/tourism associated with the permanent and semi-permanent road network is prevalent and intensive. Connectivity with habitat to the west has been compromised by adjacent forest harvesting/road networks.</p> <p><u>Potential Land Use Concerns:</u></p> <ul style="list-style-type: none"> • General transportation and access. • Existing and future forest harvesting. • Recreational access. • Mineral exploration.

Table 7. (continued) Summary of SK2 Central CHMAs on Provincial Crown lands.

CHMA	Area (km ²)	Area (Per cent of SK2 Central)	Rationale for Selection	Potential Management Concerns
TIER 2 AREAS				
Q	395	1.1	Bittern Lake East contains high- and moderate-value caribou habitat in pockets of lowlands surrounded by a matrix of upland habitat. It provides an important connection with Montreal and Bittern Lakes and habitat to the south. Much of the area was affected by wildfire in 2003 and smaller areas by historical logging activity.	<p>Area Q is surrounded by historic forest harvesting and some residual temporary roads. Permanent roads to the north and east facilitate current forest harvesting and multiple other human activities, potentially impeding connection with caribou to the north and east.</p> <p><u>Potential Land Use Concerns:</u></p> <ul style="list-style-type: none"> • General transportation and access. • Existing and future forest harvesting and roads. • Recreational access.
R	123	0.3	The Crean River area is adjacent to Prince Albert National Park. It contains a mix of high- and moderate-value caribou habitat with observed historic and persistent caribou occupancy. This area provides a connection between habitat in the National Park, areas to the west of Montreal Lake and the south around Bittern Lake. A small part of the area was affected by wildfire in 1998.	<p>Highway #2 creates a potential impediment to east-west caribou movement. This situation is worsened by ongoing harvesting along the Highway #2 corridor which may also reduce connections with habitat to the south.</p> <p><u>Potential Land Use Concerns:</u></p> <ul style="list-style-type: none"> • Forest harvesting and roads. • General transportation, access and utilities.

Table 7. (continued) Summary of SK2 Central CHMAs on Provincial Crown lands.

CHMA	Area (km ²)	Area (Per cent of SK2 Central)	Rationale for Selection	Potential Management Concerns
TIER 2 AREAS				
W	285	0.8	Napatak-Bow River area is bounded by Highway #2 and Lac La Ronge. Black spruce ridges interspersed with treed and open muskeg give way to stands of pine and lichen carpets on a sandy plateau southward.	<p>The La Ronge area at its north end is the origin of much human activity that has been spreading southward through the area.</p> <p><u>Potential Land Use Concerns</u></p> <ul style="list-style-type: none"> • Existing and future forest harvesting and roads. • Silica sand extraction. • Recreational access.
Sub-total	6,304	17.5		

Table 7. (continued) Summary of SK2 Central CHMAs on Provincial Crown lands.

CHMA	Area (km ²)	Area (Per cent of SK2 Central)	Rationale for Selection	Potential Management Concerns
TIER 3 AREA				
Sub-Total	16,579	46.0	Tier 3 accounts for more than 50 per cent of the SK2 Central area. This large area contains a mix of higher- and lower-value habitats within a broad matrix of moderate- value areas. Maintaining connectivity between the different parts of the range is the most important consideration for Tier 3. Some areas may also contain as yet undocumented areas of caribou occupancy. Tier 3 has the highest levels of human-caused disturbance and most near-term future land uses, which are anticipated to continue to be focused in these areas.	<p>Conversion of Tier 3 area through forest harvesting, road networks and multiple land uses into habitat that supports an artificially high level of other ungulates and wolves along with high densities of linear features has reduced its value as connectivity habitat for caribou and potentially increased mortality risk. Areas with as of yet undocumented caribou occupancy may also be compromised. Along the southern part of SK2 northward range retraction also a concern.</p> <p><u>Potential Land Use Concerns:</u></p> <ul style="list-style-type: none"> • Historical, current and future forest harvesting and roads. • General transportation, access and utilities. • Recreational access. • Peat harvesting (in isolated areas). • Mineral exploration and development.
Total*	31,547	87.5		

* Note: The remaining 12.5 per cent of the SK2 Central area is comprised of Saskatchewan provincial parks and ecological reserves, federal lands (Prince Albert National Park and Indian Reserves) and municipal lands (including small parcels of private/leased lands).

APPENDIX C: SK2 Central Biophysical and Disturbance Attributes

Introduction

This appendix describes the current biophysical and disturbance attributes in the SK2 Central area, as well as the projected habitat attributes resulting from a 50-year most likely future management scenario. Results are reported by the three caribou habitat management area tiers shown in Figure 9.

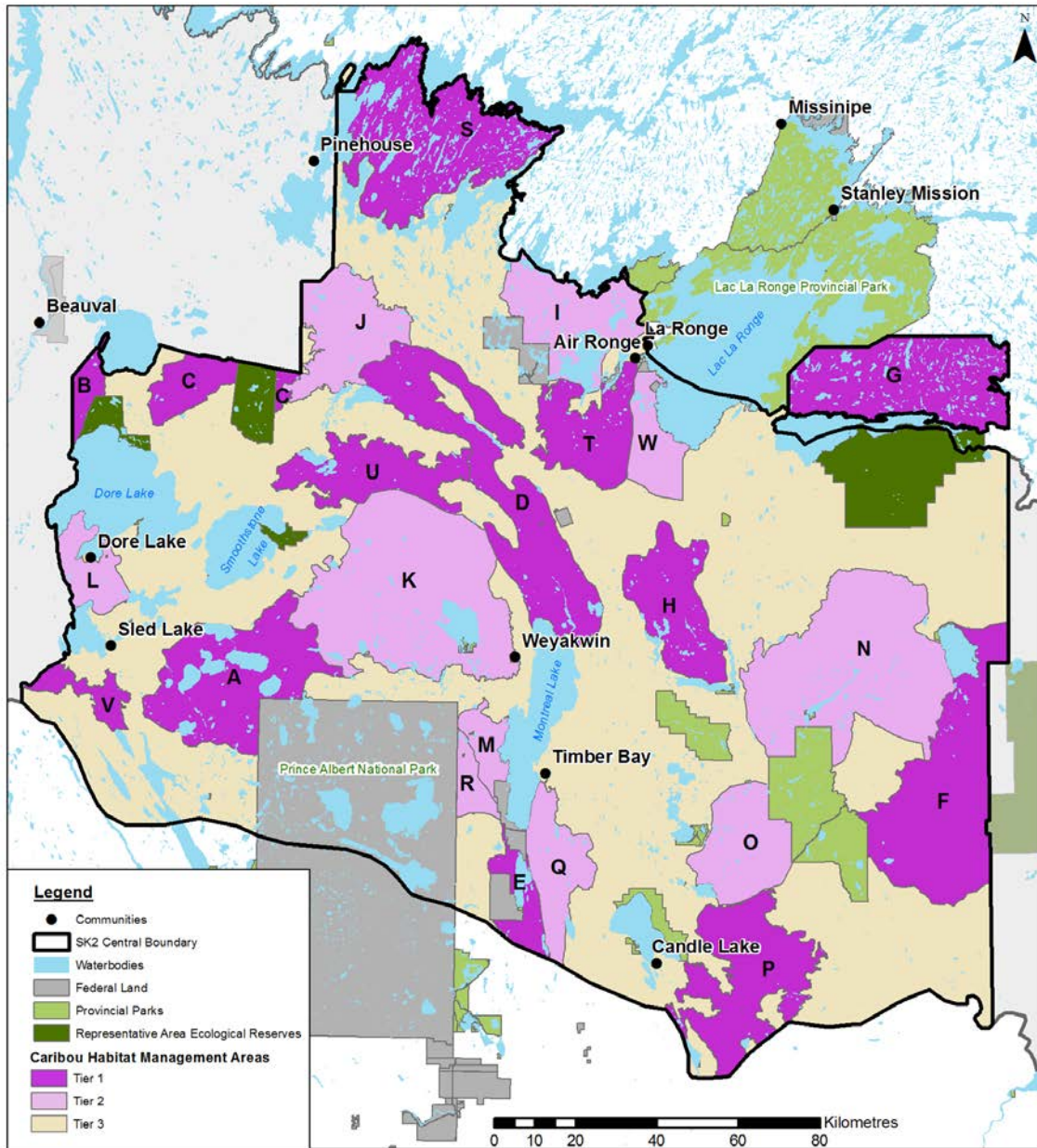


Figure 9. SK2 Central caribou habitat management areas.

Current Biophysical and Disturbance Attributes

Biophysical (Habitat) Attributes

Caribou habitat potential has been categorized into low, moderate and high classes based on the biophysical attributes of the Saskatchewan ecosite classification (McLaughlan et al., 2010) and their utility and function for caribou. Forest ecosites were evaluated for habitat potential for woodland caribou with the assistance of caribou experts with experience in Saskatchewan ecosystems during a workshop in March 2013 (Roddy, 2013). Ecosites were evaluated for their potential to provide forage, refuge or calving habitats.

Forage

Forage value was rated based on the availability of lichen and other plant species, which are palatable to caribou (Thomas and Armbruster, 1996).

- 1: Low food value for caribou
- 2: Moderate food value for caribou
- 3: High food value for caribou

Refuge

Refuge value was rated based on the availability of plant species which provide food value for other ungulates (e.g., moose, deer, elk). This was used as a surrogate for the probability of predation. If these food sources are not present, the ecosite has potential to provide refuge for caribou from predators.

- 1: High food value for other ungulates
- 2: Moderate food value for other ungulates
- 3: Little food value for other ungulates

Calving and Post-calving

Ratings were made in consideration of both the time of calving and the following two to four-week period. The primary consideration was safety from predation. The related factors considered were the ability to hide a calf and the lack of spring black bear forage. A secondary consideration was whether there was caribou forage available on the site.

