Range Plan for Woodland Caribou in Saskatchewan – APPENDICES

Boreal Plain Ecozone – SK2 West Caribou Administration Unit

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Table of Contents

List of Figures

List of Tables

Executive Summary

This appendix to the *Range Plan for Woodland Caribou in Saskatchewan Boreal Plain Ecozone (SK2 West Caribou Administration Unit)* provides an overview of the efforts taken in the SK2 West range plan to map disturbance and identify important caribou habitat management areas (CHMAs), as well as the process used to select them. It provides background information and data used in assessing and identifying the dividing line for identifying the northern and southern sub-units in SK2 West. 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 West range include forestry and associated road networks, oil and gas exploration and extraction sites and linear features (seismic lines and roads), mineral exploration, sand and gravel extraction, 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 West 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, the SK2 West range in 2016 was approximately 61.2 per cent disturbed. Human-caused and wildfire disturbance accounted for approximately 24.8 per cent and 36.5 per cent of SK2 West 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.

Using ecodistrict boundaries that also represent a change in fire regime and fire suppression efforts, SK2 West was divided into two sub-units for management purposes. The northern sub-unit represents an area with high fire disturbance and relatively low human-caused disturbance, whose fire regime more closely resembles that of the Boreal Shield. The southern sub-unit has a more equal ratio of fire and human-caused disturbance and has relatively high fire suppression efforts.

Twenty-three caribou habitat management areas (CHMAs) were identified in the SK2 West range. 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 the SK2 West.

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 West. Disturbance levels were consistent with forest harvest changes. For example, if the forest harvest rate were to decrease from current levels, disturbance reductions in SK2 West could be expected. Reclamation and restoration of linear features, especially legacy seismic lines, had a large impact on reducing disturbance levels in SK2 West. Most of the gains in disturbance reductions in SK2 West could be realized through reclamation of linear features. Other approaches that were not modelled in SK2 West but showed promise to reduce disturbance in SK2 Central include: increasing the minimum harvest patch size that can be harvested and increasing harvest event size.

1.0 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 West 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.

2.0 APPENDIX A: SK2 West Disturbance Mapping

2.1 Purpose

The Environment and Climate Change 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 West range plan.

2.2 Methods

The disturbance mapping used to support the national *Recovery Strategy for the Woodland Caribou, (Rangifer tarandus caribou), Boreal Population in Canada - 2012* (Environment Canada, 2012) assessment used satellite imagery, and captured visible human disturbances mapped at a scale of approximately 1:50,000. Based on available Government of Saskatchewan data sources, the Saskatchewan Ministry of Environment created an updated human disturbance layer that was approximately equivalent to the 1:50,000 scale of mapping used by Environment Canada for their assessment, current to 2016. Wildfire perimeters were also updated to 2016.

2.2.1 Saskatchewan Data Sources

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

2.2.2 Data Compilation

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

- 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.

- 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 (1977 to 2016), bush roads and seismic lines.
- The wildfire layer includes all wildfire perimeters for the time period 1977 to 2016. 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 10.6, to create the total disturbance layer for SK2 West.

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 lowest. A detailed breakdown of the human-caused disturbance hierarchy is provided in Table 2.

Table 1. Provincial data sources used to map SK2 West disturbances and considerations.

Disturbance Features	Data Source and Considerations
Linear Features[1]	

Roads	• The Saskatchewan Forestry Road Network (SFRN) road features was used to map roads within the commercial forest (Government of Saskatchewan, 2012).
	• Roads were 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).
	• The 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 West and so were not included in the SK2 West Saskatchewan disturbance mapping or calculations.
	  ○ The removal of trails in this assessment and in the assessment for SK2 Central does not necessarily indicate that trails will be removed in disturbance assessments in other caribou administration units.
	• In areas not covered by the Saskatchewan Forestry Road Network database and where appropriate, a combination of two other data sets were used:
	  ○ The Saskatchewan Ministry of Environment - Technical Resources branch anthropogenic disturbance mapping using FlySask imagery.
	  ○ The Environment and Climate Change Canada 2015 – anthropogenic disturbance footprint within boreal caribou ranges across Canada – As interpreted from 2015 Landsat satellite imagery.[3]

[1] Power lines were not included in the linear feature data set. In the SK2 West, all power lines follow road corridors.

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

[3] Available here: https://open.canada.ca/data/en/dataset/a71ab99c-6756-4e56-9d2e-2a63246a5e94

Table 1 (*continued*). SK2 West Saskatchewan disturbance mapping data sources and considerations.

Disturbance Features	Data Source and Considerations
Linear Features	
Seismic Lines	• Line work from the Saskatchewan Forestry Road Network database was used to map and classify seismic lines in the commercial forest. • For areas without SFRN coverage, a combination of Saskatchewan Ministry of Environment Technical Resources branch anthropogenic disturbance footprint mapping and Environment and Climate Change Canada data was used.
Fireguards	• Line work from the Saskatchewan Forestry Road Network database was used and then reclassified into fireguards.
Other Linear Features	• Pipelines have not been digitized and were not included in the analysis. • Pipelines in this area typically follow other roads or seismic lines therefore the disturbance footprint is considered captured by other linear features.
Area-based Features	
Forest Harvest Blocks	• Saskatchewan Ministry of Environment, Forest Service branch harvest block mapping: 40-year forest harvest history, 1977 to 2016.
Vertical Wells	• Saskatchewan Ministry of the Economy Integrated Resource Information System database (updated daily – accessed October 2018).
Settlements	• Saskatchewan Ministry of Environment, Technical Resources branch human disturbance mapping.
Other Area-based Disturbances	• Same as settlements.
Wildfire Perimeters	• Saskatchewan Ministry of Environment, Wildfire Management branch database 40-year wildfire boundaries, 1977 to 2016. • Waterbodies were erased from the wildfire polygons and did not contribute to the overall disturbance calculation attributed to wildfire.
Waterbodies	• CanVec 1:50,000 is the most detailed vector-based dataset depicting waterbodies in northern Saskatchewan. This dataset captures waterbodies <0.01 ha in size. • Waterbodies have been removed from wildfire polygons.

2.3 Results

2.3.1 Human Disturbance

Based on the available mapping, the total amount of non-overlapping human-caused disturbance (direct footprint plus 500 m buffer) is approximately 11,970 km^2 (i.e., 24.8 per cent of SK2 West; Figure 1). Permanent features (settlements, highways and other major roads) account for 2,297 km^2. Non-permanent human disturbances (e.g., largely forest harvest blocks less than 40-years old and non-permanent roads and seismic lines) account for the remaining 9,672 km^2. Detailed results for linear and area-based features are reported in Table 2.

2.3.1.1 Linear Features

Linear features comprise a large proportion of the total human disturbance present in SK2 West. Approximately 18, 820 km of linear features are distributed across the caribou administration unit. Permanent linear features (e.g., primary highways, secondary highways, municipal roads and major improved bush roads) total 2,007 km in length, while non-permanent linear features account for 16,813 km² of the total linear disturbance.

2.3.1.2 Area-based Features

The footprint of area-based features is 1,333 km². Permanent area-based features (e.g., settlements, recreation areas, airports, etc.) constitute only 149 km² of the total area-based disturbance. Non-permanent features (e.g., forest harvest blocks less than 40 years of age) account for 1,185 km^2 of the total amount of area-based disturbance.

2.3.2 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 2). Non-permanent linear features account for the majority of disturbance in SK2 West; however, many of these non-permanent roads also overlap non-permanent area-based disturbances (e.g., forest harvest blocks; Table 2). Even though permanent roads and area-based disturbances are at the top of the disturbance hierarchy, they account for a relatively small portion of total disturbance (Table 2).

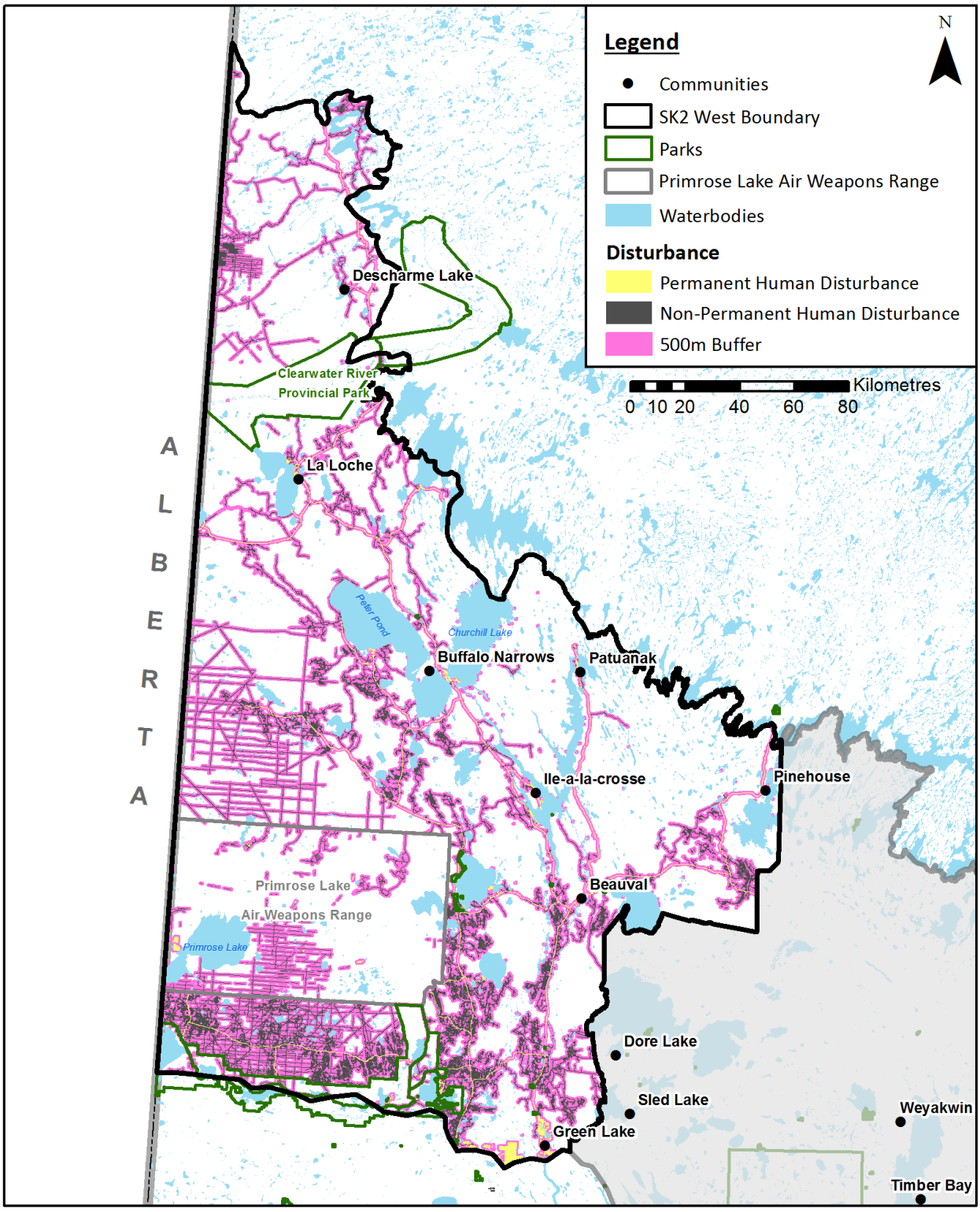

Figure 1. Current human disturbance in the SK2 West caribou administration unit.