- 1: Low value for caribou calving
- 2: Moderate value for caribou calving
- 3: High value for caribou calving

Overall habitat potential was determined from the total of the 3 habitat values of forage, refuge, and calving.

Low habitat potential = 3

Moderate habitat potential = 4,5,6

High habitat potential = 7,8

Ecosites and their associated caribou habitat potential ranks are listed in Table 8.

The amount of low, moderate and high potential caribou habitat within each CHMA tier and land category is displayed in Figure 8. The proportion of total SK2 Central habitat potential class contained within each CHMA tier, and land category is shown in Figure 10. Results are summarized as follows:

- Tier 1 areas are comprised primarily of high and moderate habitat potential:
 - Combined, approximately 93 per cent of Tier 1 areas are composed of high and/or moderate habitat potential.
 - Tier 1 areas contain the highest proportion (i.e., 42.3 per cent) of high habitat potential in SK2 Central, and the smallest area of low potential (i.e., 6.9 per cent).
 - While Tier 1 areas only account for 14.6 per cent of the SK2 Central land base, they contain 32.2 per cent of the total amount of high habitat potential in SK2 Central.
- Tier 2 areas are comprised primarily of upland ecosites with moderate habitat potential:
 - These areas are made up of 68.1 per cent moderate habitat, with low and high accounting for 14.5 per cent and 17.4 per cent respectively.
 - Overall, they contain 19.6 per cent of the total moderate habitat potential category.
- All three CHMA tiers are comprised of over 50 per cent moderate habitat potential.
- Tier 3 CHMAs, provincial conservation areas (e.g., parks and ecological reserves) and federal lands have the highest proportion of low habitat potential in SK2 Central.
 - Federal lands, including the Prince Albert National Park, have the highest proportion of low habitat potential (45.2 per cent) followed by provincial conservation areas (18.7 per cent).
 - Tier 3 areas contain the largest amount (58 per cent) of the total low potential habitat in SK2 Central.

Table 8. Caribou habitat potential and associated ecosites (McLaughlan et al., 2010).

Habitat Potential	Ecosite	Description	Habitat Potential	Ecosite	Description
LOW	BP1	June grass – mountain goldenrod grassland: moderately fresh loamy sand.	MODERATE	BP3	Jack pine/feathermoss: moderately fresh loamy sand.
	BP5	Trembling aspen/prickly rose/grass: fresh sand.		BP4	Jack pine – trembling aspen /feathermoss: moderately fresh sand.
	BP6	Trembling aspen/beaked hazel/sarsaparilla: fresh loamy sand.		BP12	Jack Pine – spruce/ feathermoss: fresh loamy sand.
	BP7	Trembling aspen – white birch/sarsaparilla: fresh loamy sand.		BP14	Black spruce/Labrador tea/ feathermoss: very moist sandy clay loam.
	BP8	Trembling aspen – white birch/mountain maple: fresh sandy clay loam.		BP18	Black spruce – tamarack treed swamp: wet humic organic.
	BP9	White spruce – trembling aspen/feathermoss: fresh sand.		BP20	Labrador tea shrubby bog: wet fibric organic.
	BP10	Trembling aspen – white spruce/feathermoss: fresh sandy clay loam.		BP21	Graminoid bog: wet fibric organic.
	BP11	White birch – white spruce-balsam fir: fresh sandy clay.		BP22	Open bog: wet humic organic.
	BP13	White spruce-balsam fir/ feathermoss: fresh sandy clay loam.		BP23	Tamarack treed fen: wet fibric organic.
	BP15	Balsam poplar – white spruce/feathermoss: very moist silty loam.		BP24	Leatherleaf shrubby poor fen: wet fibric organic.
	BP16	Balsam poplar – trembling aspen/prickly rose: Fresh clay loam.		BP25	Willow shrubby rich fen: wet humic organic.
	BP17	Manitoba maple – balsam poplar/ostrich fern: moist silty clay loam.		BP26	Graminoid fen: wet humic organic.
	HIGH	BP2		Jack pine/lichen: moderately fresh sand.	BP27
BP19		Black spruce treed bog: moderately wet fibric organic.	BP28	Seaside arrow-grass marsh: very moist humic organic.	

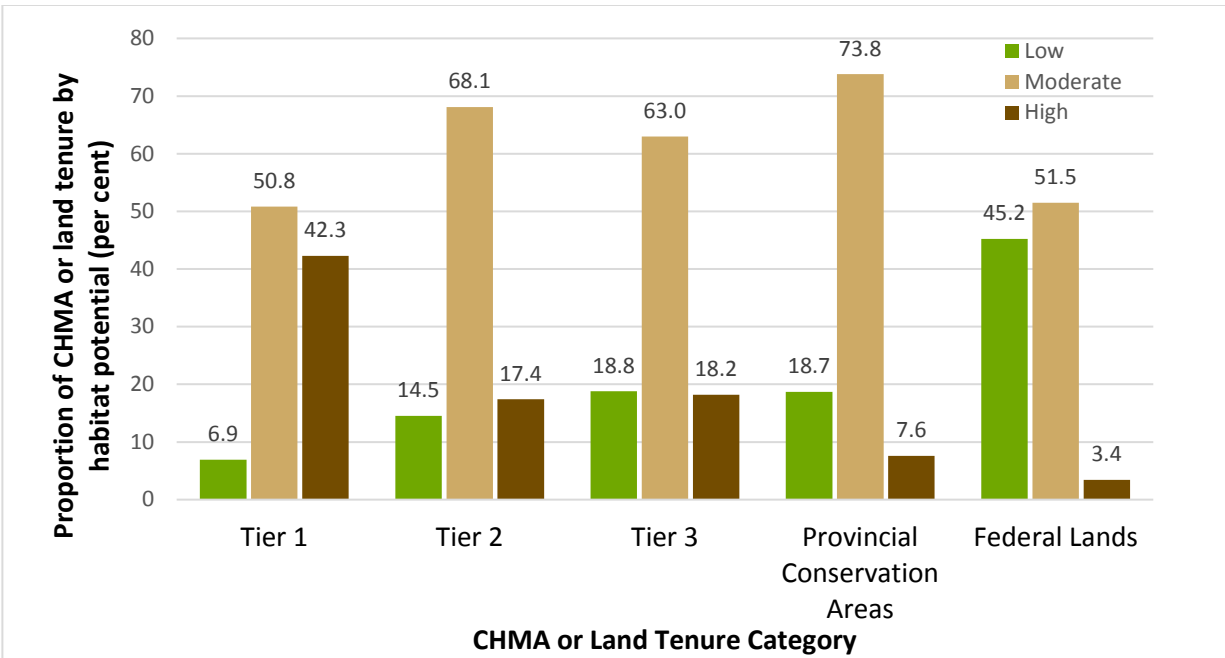


Figure 10. Proportion (per cent) of caribou habitat management tiers or land tenure categories represented habitat potential⁶.

⁶ Settlements/communities/private lands and agricultural Crown lands are not reported. In the habitat potential mapping, these land tenure types are largely classified as unknown/no data and low potential.

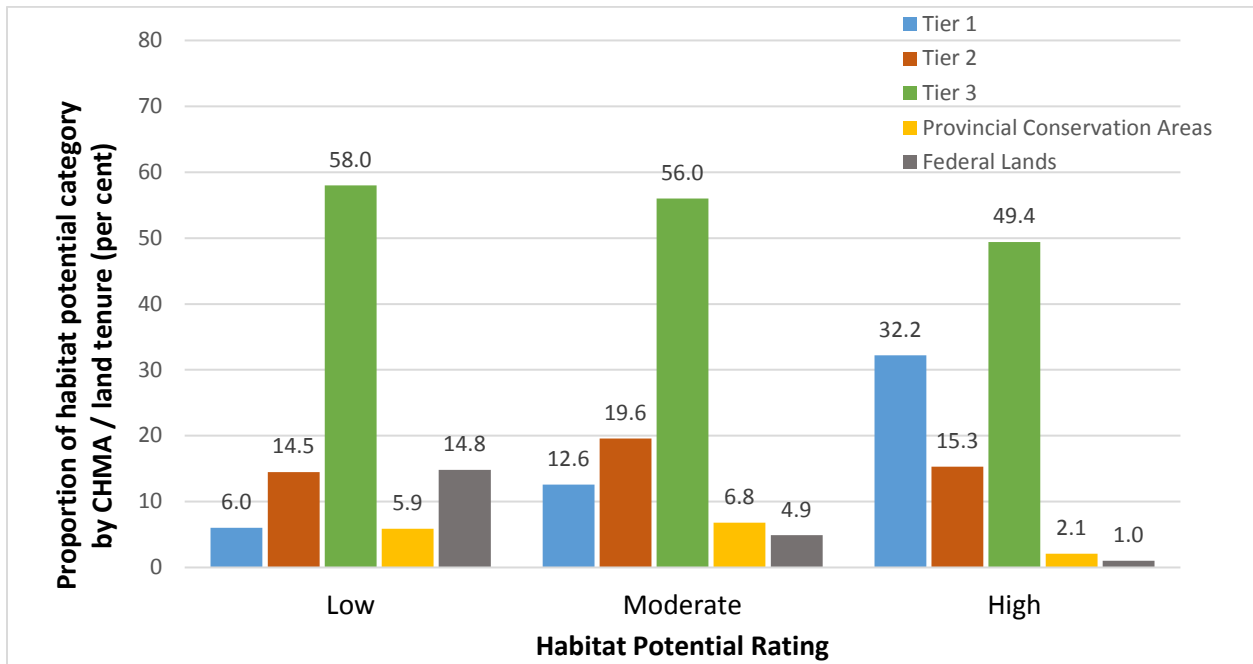


Figure 11. Proportion (per cent) of habitat potential category as represented by caribou habitat management tiers or land tenure.

Disturbance Attributes

Figure 12 shows the proportion (i.e., per cent) of non-overlapping human-caused, wildfire and undisturbed area in each CHMA tier. The proportion of total human-caused and wildfire disturbance in SK2 Central within each CHMA tier is shown in Figure 11. Results are summarized as follows:

- The majority of the total human-caused disturbance in SK2 Central is within Tier 3 areas (i.e., timber productive upland areas).
- Tier 1 areas contain the lowest proportion of human-caused disturbance (18.1 per cent) and have the second highest proportion of undisturbed habitat (63.5 per cent) in SK2 Central.
- Over 85 per cent of Tier 2 areas is affected by either human-caused (42.3 per cent) or wildfire (44.9 per cent) disturbance.
- Tier 3 areas contain the largest proportion of undisturbed habitat (64.7 per cent), but 29.4 per cent of its area is also affected by human-caused disturbance.
- The largest amount (44.9 per cent) of total recent wildfire disturbance in SK2 Central is within Tier 2 areas.

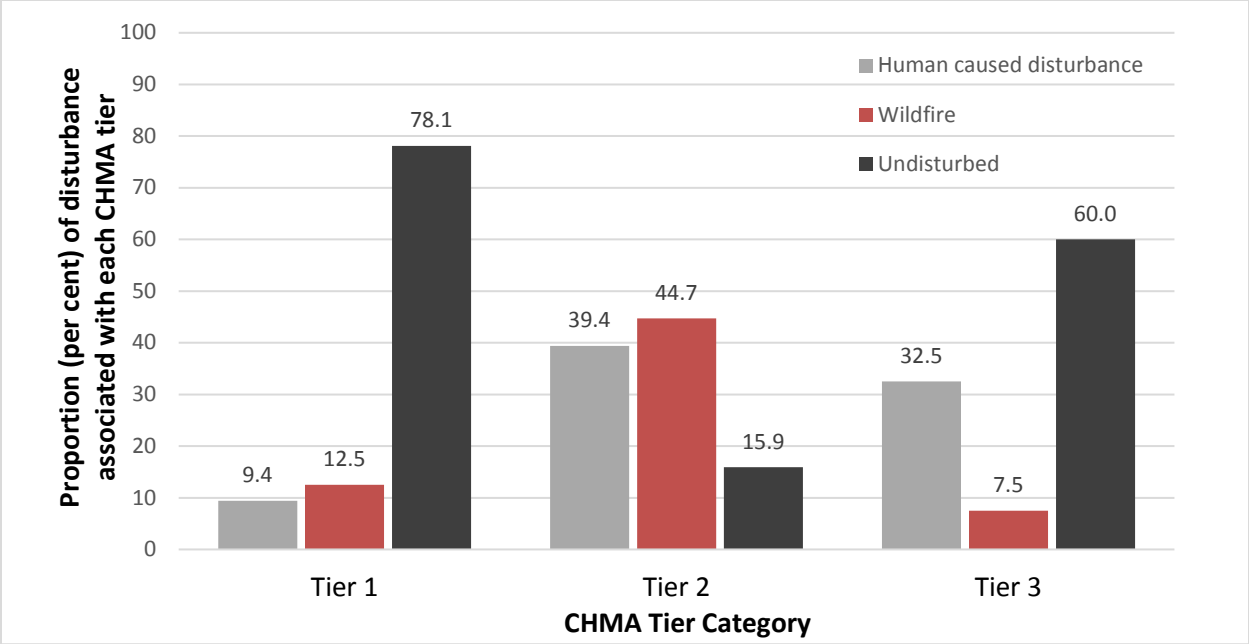


Figure 12. Proportion of disturbance associated with each CHMA tier category.

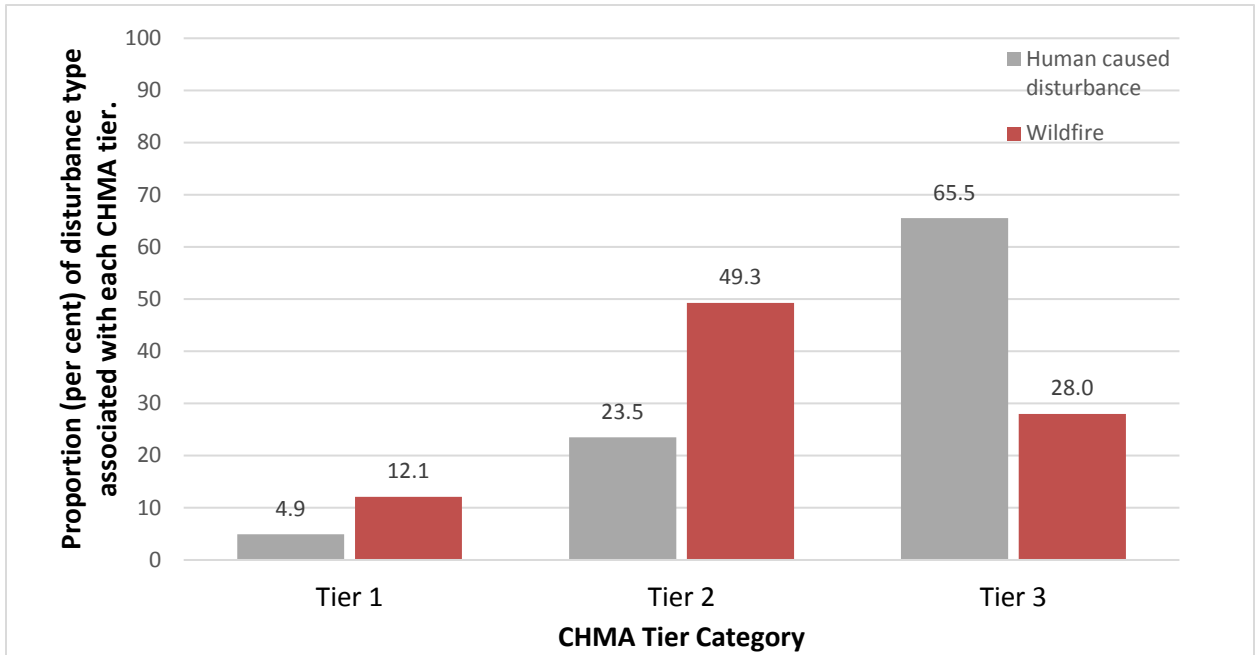


Figure 13. Proportion of disturbance types associated with each CHMA tier.

Future Situation

The most likely land use management scenario for SK2 Central is summarized in Table 10 of the range plan and described in further detail in Appendix D.

Habitat Balance Sheet

As part of its range plan guidance, Environment and Climate Change Canada (2016) recommended the inclusion of a habitat balance sheet as part of range plan reporting. The purpose of the habitat balance sheet is to track the net balance of disturbed and undisturbed habitat resulting from new human-caused disturbance, reclamation and natural regeneration of disturbed areas.

Table 9 is a habitat balance sheet for SK2 Central. It is a detailed tabular reporting of the information displayed in Figures 7 and 8. Table 9 provides a detailed breakdown of the federal range assessment (ECCC, 2015), current disturbance level reported by the Saskatchewan Ministry of Environment disturbance assessment and the amount of future potential habitat disturbance resulting from the most likely land use management scenario. Table 9 reports on the amount of disturbed and undisturbed habitat at decadal time-steps, with disturbed habitat further stratified into permanent human-caused disturbance, non-permanent human-caused disturbance, fire disturbance and total disturbance⁷. As disturbed habitat ages beyond 40 years, it moves from the disturbed to the undisturbed category.

⁷ The disturbance mapping hierarchy used to calculate net and total disturbance is described in Appendix A.

Figures 14, 15 and 16 show changes in the locations of undisturbed habitat over the 50-year time horizon over which the most-likely scenario was projected. It is important to note that in future years, newly burned areas (i.e., wildfire) are not displayed spatially, as it is not possible to show the exact location or size of future wildfire events. Therefore, only future human-caused disturbances resulting from planned forest harvest and other land uses are shown. For the purpose of calculating future total disturbance, new wildfire disturbance was considered aspatially by adding a constant non-overlapping burn rate of 134 km²/year to human-caused disturbance⁸. In Figures 14, 15 and 16, the effects of regenerating wildfire and non-permanent human-caused disturbance are apparent. Such transitions are tracked in the habitat balance sheet and show the net balance between disturbed and undisturbed habitat.

⁸ Wildfire disturbance mapping and calculated fire rates are described in Appendix A.

Table 9. Habitat balance summary table resulting from the most likely land use management scenario.