Table 2. SK2 West 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 SK2 West
Permanent Area-based Features	1,082	2.2
Permanent Roads	1,243	2.6
Non-permanent Linear Features	9,100	18.8
Non-permanent Area-based Features	537	1.1
TOTAL	11,970	24.8

2.3.3 Wildfire Disturbance

The total area of wildfire disturbance in SK2 West calculated from provincial wildfire perimeter mapping, with waterbodies removed, no human-caused disturbance removed, and allowing for overlap between fires, for the period 1977 to 2016 is 28,143.6 km^2 (Table 3).

There is considerable overlap between human-caused disturbance and wildfire disturbance. The extent of wildfire as measured between 1977 to 2016 that does not overlap with human-caused disturbance and does not include overlap between fires, and has waterbodies removed is 17,629 km^2 (i.e., Table 5 in main range plan document).

Table 3. Wildfire disturbance summary[4] for the SK2 West caribou administration unit.

Decade	Area Contained within Fire Perimeter Boundaries (km^2)	Area Contained within Fire Perimeter Boundaries (Per cent of SK2 West)
1977 to 1986	5,709	11.8
1987 to 1996	10,249	21.2
1997 to 2006	5,722	11.8
2007 to 2016	6,463	13.4
TOTAL	28,144	58.2

2.4 Summary

2.4.1 Human-caused Disturbance

Based on the Saskatchewan Ministry of Environment disturbance assessment, the total amount of human-caused disturbance (i.e., direct footprint plus 500 m buffer) is approximately 11,970 km^2 or 24.8 per cent of SK2 West. 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

[4] Reported by decade; waterbodies removed; no human-caused disturbance removed; allows for overlap between fires.

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 West 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 period of 40 years is required for the human-caused or natural disturbance feature to no longer be considered in a disturbed condition.

2.4.2 Natural Disturbance

Following ECCC (2011) methodology, wildfire disturbance is calculated based on fire perimeter mapping with waterbodies removed. 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, 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., insect infestation, wind throw) affect the Boreal Plain, but as per ECCC (2011) methodology have not been considered in the disturbance calculations.

2.4.3 Total Disturbance

The total extent of non-overlapping human-caused (i.e., direct footprint plus 500 m buffer) and wildfire disturbance is 29,598 km^2 or 61.2 per cent of SK2 West. Human-caused disturbance accounts for 11,970 km^2 (i.e., 24.8 per cent) of the total non-overlapping disturbance, with wildfire accounting for the remaining 17,628 km^2 (i.e., 36.5 per cent).

3.0 APPENDIX B: Information Supporting the Development of SK2 West Sub-units

The unequal and geographically concentrated distribution of wildfire within SK2 West makes managing disturbance levels difficult at the scale of the entire administration unit. In light of this, two sub-units were established in SK2 West (see main range plan document). This appendix describes supporting information that was used when identifying the boundary to split the SK2 West Administration Unit.

3.1 Ecodistricts

The best available information on ecologically distinctive areas of Saskatchewan was derived from the Ecoregions of Saskatchewan (Acton et al., 1998). The Firebag Hills ecodistrict (Figure 2) is characterized by short shrubby jack pine with a lichen understory, reflecting the sandy soil and frequency of fire. Black spruce and tamarack occupy poorly drained peatlands. Vegetation along the Clearwater River consists of trembling aspen, jack pine and white spruce, with sedges, grasses, willows and tamarack and black spruce occupying the valley bottom (Acton et al., 1998). The Garson Lake Plain (Figure 2) is a mosaic of peatlands dominated by black spruce and tamarack, with uplands of dense stands of black spruce and some areas of trembling aspen mixed with pine. The Palmbere Plain (Figure 2) consists of uplands areas with jack pine, occasionally mixed with black spruce and lichen or feather moss; lowland areas consist of dense stands of black spruce with an understory of Labrador tea, sphagnum moss, and feather moss.

3.2 Wildfire

Wildfire covers approximately 61.4 per cent of the northern sub-unit, while only disturbing 27.5 per cent of the southern sub-unit. This change in wildfire disturbance was one of the primary factors for considering splitting SK2 West into two management units. The ministry assesses every wildfire, no matter where it is, and makes decisions about how to manage it. However, wildfire suppression activities also differ in the northern and southern sub-units. The northern sub-unit is composed of the northern wildfire management zone, where wildfire suppression activities focus on protection of high value areas, such as communities. The southern sub-unit is composed of the primary and secondary timber areas, which are also considered high value areas requiring fire suppression efforts (Figure 3).

The fire regimes in the northern and southern sub-units also differ. Boulanger et al., (2012) and Boulanger et al., (2014) both found that the fire regime in the northern sub-unit of SK2 West more closely resembled that of the Boreal Shield ecozone (i.e., SK1) rather than the Boreal Plain ecozone (Figure 4). Whereas, the southern sub-unit tends to have a fire regime more closely resembling that of the Boreal Plain (i.e., SK2) (Figure 4). Understanding how these two areas are currently similar in terms of fire regime is important, but understanding how they may also differ in the future is equally important. Wood volume in the northern sub-unit was deemed to be at the same risk of threat from fire, drought, and insects in the future as the boreal shield (Boucher et al., 2018) (Figure 5). In this same

research, the southern sub-unit and the boreal plain were considered to be similarly at risk from fire, drought, and insects in the future (Boucher et al., 2018) (Figure 5).

3.3 Human Footprint

The northern sub-unit had small amounts of historic harvest, currently has negligible forestry activities, and it is projected that there will be very limited future forestry activities. Linear features and oil well infrastructure in this area are also the subject of both intensive industrial reclamation activities and natural regeneration and so will likely be removed from the northern sub-unit at some time in the future. There is the potential for uranium development in this area, but the resulting footprint is likely to be small. Given the current low human footprint (16 per cent) and continued efforts to reclaim legacy oil and gas infrastructure, the landscape of the northern sub-unit will likely more closely resemble the high fire and low anthropogenic disturbance landscape of the Boreal shield as compared to the Boreal plain. The southern sub-unit contains a mix of forestry activities and oil and gas activities, with smaller amounts of fire disturbance and more closely resembles the rest of the Boreal Plain.

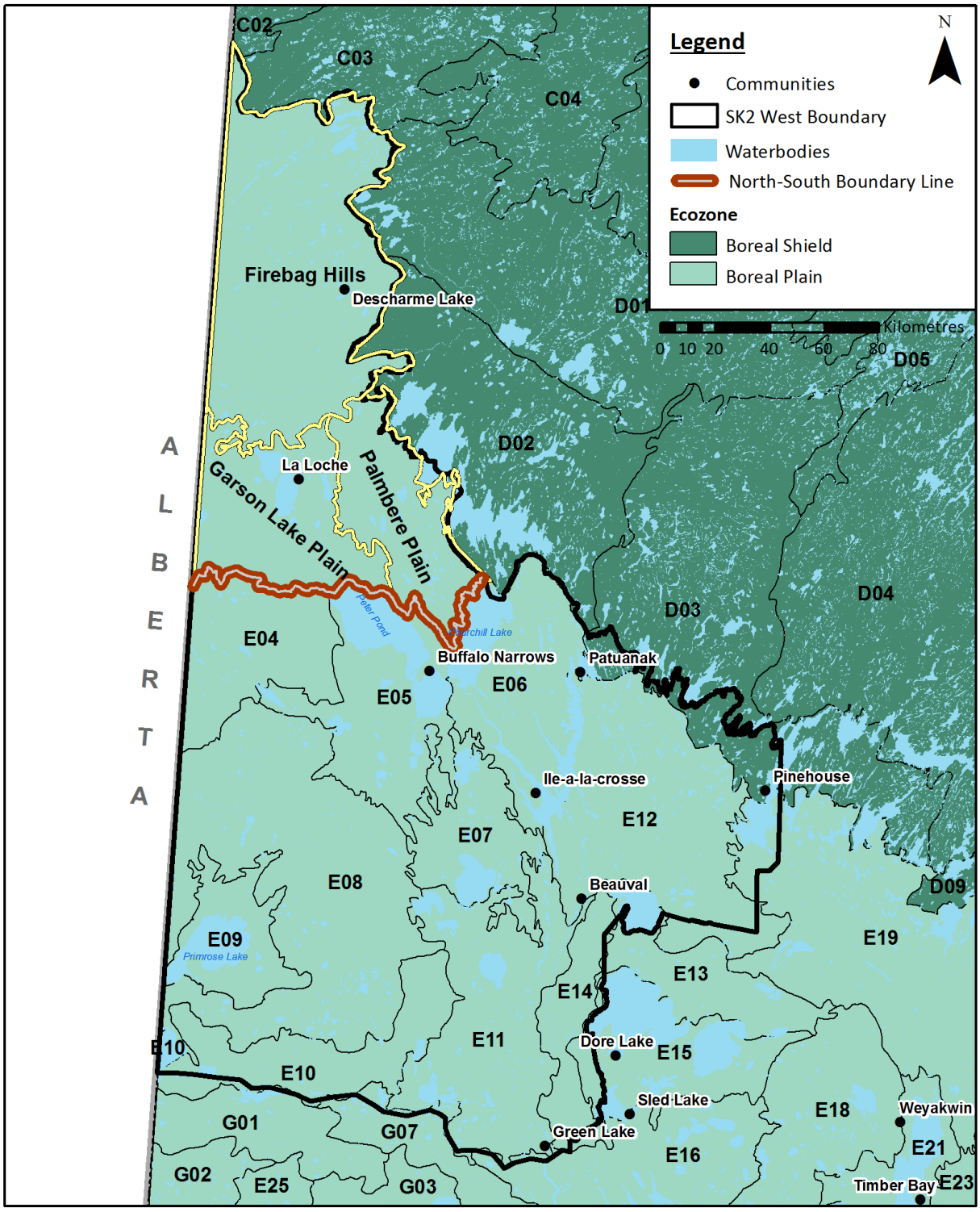

Figure 2. Ecodistricts of the SK2 West illustrating how the Firebag Hills (E1), Garson Lake Plain (E2), and Palmbere Plain (E3) ecodistricts delineate the northern and southern sub-unit boundaries.