Years from present	Undisturbed habitat		Disturbed habitat																					
	TOTAL undisturbed habitat		TOTAL disturbed habitat (Total Permanent + Net Non-permanent + Net fire)				Permanent anthropogenic disturbance (including 500m buffer)				Non-permanent anthropogenic disturbance (including 500m buffer)				Fire Disturbance (no buffer)									
			TOTAL		New		TOTAL (Non-overlapping new + 10-40 yr non-permanent disturbance)		Net (Outside of Permanent)		New (< 10 year old)		Area of non-permanent anthropogenic disturbance 10-40 years old (erased by new)		TOTAL		Net fire disturbance Outside of anthropogenic		Total New disturbance ** (i.e. < 10 years old)		Area of fires 10-40 years old regenerating			
			per cent	km ²	per cent	km ²	per cent	km ²	per cent	km ²	per cent	km ²	per cent	km ²	per cent	km ²	per cent	km ²	per cent	km ²	per cent	km ²	per cent	km ²
Science Assessment (2015)	58.1	20933.7	41.9	15118.3															17.1	6172.5				
0	57.2	20610.0	42.8	15442.0	7.6	2752.6	0	0	25.4	9168.7	20.3	7331.8		N/A	25.4	9168.7	23.6	8502.1	14.9	5356.3		N/A	23.6	8502.1
10	53.1	19146.4	46.9	16905.5	7.6	2752.6	0	0	28.5	10268.7	23.4	8447.3	20.4	7344.9	8.1	2923.8	26.8	9657.2	15.8	5705.6	7.6	2743.6	19.2	6913.6
20	53.5	19297.2	46.5	16754.8	7.6	2752.6	0	0	30.0	10831.2	25.3	9118.8	19.7	7107.1	10.3	3724.2	30.4	10974.3	13.5	4883.4	7.6	2743.6	22.8	8230.7
30	55.4	19959.0	44.6	16092.9	7.6	2752.6	0	0	28.6	10300.4	24.4	8810.3	16.9	6100.6	11.6	4199.8	29.7	10701.2	12.6	4530.0	7.6	2743.6	22.1	7957.6
40	51.7	18651.3	48.3	17400.6	7.6	2752.6	0	0	29.7	10720.6	25.8	9288.0	16.1	5790.0	13.7	4930.6	30.4	10956.7	14.9	5360.0	7.6	2743.6	22.8	8213.1
50	53.4	19266.5	46.6	16785.4	7.6	2752.6	0	0	27.5	9931.9	24.1	8672.8	13.1	4734.3	14.4	5197.6	30.4	10956.7	14.9	5360.0	7.6	2743.6	22.8	8213.1

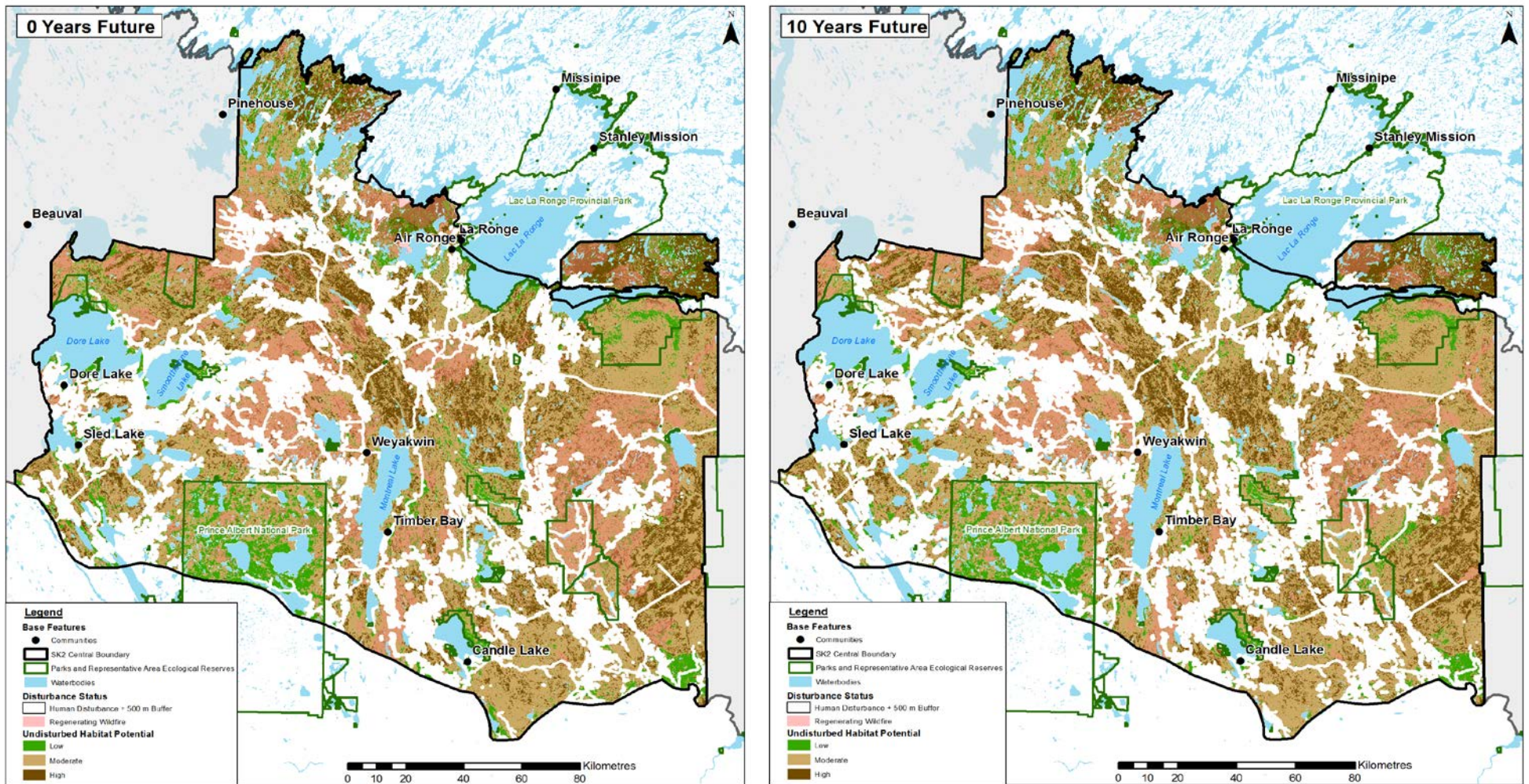


Figure 14. SK2 Central current and projected levels of human-caused disturbance 10 years into the future**.

** Caribou habitat potential in SK2 Central is shown (low, moderate and high) when it is in an undisturbed state, but is erased from the map (i.e., shown in white) when it has been disturbed by human-caused factors. Because of uncertainties of where future wildfire might occur spatially, future wildfire is not shown in these maps. The locations of current wildfire are provided (i.e., regenerating wildfire) and then subsequently removed from the landscapes once they reach 40 years of age.

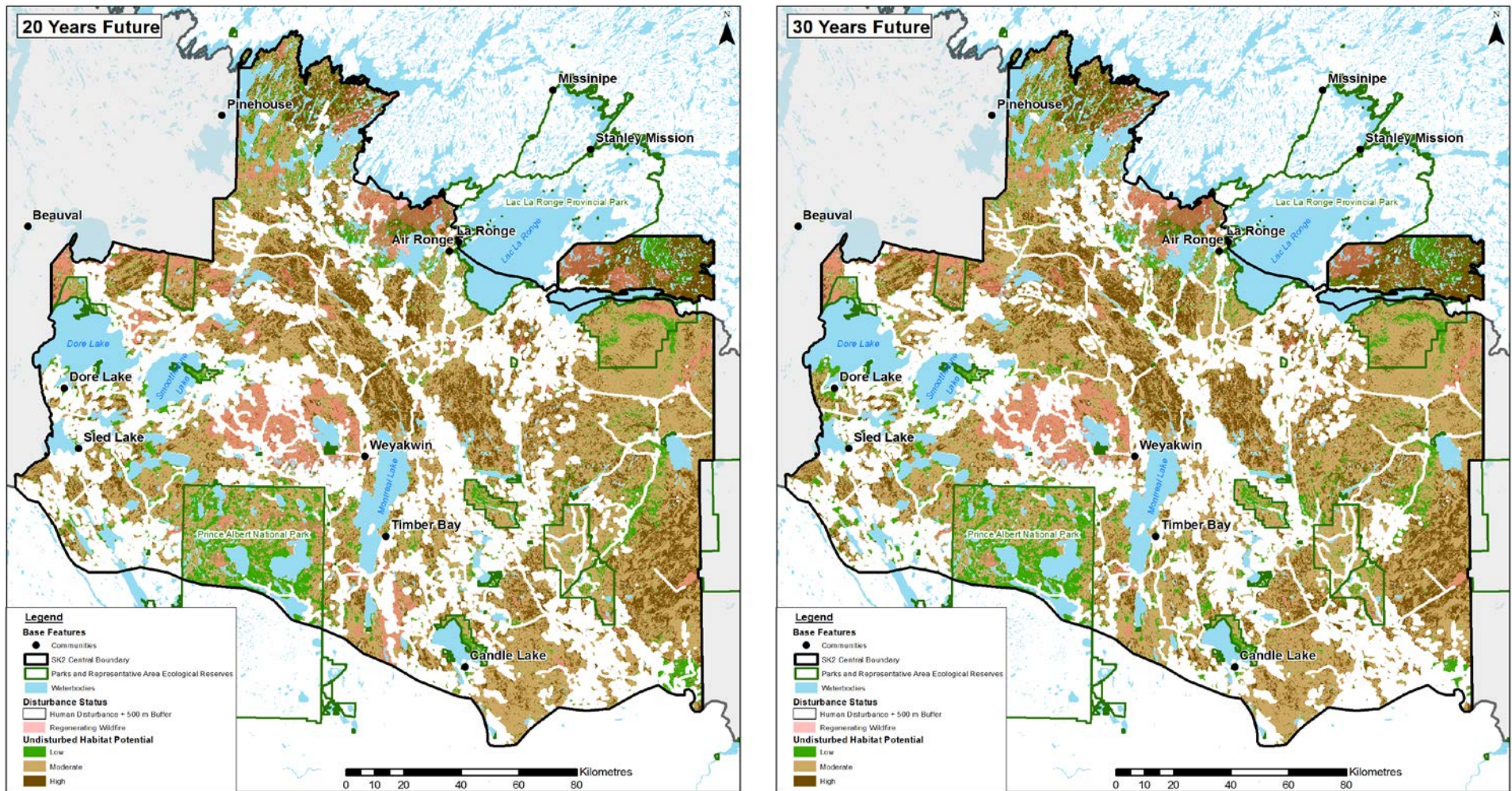


Figure 15. SK2 Central projected levels of human-caused disturbance 20 and 30 years into the future**.

** Caribou habitat potential in SK2 Central is shown (low, moderate and high) when it is in an undisturbed state, but is erased from the map (i.e., shown in white) when it has been disturbed by human-caused factors. Because of uncertainties of where future wildfire might occur spatially future wildfire is not shown in these maps. The locations of current wildfire are provided (i.e., regenerating wildfire) and then subsequently removed from the landscapes once they reach 40 years of age.

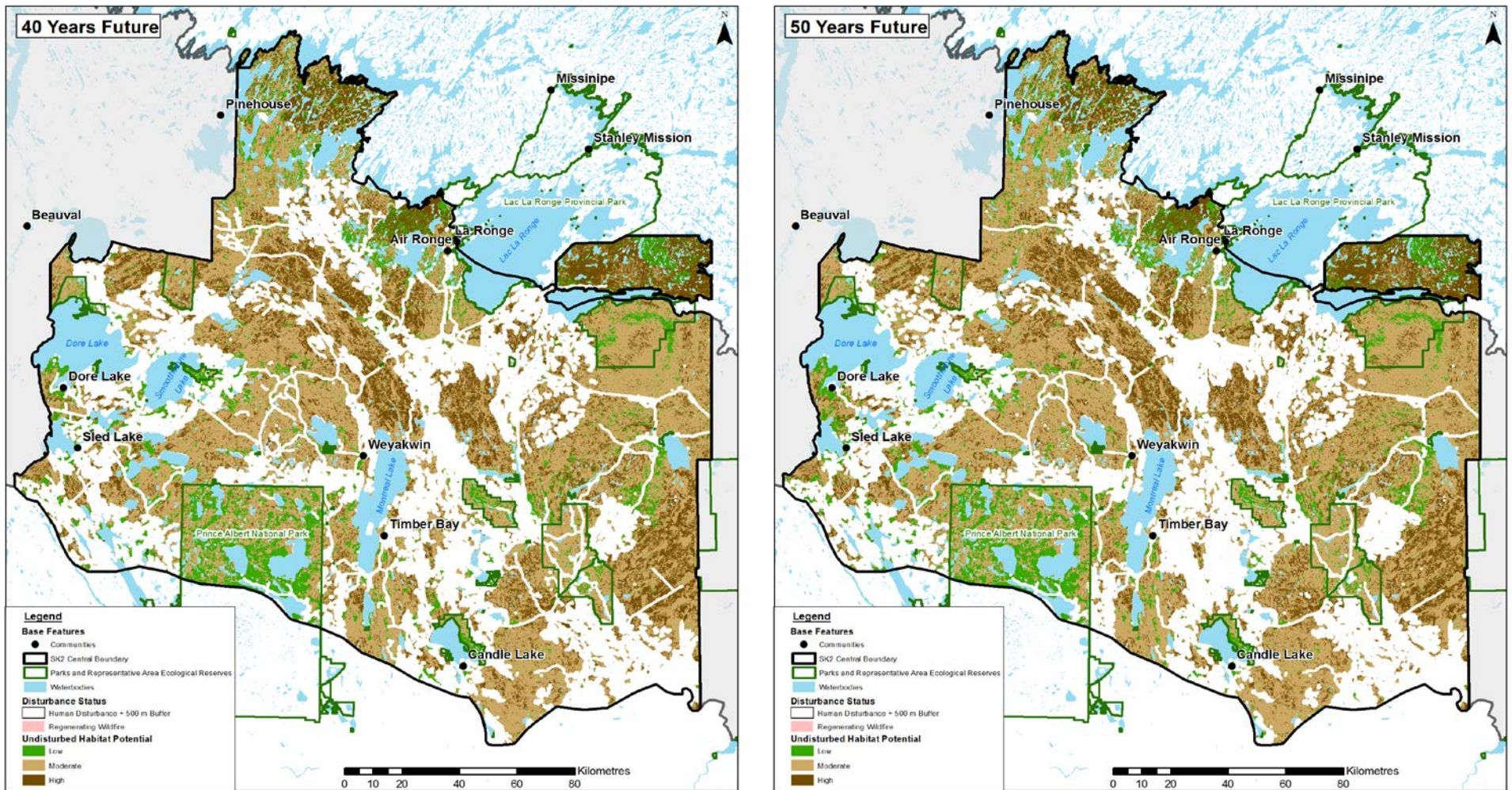


Figure 16. SK2 Central projected levels of human-caused disturbance 40 and 50 years into the future**.

** Caribou habitat potential in SK2 Central is shown (low, moderate and high) when it is in an undisturbed state, but is erased from the map (i.e., shown in white) when it has been disturbed by human-caused factors. Because of uncertainties of where future wildfire might occur spatially, future wildfire is not shown in these maps. The locations of current wildfire are provided (i.e., regenerating wildfire) and then subsequently removed from the landscapes once they reach 40 years of age.

Projected Changes in Caribou Habitat Potential

Projected changes in caribou habitat potential classes resulting from the most likely land use management scenario are shown in Figure 17. Future forest harvesting and most other land uses are expected to continue to occur within low and moderate habitat potential classes, resulting in the amount of high potential habitat disturbed by human activities remaining relatively unchanged from current conditions (i.e., approximately 20-25 per cent disturbed, meaning approximately 75-80 per cent remains in an undisturbed condition). Maintaining 80 per cent of high potential habitat has been identified as a landscape management objective for the SK2 Central range plan.

Historically, much forest harvesting was directed to hardwood sites with low habitat potential. In year 50, as legacy roads begin to regenerate either naturally or through active reclamation, the amount of low potential habitat affected by human-caused disturbance is anticipated to decline from its current level of approximately 50 per cent to 48.6 per cent. To compensate for declining forestry in hardwood ecosites, the amount of future forest harvesting is expected to increase slightly on softwood ecosites with moderate habitat potential, with 29 per cent to 36 per cent of moderate habitat potential being affected.

Similar results are shown in Figure 18, with the amount of habitat potential class affected by human-caused disturbance reported by decade (e.g., in year 20, of the total amount of human-caused disturbance, 26.6 per cent affects habitats with low potential, 60.5 per cent affects moderate potential habitats, and the remaining 12.9 per cent occurs in high potential habitat). The majority (e.g., 58 per cent to 61 per cent) of the area affected by human-caused disturbance occurs in moderate potential caribou habitats throughout the 50-year scenario period.

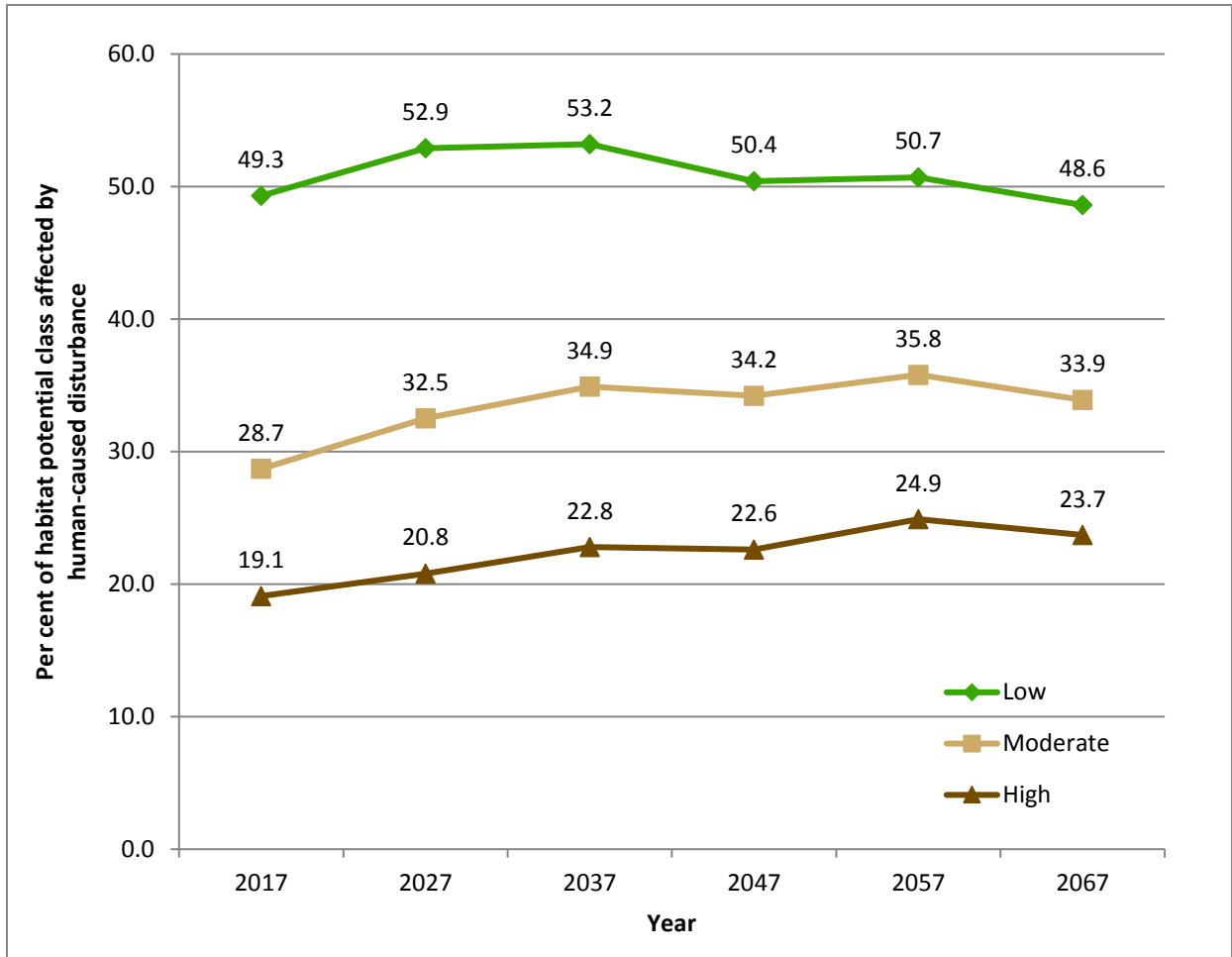


Figure 17. Projected proportion of total habitat potential class affected by human-caused disturbance resulting from the most likely land use management scenario.