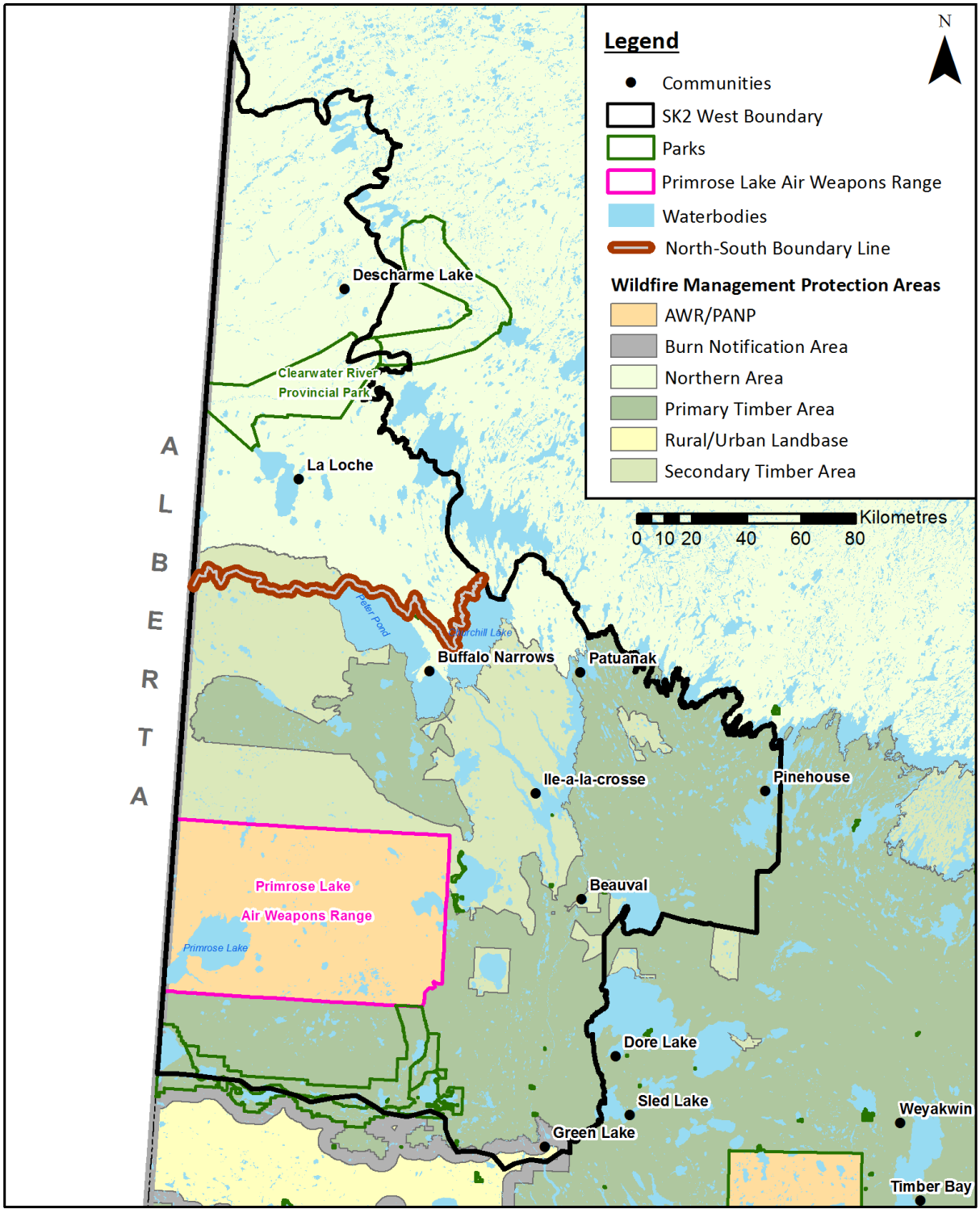

Figure 3. Wildfire management zones within the SK2 West caribou administration unit.

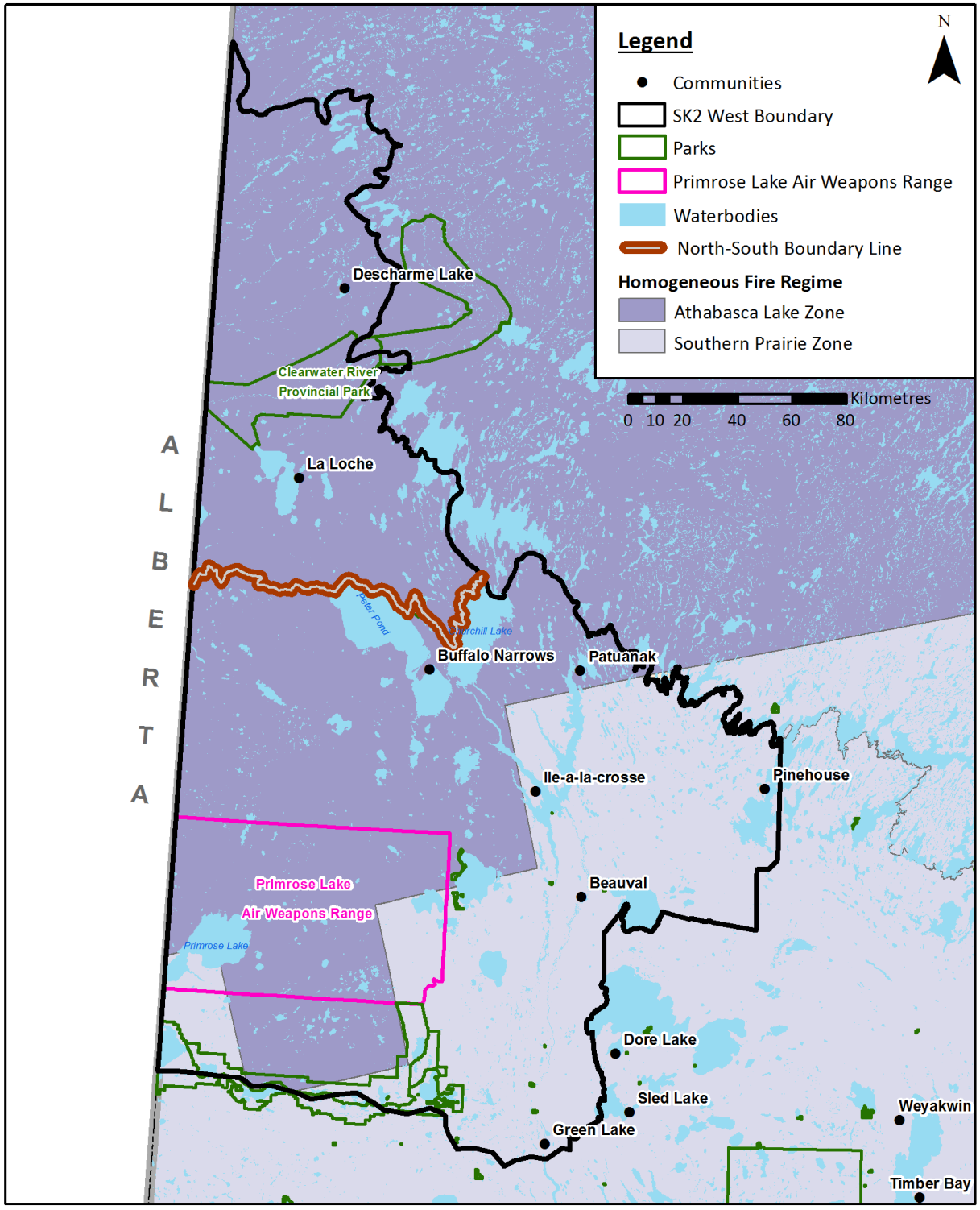

Figure 4. Homogenous fire regime zones as described by Boulanger at al., 2014.

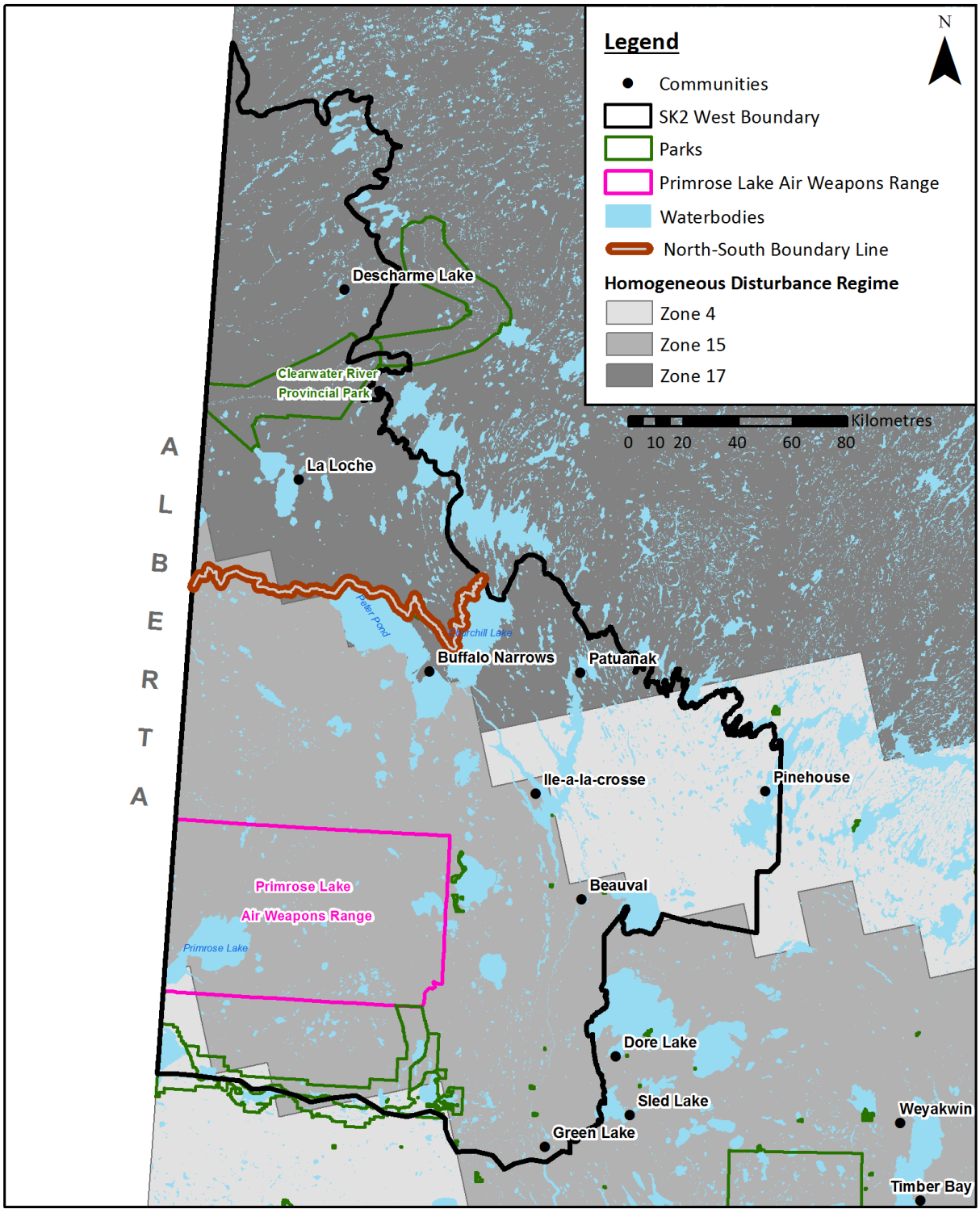

Figure 5. Homogenous disturbance zones as described by Boucher et al., 2018.