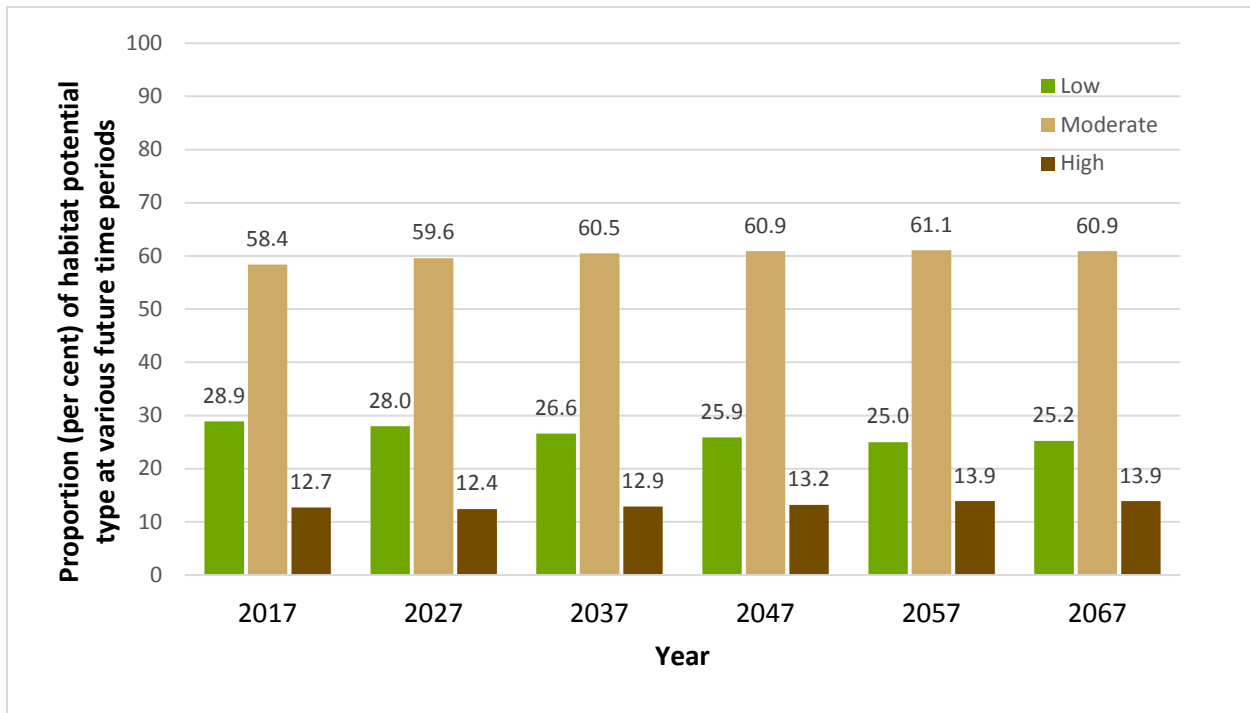


Figure 18. Projected proportion of habitat potential type at future periods for the most-likely land-use management scenario.

Summary

Current Situation

The current biophysical and disturbance attributes of SK2 Central habitats are summarized as follows:

- Low, moderate and high potential terrestrial habitats comprise 15.7 per cent, 54.2 per cent and 17.7 per cent, of SK2 Central, respectively.
- The highest proportion of high-potential caribou habitat occurs in Tier 1 CHMAs.
- Given their large spatial extent, moderate-potential habitats comprise over 50 per cent of all CHMA or land tenure classes in SK2 Central.

Future Situation

Future potential biophysical and disturbance conditions are summarized as follows:

- Based on the anticipated types, locations and rates of future land use:
 - The amount of human-caused and total disturbance is anticipated to increase above current levels.
 - The amount of undisturbed high-potential habitat is projected to remain near 80 per cent.

APPENDIX D: SK2 Central Sensitivity Analyses

Purpose

This appendix describes sensitivity analyses methods and results used to support the SK2 Central range plan. Sensitivity analysis assisted in developing and testing land management and disturbance reduction concepts that may contribute to reduced landscape disturbance and improved woodland caribou habitat conditions in the SK2 Central caribou administration unit.

Methods

Approach

Scenario analysis allows the exploration of potential future conditions based on different assumptions. Different factors affecting future conditions can be systematically varied to better understand the relative influence or magnitude of change on potential outcomes. The scenario analysis approach used to support the SK2 Central range plan examined major human factors that create or influence the amount and pattern of landscape disturbance in SK2 Central. The three major factors examined were:

- forest harvest rate;
- forest harvest patterns; and
- reclamation of linear features.

Wildfire suppression effectiveness was not included in the management strategies evaluated. Most of SK2 Central is already within the high-value commercial forest full response wildfire management zone, where all fires are extinguished or controlled, given sufficient resources and weather conditions. A coarse-scale analysis of the financial resources required to minimally reduce the annual area burned under extreme fire conditions (when the majority of area burned occurs) concluded that increasing the effectiveness of wildfire suppression as a forest disturbance reduction strategy would likely not be feasible. A further reduction in wildfire rates may also not be desirable and could have negative ecological consequences for forest health, caribou and other boreal wildlife species.

Land Use Assumptions

Major assumptions for each land use sector considered in the SK2 Central sensitivity analyses are described in Table 10. The location of major land use activities is shown in Figure 19. The future location of mineral, peat harvesting and other existing land uses was assumed to be similar to current interests. The location of future forest harvesting will occur on the productive forest land base (shown in green), with specific locations determined through detailed forest estate modelling.

Table 10. Land use assumptions guiding the SK2 Central future scenarios by sector.

Land Use Sector	Assumptions
Forestry	Forestry is expected to remain as the dominant land use activity in SK2 Central for the coming decades. Rate of forest harvest in SK2 Central was one of the key factors that was systematically altered in the sensitivity analyses.
Peat Harvesting	In the past five years, peat harvesting interest in the Saskatchewan Boreal Plain has increased. Several areas in SK2 Central are currently under exploration lease or have been identified for peat exploration. Our scenarios assume that most of the areas currently identified as potential peat harvesting areas will become peat harvesting mines and operate for the duration of the scenario period.
Mineral Exploration and Development	The Boreal Plain generally has lower mineral potential than the Boreal Shield. With the exception of isolated kimberlite deposits, most mineral exploration interest is assumed to continue to be focused in the northern part of SK2 Central.
Oil and Gas Exploration and Development	In comparison to other areas of the Boreal Plain (e.g., SK2 West), SK2 Central has relatively low oil and gas potential. Oil and gas exploration and development is not anticipated to be a major activity in the coming decades.
Transportation	SK2 Central has a well-developed all-season road network, including several paved highways. With the exception of new access roads required for forestry, mineral exploration and similar activities, a major expansion of the public road network is not anticipated. The amount and location of new access roads will be dependent on the location, intensity and operating practices of future forestry, mineral exploration and similar activities.
Electricity Generation and Transmission	Most power lines currently parallel existing major roads. New major electrical utility transmission corridors are not anticipated.
Settlements	SK2 Central includes several existing communities, villages and recreational cottage subdivisions. While community growth is expected for existing settlements, the establishment of new communities or new major recreational subdivisions is not anticipated.
Recreation	Multi-season motorized and non-motorized recreation is an important activity in SK2 Central. Interest and participation in these activities are anticipated to remain similar to current levels or to increase. The extensive SK2 Central road and trail network receives high levels of summer and winter use. Managing future recreational use may be challenging.