4.0 APPENDIX C: Overview of SK2 West Caribou Habitat Management Areas

4.1 Introduction

This appendix describes the rationale and management considerations associated with the caribou habitat management areas (CHMAs) on provincial Crown lands in the SK2 West caribou administration unit. Map overlays demonstrate how three important factors (i.e., habitat potential, human-caused disturbance and recent wildfire disturbance) helped guide the identification and boundary delineation of the CHMAs. Summary tables 4, 5, and 6 describe the area and management considerations for each caribou habitat management area.

4.2 Overview of the Caribou Habitat Management Areas

Section 5.3.1 of the range plan describes the CHMA framework for the SK2 West. Provincial Crown lands within the SK2 West area have been divided into three types of CHMAs: Tier 1, 2 and 3 (Figure 6). Tier levels are 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:

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

Current and long term use by caribou was the first criteria for selection of tier 1 habitat areas. Caribou occupancy information in some parts of caribou range in SK2 West is limited, so this was supplemented by habitat potential, where areas made up of a good mix of high and moderate potential habitat were included. Most tier 1 areas have low disturbance, but some like #1 (Figure 6) still have consistent caribou use, even though mostly disturbed by wildfire. Because of the low human-caused disturbance footprint, this area continues to provide habitat value to caribou similar to the Boreal Shield (SK1).

Tier 2 areas are typically identified as areas with a combination of high and moderate habitat potential, where there has been moderate to high levels of disturbance (both natural and human-caused). In some cases, information of past caribou occupancy was also available and was used to help delineate boundaries.

On average, tier 1 CHMAs have the greatest proportion of high value habitat potential when compared to tier 2 and tier 3 areas. Conversely, tier 3 CHMAs have the greatest proportion of low value habitat

potential compared to tier 1 and tier 2 areas. However, tier 3 areas are still comprised of approximately ten per cent high value habitat potential.

Map overlays of the CHMAs and habitat potential, human-caused disturbance, recent wildfire (1977-2016), and Indigenous traditional knowledge (Mamun and Brook, 2017) are shown in Figures 7-10, respectively. Table 4 lists the areas and describes the rationale, and potential management concerns within each CHMAs. Table 5 provides information on the size, disturbance (human-caused and wildfire) amounts, and the amount of low, moderate and high habitat potential within each of the CHMAs.

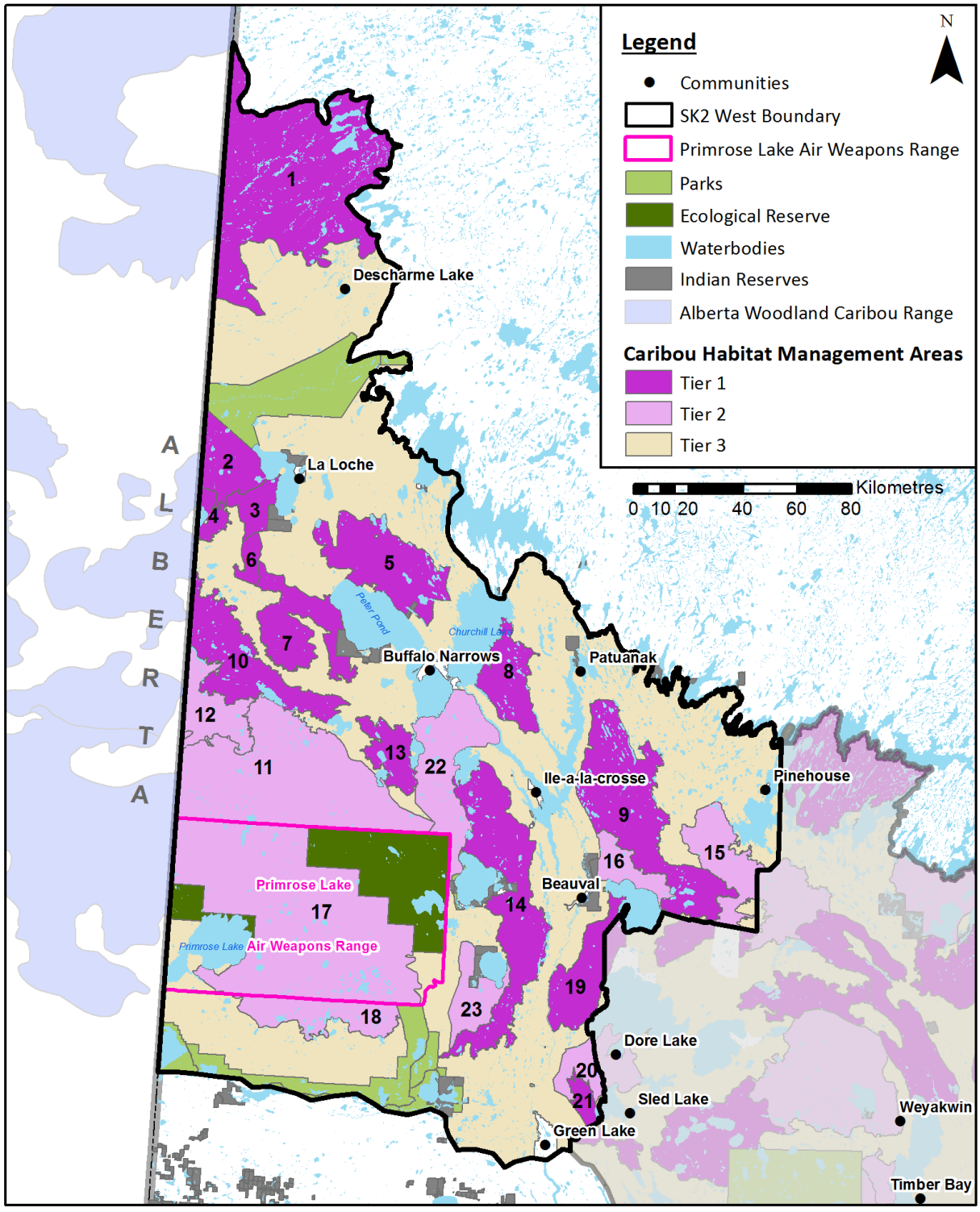

Figure 6. SK2 West caribou habitat management areas.

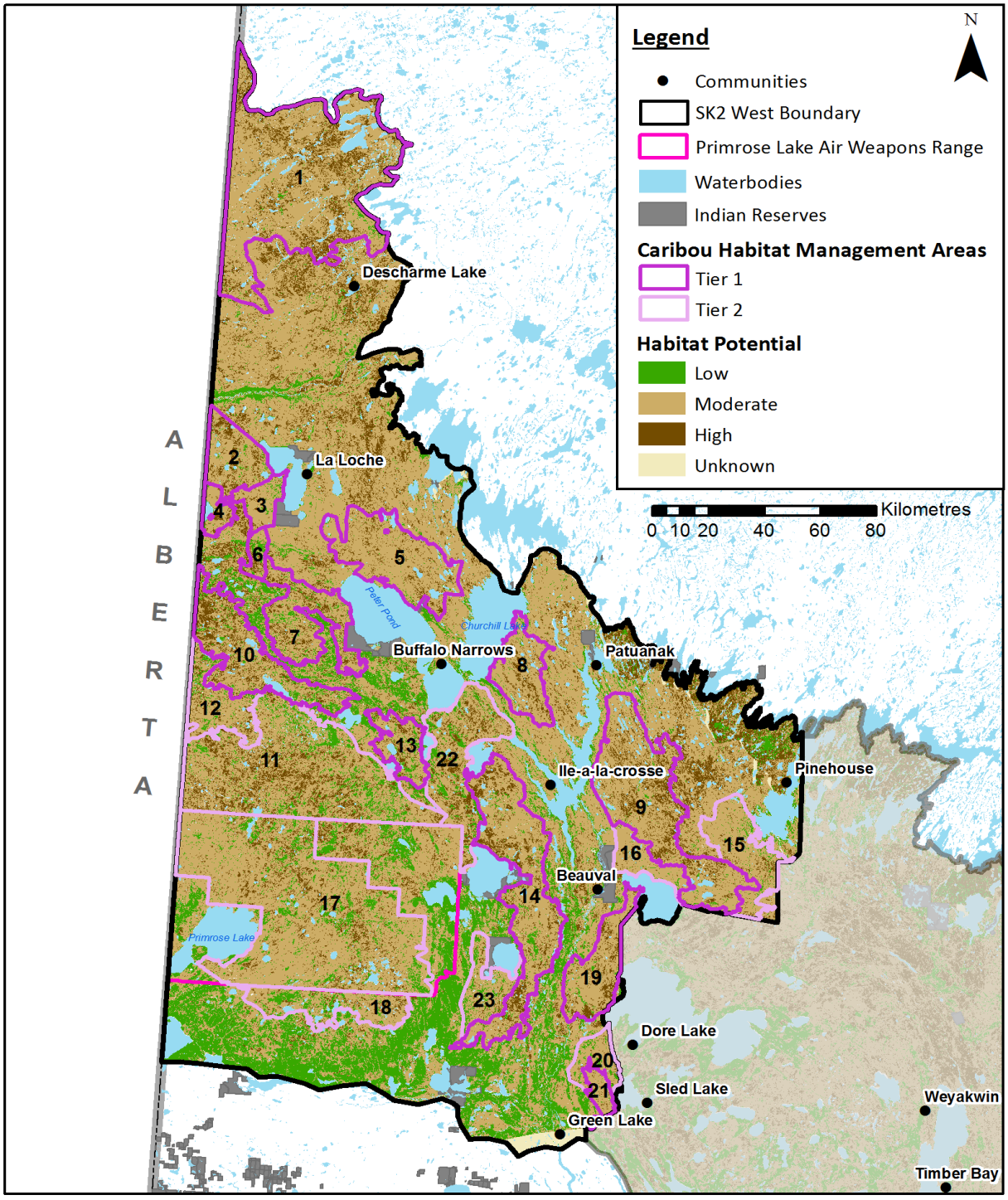

Figure 7. Tier 1 and tier 2 caribou habitat management areas with caribou habitat potential.