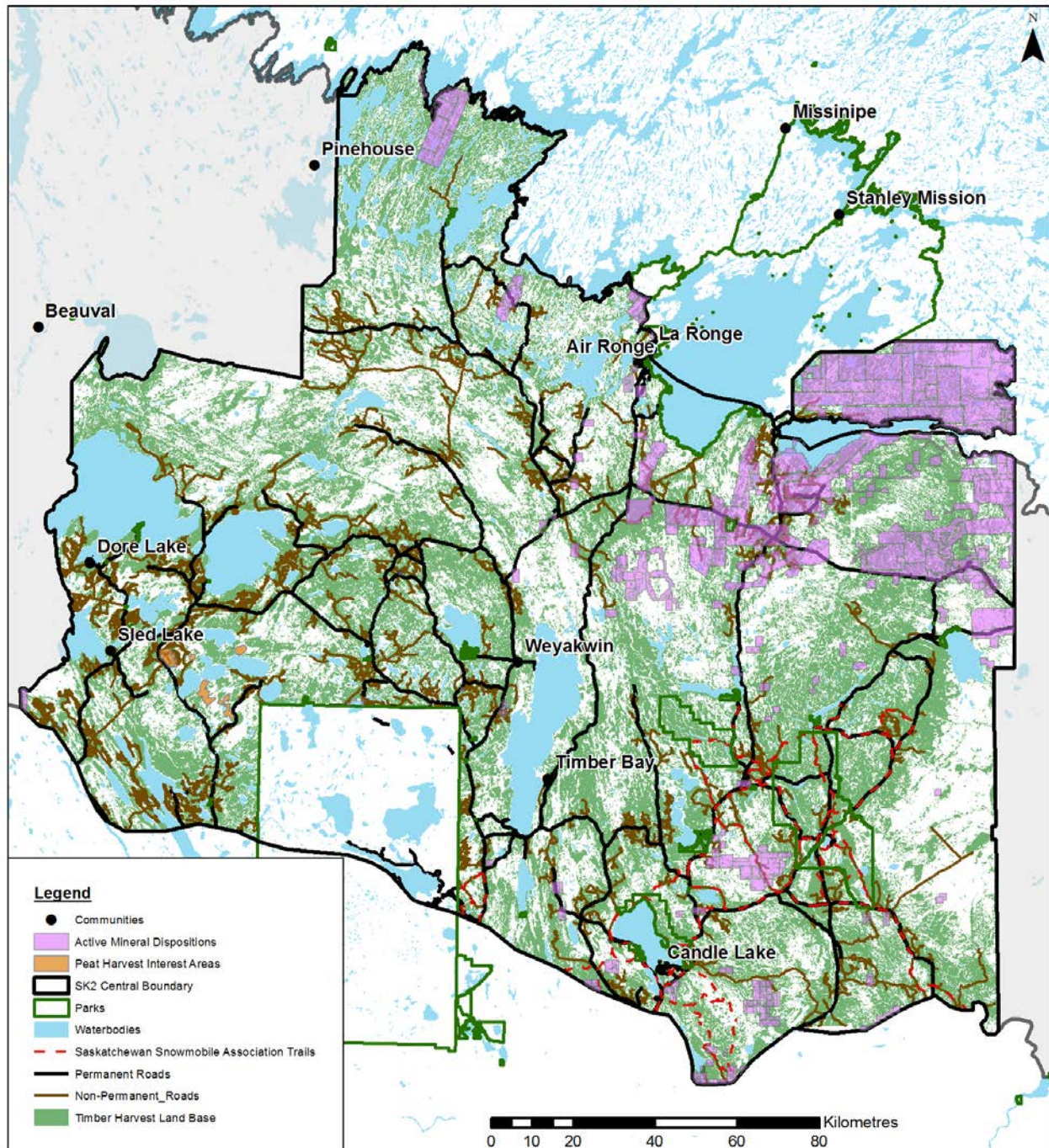


Figure 19. Distribution of major land-use activities across the SK2 central**.

** Future forest harvesting will be limited to the timber harvest land base subsequently removed from the landscapes once they reach 40 years of age.

Sensitivity Analyses Conducted

Unless otherwise stated, all sensitivity analyses used the same assumptions as the most-likely management scenario previously described in these appendices and the range plan. However, the sensitivity analyses focused on changing three key assumptions from the most-likely scenario:

- forest harvest levels in SK2 Central;
- harvest patch size distribution; and
- road reclamation.

Changes to forest harvest levels invariably result in changes to disturbance levels in SK2 Central. However, the magnitude of change is unknown. Decreasing the number of small, non-overlapping sources of human-caused disturbance disproportionately reduces overall disturbance levels (Figure 20). Roads comprise a significant proportion of the overall human-caused disturbance in SK2 Central. Understanding how different road reclamation strategies influence disturbance outcomes is important. Table 11 identifies each sensitivity analysis completed concerning changing assumptions regarding harvest levels and minimum harvest patch size changes and lists parameters that were changed compared to the most-likely scenario. Harvest volume schedule is assessed within the SK2 Central boundaries. A separate analysis on road reclamation strategies was completed and is described later in this appendix.

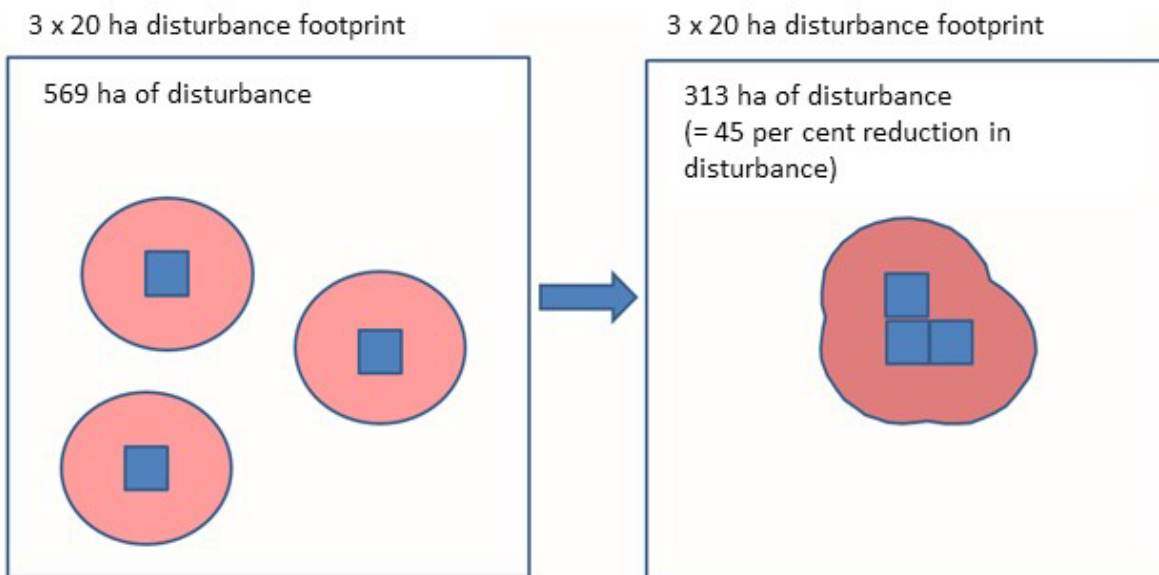


Figure 20. Example illustrating the difference in overall buffered disturbance level when site disturbances are portioned into separate or amalgamated activities.

Table 11. Sensitivity analysis scenarios comparing varying annual allowable harvest levels and minimum harvest patch sizes allowed to be cut⁹.

Sensitivity Analysis	Harvest Volume Schedule (i.e., annual allowable cut)	Minimum Patch Size Allowed to be Cut
1	30-40 per cent	20 ha
2	35-45 per cent	20 ha
3 - Most likely scenario	50-60 per cent	20 ha
4	100 per cent	20 ha
5	40-50 per cent	40 ha
6	45-55 per cent	80 ha
7	50-60 per cent	200 ha

Roads

Modelling road dynamics was the most challenging part of the spatial analysis. Two factors required consideration: the age/status of existing roads and the amount and location of future roads. To approximate the age of existing roads, the non-permanent road layer was intersected with 1975-76 to 2014-15 forest harvest blocks. As not all Class 4 roads segments intersected harvest blocks, a search distance of 100 m was added.

Further, some roads segments were associated with multiple harvest blocks. To determine the most likely age, results were imported to a Microsoft Access Database where the age of the youngest associated cut block was used to date the road segment. During this exercise, all non-permanent roads were assigned an age. If a road was not associated with a harvest block, it was assigned an age of 0. Assigning an age to all non-permanent roads allowed different reclamation assumptions to be investigated.

New future roads needed to be considered in the SK2 Central disturbance scenarios, but are challenging to represent spatially. We assumed that most new roads in SK2 Central would be required to support forest harvesting operations. The analysis was conducted to explore the possible cumulative road length associated with the different scenarios. The total length of Class 1 to 4 forest resource roads was compared with the total area of forest harvest between 1975 and 2014, resulting in a ratio of kilometre of road to square kilometres of harvest area. A maximum ratio was calculated by including Class 4 (in-block) roads into the calculation, and a minimum ratio was developed by excluding them. Additional intermediate road ratios were developed to examine potential differences between the ratios in resulting road length. Natural forest pattern harvesting techniques are expected to reduce the amount of new roads required to access forest harvesting areas.

⁹ Parameters for modelling are the same as those described in the most-likely scenario unless otherwise noted.

Results

Harvest Levels

If forest harvest level is slightly increased over the coming 50 years, the human-caused disturbance is projected to increase compared with current conditions. Increasing harvest to the maximum harvest level (i.e., 100 per cent harvest volume schedule) results in large increases in landscape disturbance, increasing from the current 43.1 per cent disturbance levels to a maximum, over the 50-year period, of 60.5 per cent (Figure 19). The large increases result from the cumulative increase in harvest area and the 40-year reclamation lag time between harvesting and undisturbed conditions. Forest harvest levels representing 50-60 per cent, 35-45 per cent, and 30-40 per cent of the maximum harvest volume schedule, reduce disturbance in the SK2 Central to its lowest point at year 50 with 34.0 per cent and 33.0 per cent disturbance, respectively (Figure 21).

Harvest Patch Size

For many practical and logistical purposes, increasing forest harvest patch sizes is difficult to operationalize. Larger forest harvest patch sizes can have unintended and negative economic implications for non-forestry related activities and may have negative social perceptions. Therefore, the sensitivity analyses conducted here do not represent predetermined paths forward but offer insight into the effectiveness of tools that may be used to reduce disturbance in the SK2 Central while still maintaining current or slightly increased forest harvest levels.

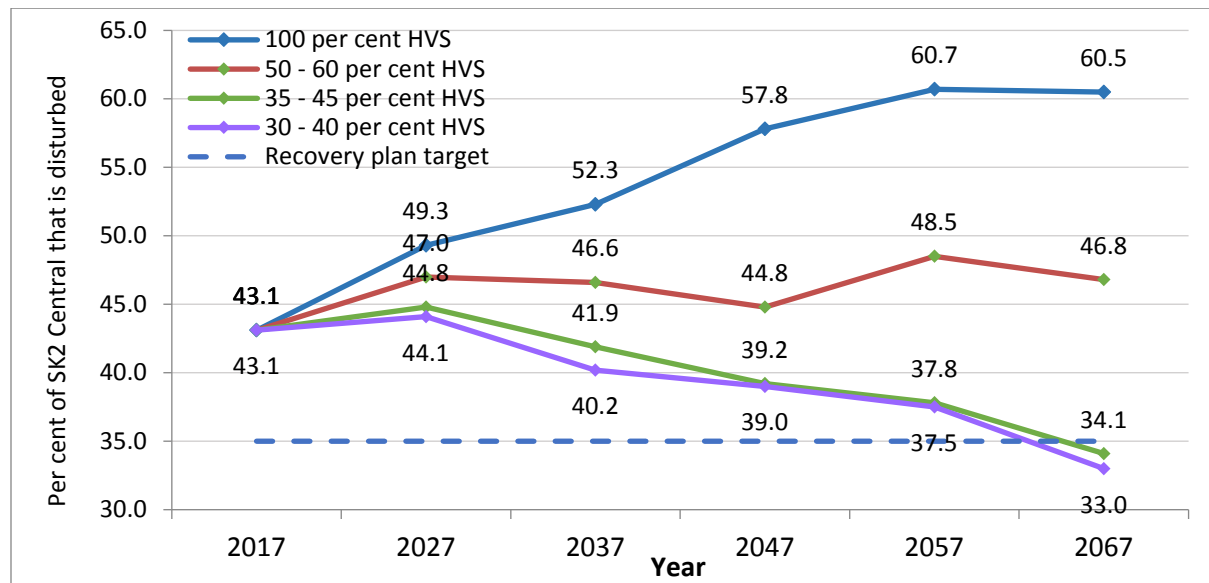


Figure 21. Sensitivity analysis conducted to assess the influence of varying forest harvest levels (harvest volume schedule) on total landscape disturbance**.