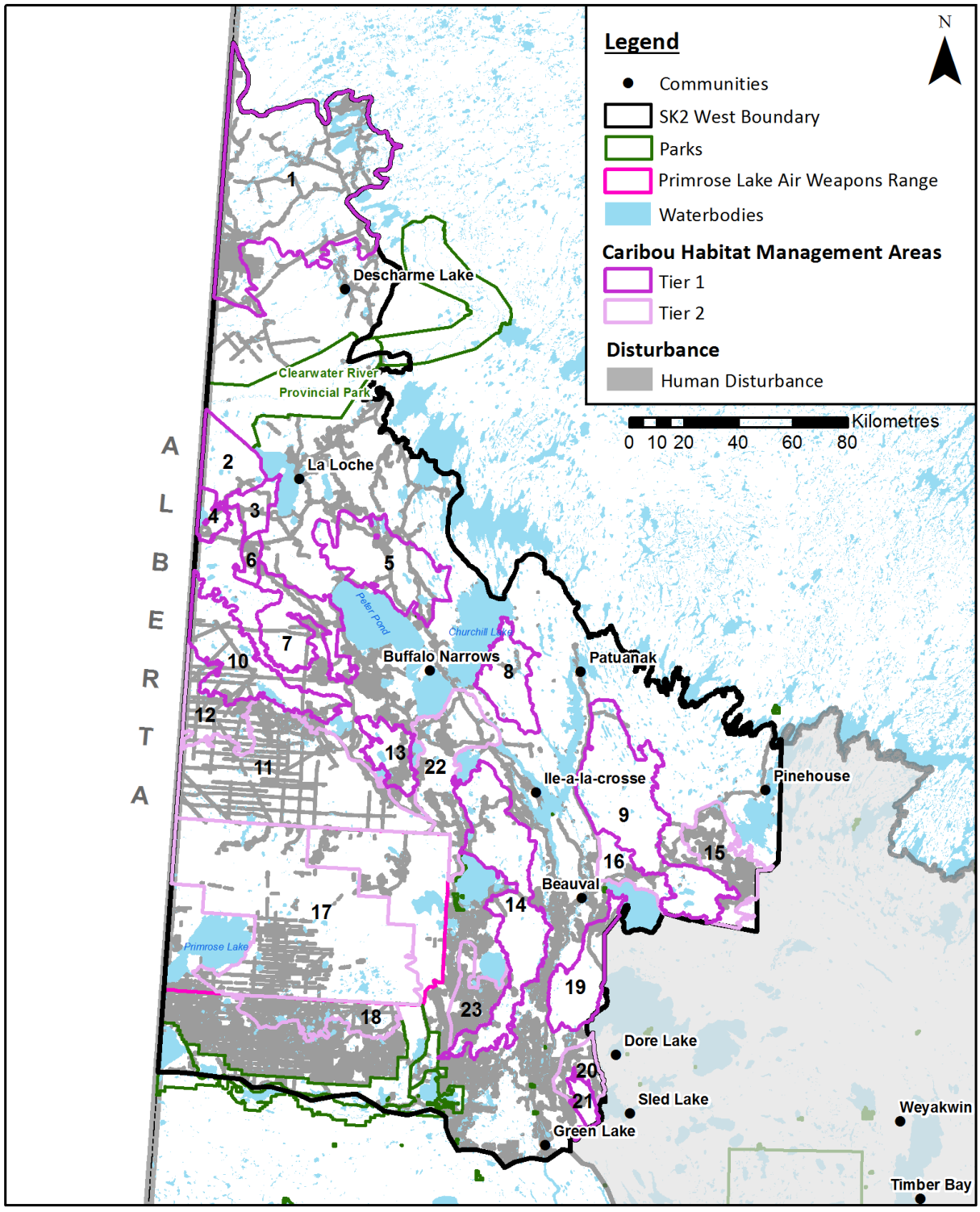

Figure 8. Tier 1 and tier 2 caribou habitat management areas with total human-caused disturbance.

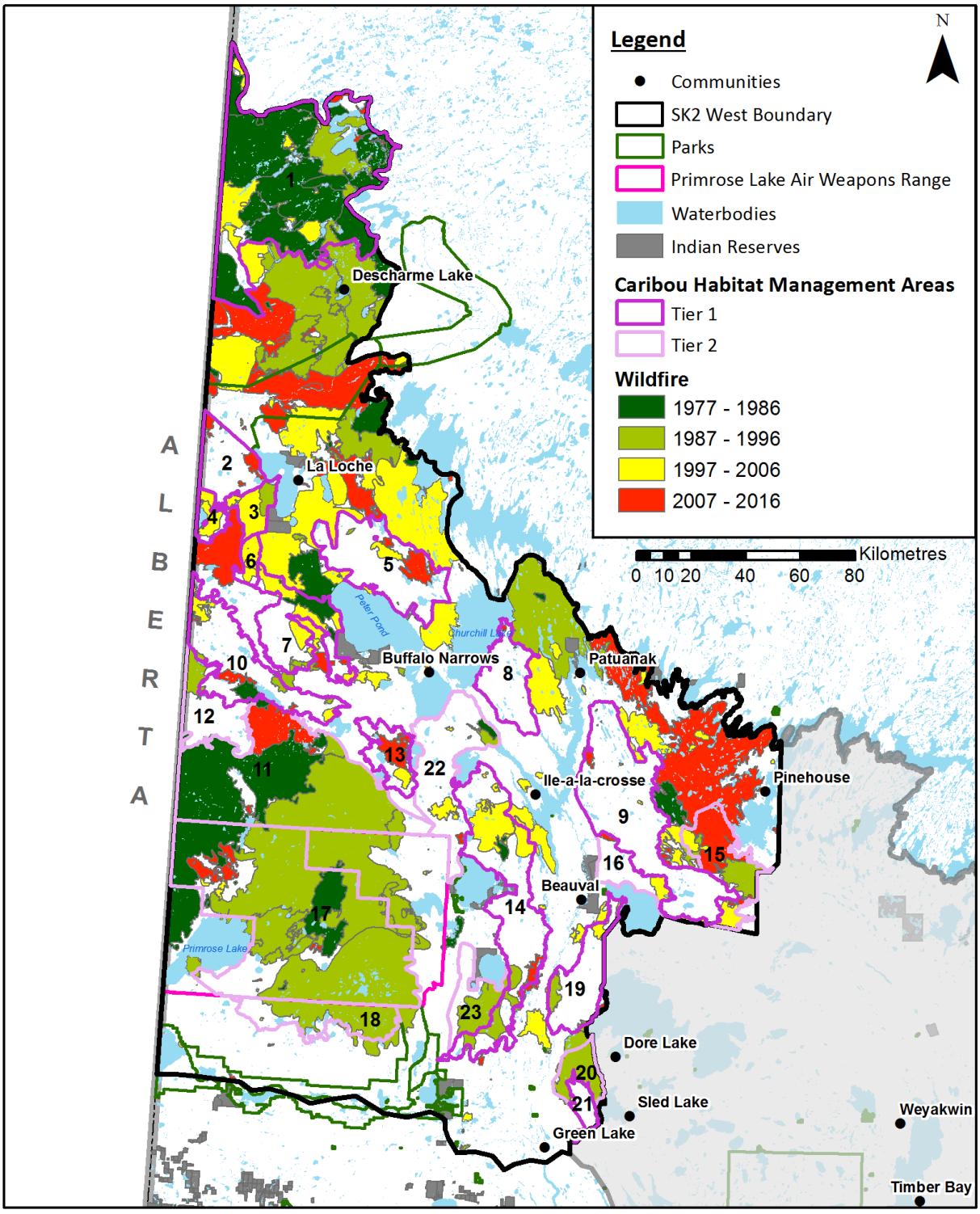

Figure 9. Tier 1 and tier 2 caribou habitat management areas with recent wildfire by decade.

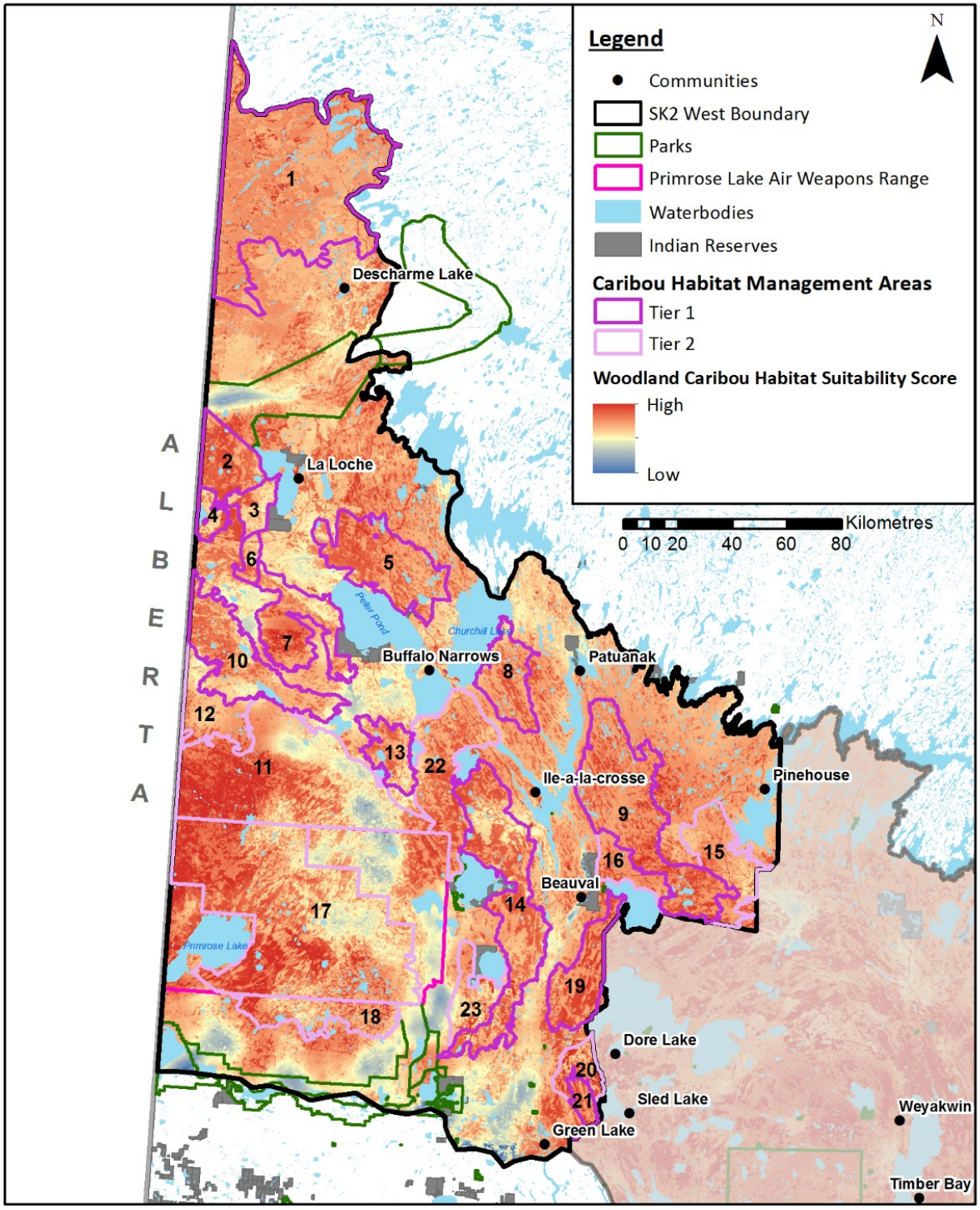

Figure 10. Tier 1 and tier 2 caribou habitat management areas with habitat suitability defined by Indigenous traditional knowledge (Mamun and Brook, 2017).

Table 4. Descriptive summary of SK2 West tier 1 caribou habitat management areas and potential management concerns.

CHMA	Area Description	Potential Management Concerns
1	The Firebag - Patterson area has long-term and current documented caribou use on a landscape of jack pine on sand interspersed with black spruce peatlands. It is currently relatively undisturbed from human activities. It is connected to identified caribou range in Alberta.	Future human disturbance could disrupt caribou movements and distribution, contributing to range retraction. Potential Land Use Concerns: • Uranium exploration and mine development. • Increased highway traffic on Highway #955. • Recreational ATV access.
2	La Loche Northwest area is a mix of basin lakes surrounding a few hills of moderate elevation. These source lakes offer a mix of high-value forage and refuge habitat for caribou. The forest age is mature with conditions favorable to historic use by caribou and refuge given more recent burns adjacent to it. It is connected to identified caribou range in Alberta.	The area is relatively undisturbed and is bounded by Clearwater Provincial Park along its northern boundary. Potential Land Use Concerns: • Future exploration. • Recreational ATV use.
3	La Loche Southwest area contains high-value habitat and documented presence of caribou. It is recovering from fire that occurred in the late 1990s.	Potential Land Use Concerns: • Recreational activity • Residential development along its eastern side
4	Garson Lake East area contains high-value caribou habitat and documented historic use by caribou. The prevailing peatland complex is bounded by a moderate range of hills to the East. The area is recovering from fire that occurred in the late 1990s. It is connected to identified caribou range in Alberta.	The Garson Lake road cuts through the southern fifth of this area. Future human disturbance would reduce the value of this important area for caribou. Potential Land Use Concerns: • Future exploration. • Human activity associated with the community of Garson Lake along its western flank. • Increased highway traffic along the Garson Lake road.
5	The Bear Creek area contains high-value mature habitat and a locally reported history of caribou occupancy. Large numbers of caribou have been reported recently. The area is bounded by La Loche River and Peter Pond Lake on the west, and the Lynvall-Palmbere Lakes to the north.	Highway #955 passes through this area. Future human disturbance would reduce the value of this important area for caribou. Potential Land Use Concerns: • Future mineral exploration. • Human activity associated with the communities of Bear Creek and Buffalo Narrows. • Increased highway traffic along Highway #955.

Table 4. (*continued*). Descriptive summary of SK2 West tier 1 caribou habitat management areas and potential management concerns.

CHMA	Area Description	Potential Management Concerns
6	The Kimowin-Brown Creek area contains moderate and high-value caribou habitat with historic caribou use. It connects #3 and #7b tier 1 areas. The area is recovering from fire in the late 1990s.	The Garson Lake road runs through the northern part of this area. Future human disturbance would reduce the habitat and connectivity value of this area for caribou. Potential Land Use Concerns: • Increased road traffic • Mineral exploration • Recreational access
7	The Dillon Lake area contains high-value habitat, both peatland and jack pine/black spruce ridges. This area has documented current and long-term occupancy of caribou. It is relatively unburned mature forest.	The southern part of the area could see an expansion of human activity off the Vermette Lake road affecting viability of the area for caribou. Potential Land Use Concerns: • Logging in high-value caribou habitat. • Forestry road expansion. • Increased recreational access.
8	Churchill Lake southeast is an undisturbed mix of string bogs and upland habitat in boreal shield transition. The numerous source lakes in this basin that feed Churchill Lake contain high value habitat for caribou and a history of use.	Future human disturbance would reduce the value of this important area for caribou. Potential Land Use Concerns: • Expansion of forest harvesting and roads. • Roads to fishing lakes. • Snowmobile tourism.
9	The Pine River - Tippo Lake area has documented use by caribou, historic presence, and mix of high and moderate value habitat. It transitions from string bogs, small peatlands and jack pine ridges interspersed with numerous source lakes in a rocky landscape east of Lac Isle a La Crosse to predominantly peatland dotted with sandy jack pine ridges southeast to Tippo Lake. It joins a tier one area in SK2 Central.	This tier is bounded on the west by Highway #918 to Patuanak, and has Highway #165 transecting the southeastern portion. Increasing and future human use of the area could result in shrinking use of the area by caribou. Potential Land Use Concerns: • Forestry activity and seasonal forest road development. • Trail development – snowmobile tourism. • Local resource extraction and associated disturbance.
10	The Dillon Lake area contains high-value habitat, both peatland and jack pine/black spruce ridges. This area has documented current and long-term occupancy of caribou. It is relatively unburned mature forest.	The southern part of the area could see an expansion of human activity off the Vermette Lake road affecting viability of the area for caribou. Potential Land Use Concerns: • Logging in high-value caribou habitat. • Forestry road expansion. • Increased recreational access.

Table 4. (*continued*). Descriptive summary of SK2 West tier 1 caribou habitat management areas and potential management concerns.

CHMA	Area Description	Potential Management Concerns
13	Upper Cummins-Niska Lakes area is a mix of high and moderate value habitat and documented historic caribou use. There are forestry roads through the area and a large burn within the past decade.	This area is already impacted by human-caused and natural disturbance. Additional activity could preclude future use of the area by caribou. Potential Land Use Concerns: • Forestry road access. • Additional forestry. • Recreational fishing and local resource use. • Access along Cummins Lake Road (Hwy 903).
14	The Keeley-Kazan corridor is a mix of peatlands, ridges and undulating landscape with both high and moderate value caribou habitats. The area has documented historic caribou use throughout, and current use in some parts.	Forestry activity borders east and west of the corridor in addition to Highway #155. Existing and future movement of caribou east into SK2 Central (Dore-Sled Lake) could cease without addressing disturbance east of the corridor. Potential Land Use Concerns: • Future incursion of forest harvesting and roads into the corridor from east or west. • Fishing, increased residential and recreational development and access on Canoe Lake, Keeley Lake and Kazan Lake. • Trail development – snowmobile tourism. • Future peat harvesting.
19	The Dore Lake West area has a strong complement of high value caribou habitat and long history of caribou use to present. It begins as a peatland along the southwest side of Lac La Plonge, breaking into a series of north-south string bogs interspersed with black spruce-jack pine ridges. The area is mature forest and largely undisturbed by human activity. It matches up with a tier 1 area in SK2 Central.	Future human disturbance would reduce the value of this important area for caribou. Potential Land Use Concerns: • Future forest harvesting adjacent to the west and road access. • Proliferation of resource use eastward from Highway #155 • Snowmobile tourism. • Shoreline development on west side of Dore Lake and southwest side of Lac La Plonge.
21	The Sled Lake West area is a mix of high and moderate value habitat and documented historic use by caribou. It is a series of north-south ridges with string bogs in between. A tier 1 area in SK2 Central meets up south of Sled Lake. A regenerating burn from the late 1980s lies to the north.	There are several winter trails in the area. Its small size, combined with extensive adjacent disturbance, makes it vulnerable to future disturbance. Potential Land Use Concerns: • Reclaiming adjacent disturbance related to forestry and road access. • Recreational access for hunting. • Residential and recreational development on west side of Sled and Little Sled Lakes.

Table 5. Descriptive summary of SK2 West tier 2 caribou habitat management areas and potential management concerns.

CHMA	Area Description	Potential Management Concerns
11	The northern portion of the Primrose Lake Air Weapons Range (PLAWR) has large amounts of high value habitat and historic caribou use. The area is a complex of regenerating burns ranging from the late 1970s to the recent decade. Oil and gas seismic lines exist over about half the area. It is connected to identified caribou range in Alberta.	Recovery to useful caribou habitat after fire is highly achievable. Potential Land Use Concerns: • Forest harvesting and road access.
12	PLAWR North area a mix of moderate and high value habitat and historic and current caribou use. Oil and gas seismic lines exist over about half the area. It is connected to identified caribou range in Alberta.	Recovery to useful caribou habitat is after fire is highly achievable. Potential Land Use Concerns: • Forest harvest.
15	The Masinahikan River area is moderate value caribou habitat with some recent and historic documented use. It was mostly burned in 2015 and is a mosaic of landforms including sandy-gravelly ridges and rounded low-lying hills with string bogs and peatland basin to the west. It is connected to a tier 2 area in SK2 Central.	Increased human disturbance would reduce the value of this area for caribou. Post-cutting targets important caribou foraging areas and results in high forestry trail density to access the sparse wood supply. Potential Land Use Concerns: • Forest harvesting and road access. • Other local resource use and extraction.
16	Lac La Plonge North area contains moderate and some high value habitat and documented historic use by caribou. The area is a mosaic of forest cover and landforms in a gently undulating landscape descending to the north shore of Lac La Plonge. Peatlands exist including some large ones to the north and east.	The area is dissected by Highway #165, and has been subjected to human disturbance over a long period of time. Caribou use of this area could be affected as a result of road and trail access. Potential Land Use Concerns: • Forest harvesting and roads. • Recreational development and access. • Residential development. • Proximity to the settlement of Beauval.
17	The central PLAWR has large amounts of moderate value habitat and historic caribou use. It is a mix of large peatlands, string bogs and fens, and jack pine-black spruce ridges trending to numerous small source lakes to the southeast. The area is predominantly regenerating burns from 1997-2006 and to a lesser degree from 1977-1986. Oil and gas seismic lines influence the southern portion of the area.	Recovery to functional caribou habitat after fire may be achievable. Potential Land Use Concerns: • Active military range. • Oil and gas exploration.