** Disturbance levels illustrated include both human-caused and natural (i.e., wildfire) disturbance on the landscape.

The sensitivity analysis suggests that increasing minimum harvest patch sizes from the current Forest Management Planning Standard, while maintaining relatively high harvest levels, has the potential to result in realized reductions in disturbance (Figure 22). Compared to the most-likely scenario (i.e., 50-60 per cent HVS), increasing the minimum harvest patch size to 40 ha from 20 ha resulted in a reduction in disturbance by year 50 of about 5 per cent (i.e., 46.8 per cent vs 41.7 per cent). Concurrent reductions in forest harvest levels and increases in minimum forest harvest patch sizes had the largest effects on reducing disturbance in SK2 Central (Figure 22).

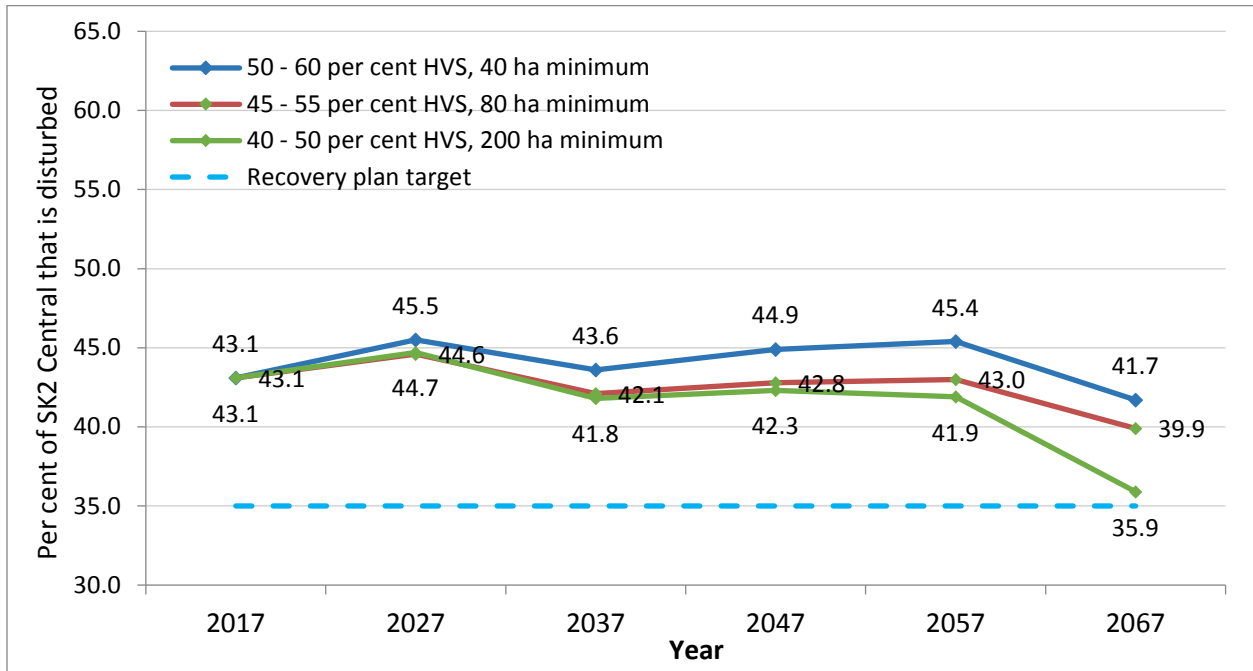


Figure 22. Sensitivity analysis conducted to assess the influence of varying both forest harvest levels (HVS) and minimum forest harvest patch sizes on total landscape disturbance**.

** Disturbance levels illustrated include both human-caused and natural (i.e., wildfire) disturbance on the landscape.

Road Reclamation

Figure 23 shows the results of varying road distance to area harvested ratios, under a high reclamation assumption. High road reclamation scenarios result in lower levels of human-caused disturbance for all harvest scenarios. However, given the 40-year reclamation lag time currently being assumed, the disturbance reduction effects associated with reclaiming legacy roads are not readily realized until near the end of the scenario period, in year 40 or 50. These effects are most visible in the current and increasing harvest scenarios, where the cumulative disturbance levels begin to decline between year 40 and 50. It is possible that if the scenario modelling period was extended another 20 or more years, further reductions might be observed.

While the high road reclamation scenario results in a reduction in total human-caused disturbance, assumptions about harvest level have a much larger effect on total human-caused disturbance.

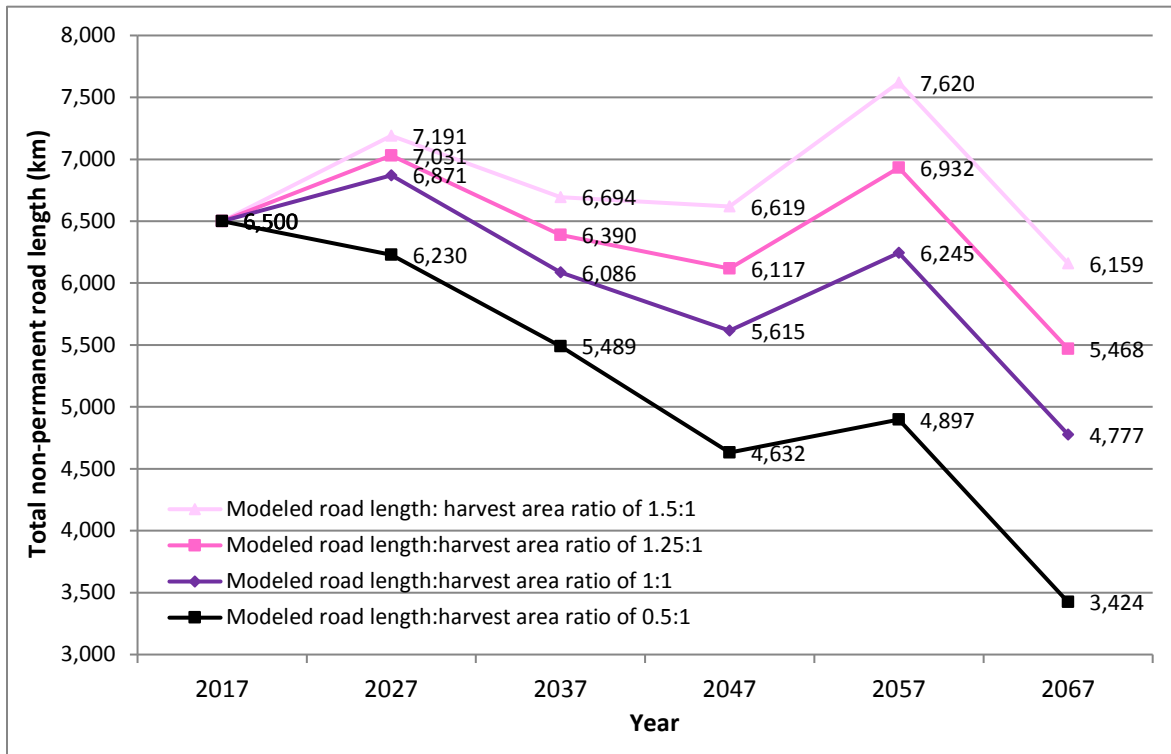


Figure 23. Different ratios of road length to harvest area result in varying amounts of roads persisting on the landscape**.

** Road length to harvest ratios greater than 1:1 typically result from traditional two-pass forest harvesting. Natural forest pattern-based harvesting is expected to result in less than 1:1. This figure shows results of different future road lengths under a high reclamation scenario, where a large number of roads are reclaiming off the landscape in 40 to 50 years

Summary

This appendix (i.e., D) describes methods for the various sensitivity analyses used to support the SK2 Central range plan. Four varying forest harvest levels (i.e., 100 per cent of HVS, 50-60 per cent of HVS, 35-40 per cent of HVS, and 30-40 per cent of HVS) and three harvest patch sizes (i.e., 40, 80, and 200 ha) were analyzed and modelled into the future for a period of 50 years. Levels of disturbance resulting from the different scenarios were reported for each decade of the scenario period. Major results are summarized as follows:

- The current forest harvest rate in SK2 Central utilizes approximately 50 per cent of the theoretical maximum sustainable harvest. Forest harvest levels are projected to increase slightly in SK2 Central, and as a result, the amount of human-caused disturbance in SK2 Central is expected to increase, compared to current conditions.
- If the forest harvest rate increases to the maximum licensed amount (i.e., 100 per cent), a large increase in the amount of human-caused disturbance in SK2 Central could be expected.
- If forest harvest rate were to decrease from current levels, disturbance reductions in SK2 Central could be expected.
- While difficult operationally, increases in forest harvest patch size, in the form of increases in the minimum patch size that can be harvested, could have important implications for the reduction of disturbance due to forestry-related activities in SK2 Central.
- Future wildfire rate and the amount and location of other land uses were held constant for the 50-year scenario period. While varying these factors may be instructive, higher levels of range disturbance could be expected since wildfire suppression is already at maximum, and the level of other industrial land uses low.

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