Table 5. (*continued*). Descriptive summary of SK2 West tier 2 caribou habitat management areas and potential management concerns.

CHMA	Area Description	Potential Management Concerns
18	The PLAWR South area contains moderate value habitat and has documented current and historic use by caribou. It is a continuation of the landscape and habitat features of 11 and is part of the same regenerating burns.	The area is threatened by incursion of resource extraction from the south. Potential Land Use Concerns: • Forest harvesting and roads. • Oil and gas exploration. • Recreation and tourism to the south.
20	Sled Lake North area contains moderate value caribou habitat and historic use by caribou. It is a continuation of the landforms and land cover described in tier 1 #21 area. The area is regenerating from burns of the 1980s. It is connected to a tier 2 area in SK2 Central.	Future human disturbance would further reduce the value of this area for caribou. Potential Land Use Concerns: • Numerous seasonal trails. • Existing and future forest harvesting. • Recreational access.
22	Kazan Lake West area contains high value and moderate value habitat and reported historic caribou use. It is a mix of peatlands and levees with several stream and river channels between Peter Pond, Niska and Kazan Lakes. The forest is mature – unburned in recent decades.	Highway #925 to Dillon cuts through northern part of the area. Logging is prevalent closer to the highway and down a narrow corridor to Kazan Lake. Proximity to Buffalo Narrows and local resource use and extraction pressures could prevent future use by caribou. Potential Land Use Concerns: • Future forest harvesting and roads. • Local Resource use. • Recreation and tourism.
23	Keeley Lake West area contains moderate value habitat. Several irregular-shaped peatlands combine with small lakes, black spruce and adjacent uplands.	Logging to the edge of the wettest area has been prevalent. Highway #903 bisects the area north to south, and Highway #904 east to west. Proximity to local resource use and extraction pressures could prevent future use by caribou. Potential Land Use Concerns: • Logging and road access. • Highway traffic. • Local resource use. • Recreational fishing, camping.

Table 6. Descriptive summary of the SK2 West tier 3 caribou habitat management area and potential management concerns.

CHMA[5]	Area Description	Potential Management Concerns
Tier 3	Tier 3 accounts for almost 50 per cent of the SK2 West 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.	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 West northward range retraction is also a concern. <u>Potential Land Use Concerns:</u> • Historical, current and future forest harvesting and road development. • Oil and gas exploration and development. • General transportation, access and utilities. • Recreational access. • Peat harvesting • Mineral exploration.

[5] The remaining areas in SK2 West (approximately 9.8 per cent) not included in tier 1,2 and 3 areas are comprised of Saskatchewan provincial parks, ecological reserves, federal lands (Indian Reserves) and municipal lands (including small parcels of private/leased lands).

Table 7. Area, disturbance, and habitat potential associated with individual caribou habitat management areas within the SK2 West caribou administration unit.

CHMA	Area (km^2)	Per cent of SK2 West	Habitat Potential Class Area (km^2)			Per cent of Individual CHMA Disturbed		
			Low	Moderate	High	Human-caused	Wildfire	Total
TIER 1								
1	3,298	6.8	52	2,348	565	22.0	68.8	90.9
2	492	1.0	20	347	100	4.8	12.0	16.8
3	225	0.5	16	190	17	20.3	74.6	94.9
4	153	0.3	5	104	20	18.1	50.4	68.5
5	1,020	2.1	22	832	103	18.6	10.5	29.0
6	119	0.2	25	71	23	38.2	41.7	79.9
7	746	1.5	70	548	127	22.5	29.2	51.7
8	518	1.1	28	401	69	6.0	0.8	6.7
9	1,631	3.4	30	1,195	315	2.1	1.4	3.5
10	1,000	2.1	97	606	230	22.9	16.5	39.4
13	346	0.7	40	234	58	28.1	21.2	49.3
14	1,552	3.2	83	1,142	275	10.5	25.1	35.6
19	581	1.2	24	44	109	10.6	11.7	22.3
22	135	0.3	4	120	8	35.4	6.6	42.0
Subtotal	11,815	24.4	516	8,583	2,018	$\bar{x}$ = 18.6	$\bar{x}$ = 26.5	$\bar{x}$ = 45.0
TIER 2								
11	2,638	5.5	335	1,737	506	36.6	58.2	94.8
12	531	1.1	69	369	66	47.0	10.4	57.4
15	618	1.3	43	529	41	56.0	40.6	96.7
16	296	0.6	14	262	13	19.6	17.3	36.8
17	3,978	8.2	406	3,082	366	17.0	71.0	88.0
18	611	1.3	98	423	54	73.2	19.7	92.9
20	243	0.5	34	196	11	46.4	49.5	95.9
21	970	2.0	160	604	188	15.1	0.0	15.1
23	385	0.8	82	267	28	80.2	5.9	86.1
Subtotal	10,270	21.3	1,240	7,470	1,273	$\bar{x}$ = 43.5	$\bar{x}$ = 30.3	$\bar{x}$ = 73.7
TIER 3								
Subtotal	21,486	44.5	4,094	10,987	2,052	$\bar{x}$ = 25.5	$\bar{x}$ = 33.6	$\bar{x}$ = 59.1

Table 8. Area and habitat potential associated with Ecological Reserves and Provincial Parks within the SK2 West caribou administration unit

CHMA[6]	Area (km^2)	Per cent of SK2 West	Habitat Potential Class Area (km^2)			Per cent of Individual Area Disturbed		
			Low	Moderate	High	Human-caused	Wildfire	Total
Ecological Reserves								
	1,590	3.3	389	963	140	na	na	na
Provincial Parks								
	2,378	4.9	846	1,081	166	na	na	na

[6] Area not accounted for in this table is comprised of federal lands (e.g., Indian Reserves), municipal lands, and small parcels of private or leased lands.

5.0 APPENDIX D: Determination of Habitat Potential

5.1 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

5.1.1 Forage

Forage value was rated based on the availability of lichen and other plant species, which are palatable to caribou (Thomas and Armbruster, 1996). The categories of forage value were ranked as follows:

1 = low food value for caribou;
2 = moderate food value for caribou; and
3 = high food value for caribou.

5.1.2 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. The categories of refuge value were ranked as follows:

1 = high food value for other ungulates;
2 = moderate food value for other ungulates; and
3 = little food value for other ungulates.

5.1.3 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. The categories of calving and post-calving habitat value were ranked as follows:

1= low value for caribou calving;
2 = moderate value for caribou calving; and
3 = high value for caribou calving.

Overall habitat potential was determined from the sum of the three habitat values of forage, refuge, and calving. Therefore, overall habitat potential values of:

3 = low habitat potential for woodland caribou;

4, 5 and 6 = moderate habitat potential for woodland caribou; and

7, 8, and 9 = high habitat potential for woodland caribou.

The ecosites of the Boreal Plain ecozone and their associated caribou habitat potential ranks are listed in Table 9.

Table 9. Caribou habitat potential of Boreal Plain ecozone ecosites (McLaughlan et al., 2010).

Ecosite	Forage	Refuge	Calving	Overall Habitat Suitability	Habitat Potential
BP1 - June grass - mountain goldenrod grassland: Moderately fresh loamy sand	1	N/A	N/A	0	LOW
BP5 - Trembling aspen / prickly rose / grass: Fresh sand	1	1	1	3	
BP6 - Trembling aspen / beaked hazel / sarsaparilla: Fresh loamy sand	1	1	1	3	
BP7 - Trembling aspen - white birch / sarsaparilla: Fresh loamy sand	1	1	1	3	
BP8 - Trembling aspen - white birch / mountain maple: Fresh sandy clay loam	1	1	1	3	
BP9 - White spruce - trembling aspen / feathermoss: Fresh sand	1	1	1	3	
BP10 - Trembling Aspen - white spruce / feathermoss: Fresh silty loam	1	1	1	3	
BP11 - White birch - white spruce - balsam fir: Fresh sandy clay loam	1	1	1	3	
BP13 - White spruce - balsam fir / feathermoss: Fresh sandy clay loam	1	1	1	3	
BP15 - Balsam poplar - white spruce / feathermoss: Very moist silty loam	1	1	1	3	
BP16 - Balsam poplar - trembling aspen / prickly rose: Fresh clay loam	1	1	1	3	
BP17 - Manitoba maple - balsam poplar / ostrich fern: Moist silty clay loam	1	1	1	3	
BP3 - Jack pine / feathermoss: Moderately fresh loamy sand	1	3	1	5	MODERATE
BP4 - Jack pine - trembling aspen / feathermoss: Moderately fresh sand	1	3	1	5	
BP12 - Jack pine - spruce / feathermoss: Fresh loamy sand	1	3	1	5	
BP14 - Black spruce / Labrador tea / feathermoss: Very moist sandy clay loam	1	3	2	6	
BP18 - Black spruce - tamarack treed swamp: Wet humic organic	1	2	2	5	
BP20 - Labrador tea shrubby bog: Wet fibric organic	2	3	1	6	
BP21 - Graminoid bog: Wet fibric organic	1	2	1	4	
BP22 - Open bog: Wet humic organic	1	3	1	5	
BP23 - Tamarack treed fen: Wet fibric organic	2	2	1	5	
BP24 - Leatherleaf shrubby poor fen: Wet fibric organic	1	2	1	4	
BP25 - Willow shrubby rich fen: Wet humic organic	1	2	1	4	
BP26 - Graminoid fen: Wet humic organic	1	2	1	4	
BP27 - Open fen: Wet fibric organic	1	3	1	5	
BP28 - Seaside arrow-grass marsh: Very moist humic organic	1	2	1	4	
BP2 - Jack pine / lichen: Moderately fresh sand	3	3	1	7	HIGH
BP19 - Black spruce treed bog: Moderately wet fibric organic	2	3	3	8	

6.0 APPENDIX E: Habitat Balance Sheet for Future Scenarios

As part of its range plan guidance, Environment and Climate Change Canada (2016) identified the inclusion of a habitat balance sheet for reporting. The purpose 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 7 is a habitat balance sheet for SK2 West and provides a tabular reporting of the information displayed in scenarios 1 and 2 in Figure 18 of the range plan document. Table 7 provides a detailed breakdown of the current disturbance level reported by the Saskatchewan Ministry of Environment disturbance assessment and the amount of future potential habitat disturbance resulting from scenarios 1 and 2 as described in the range plan document. Scenario 1 projects most-likely forest harvest levels, extensive reclamation of forestry and non-resources related roads, and only reclamation of oil and gas linear features in the northwest portion of SK2 West. Scenario 2 projects most-likely forest harvest levels, extensive reclamation of forestry and non-resources related roads, and extensive reclamation of all oil and gas linear features north of Primrose Lake Air Weapons Range. Table 7 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 disturbance[7]. As disturbed habitat ages beyond 40 years, it moves from the disturbed to the undisturbed category. The total amount of new non-permanent disturbance added to SK2 West as a result of forest harvest is shown in Table 8, as well as the total kilometres of linear feature reclamation.

Figures 11, 12, 13, and 14 show changes in the locations of undisturbed habitat over the 50-year time horizon for which the most-likely scenarios were 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 are shown, as well as the locations of linear feature reclamation. For the purpose of calculating future total disturbance, new wildfire disturbance was considered aspatially (see description in main range plan document for how the amount of fire disturbance was calculated). As such, transitions are tracked in the habitat balance sheet and show the net balance between disturbed and undisturbed habitat.

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

Table 10. Habitat balance summary table resulting from the moderate land use management scenario.

Years Future	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		TOTAL (Non-overlapping new + 10-40 yr. non-permanent disturbance)		New (< 10 year old)		Non-permanent anthropogenic disturbance 10-40 years old (erased by new)		TOTAL	
	per cent	km²	per cent	km²	per cent	km²	per cent	km²	per cent	km²	per cent	km²	per cent	km²
0	**38.8**	**18,729**	**61.2**	**29,598**	4.8	2,297	**20.0**	**9,672**	n/a	n/a	n/a	n/a	36.5	17,629
10	36.3	17,554	63.7	30,773	4.8	2,297	21.0	10,131	1.3	640	24.4	11,789	38.0	18,344
20	43.8	21,184	56.2	27,143	4.8	2,297	20.3	9,806	0.8	392	24.2	11,712	31.1	15,040
30	44.8	21,662	55.2	26,665	4.8	2,297	17.7	8,575	0.7	342	21.8	10,530	32.7	15,793
40	47.6	23,026	52.4	25,301	4.8	2,297	16.4	7,917	0.8	370	20.4	9,844	31.2	15,086
50: Scenario 1	51.8	25,024	48.2	23,303	4.8	2,297	12.2	5,919	0.5	238	16.5	7,979	31.2	15,086
50: Scenario 2	55.1	26,604	44.9	21,723	4.8	2,297	9.0	4,340	0.5	238	13.2	6,399	31.2	15,086

Table 11. Length of non-permanent linear features being removed from the landscape and area of new non-permanent area based disturbance added to the landscape.

Years Future	Length of Reclaimed Linear Features (km)	Length of Oil and Gas Linear Features Reclaimed (km)	New Forest Harvest (km^2)
10	283	0	97
20	1,569	0	115
30	3,540	0	112
40	2,264	0	130
50: Scenario 1	1,586	444	129
50: Scenario 2	1,586	2,810	129

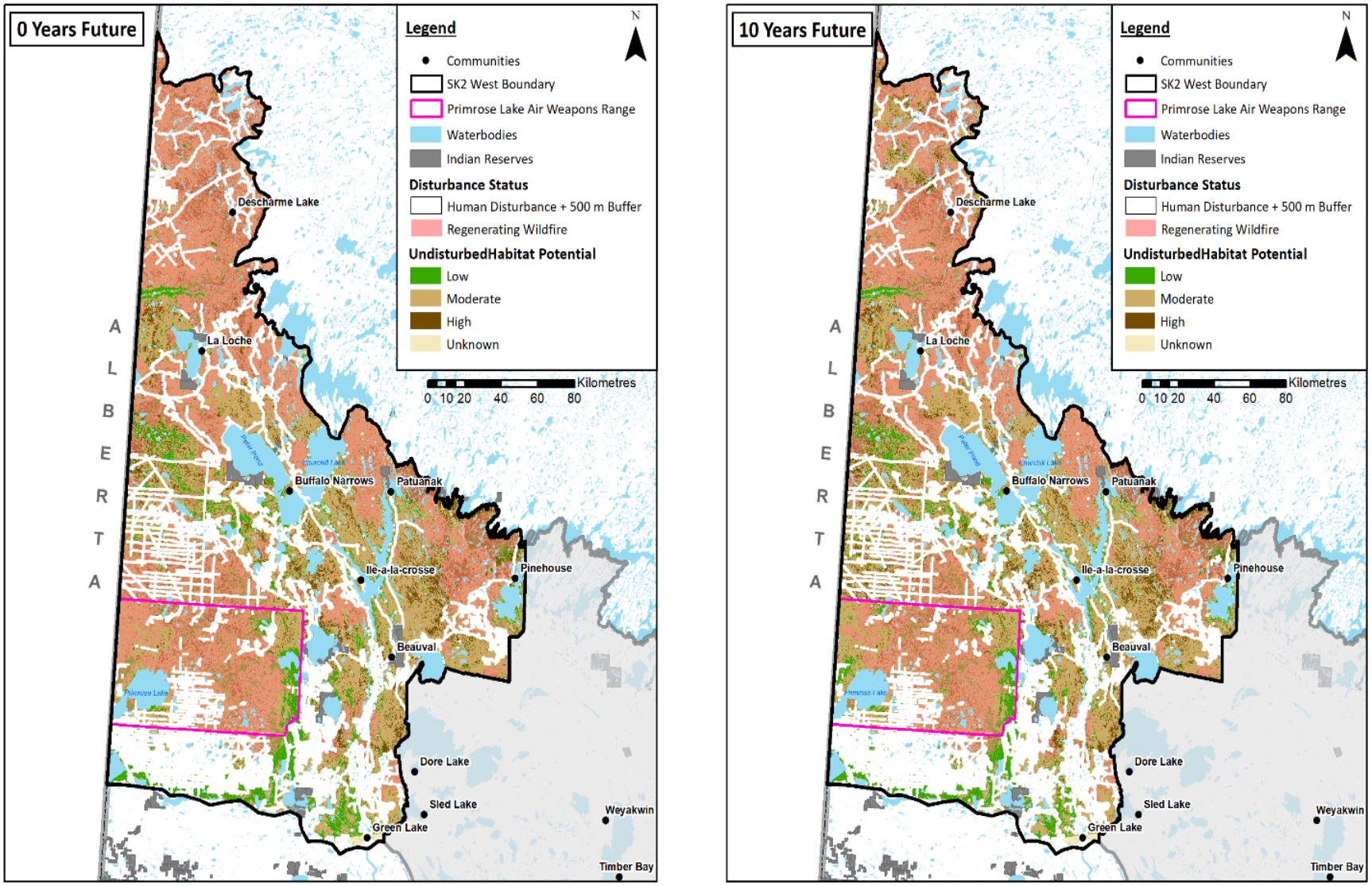

Figure 11. SK2 West projected levels of human-caused disturbance 0 and 10 years into the future.

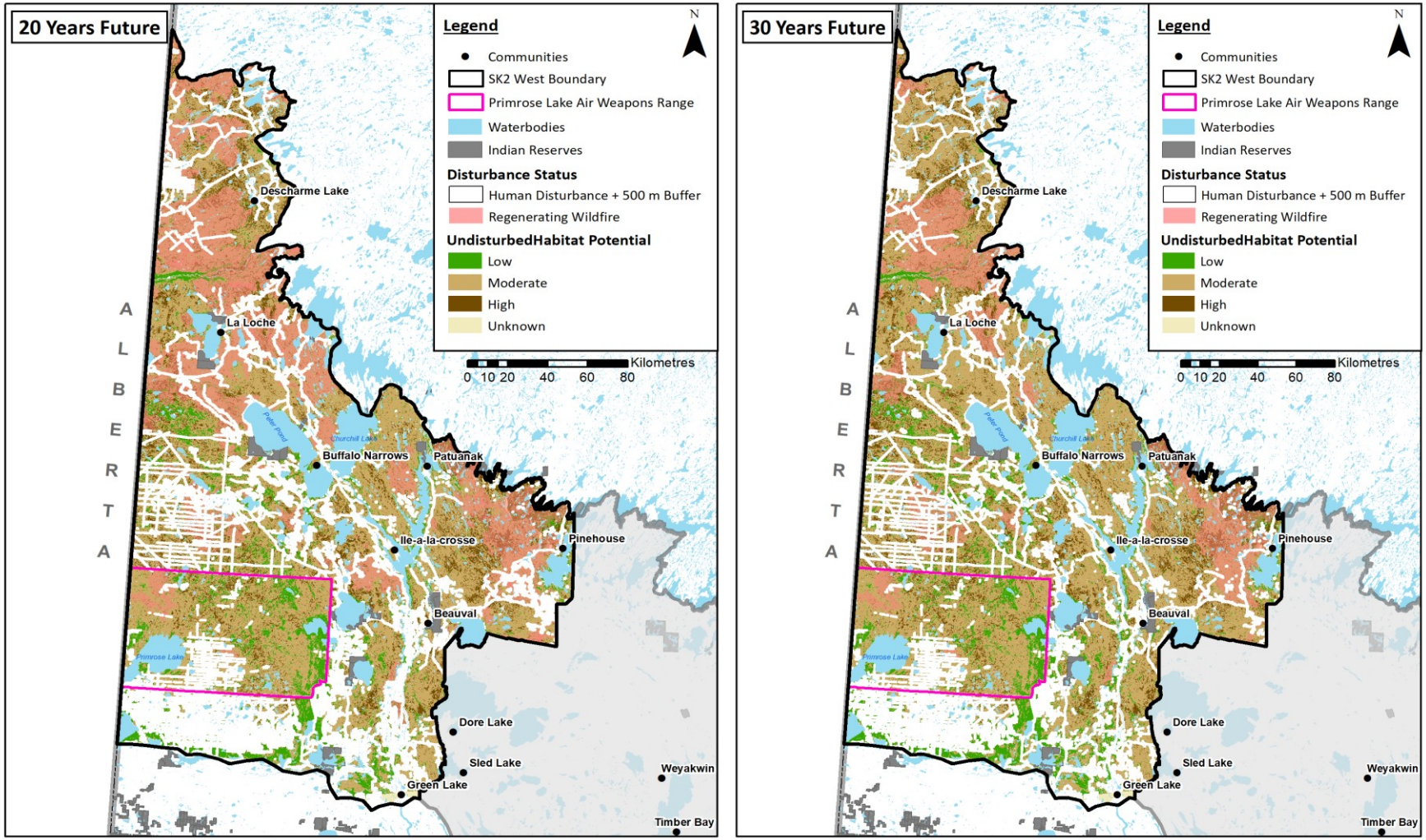

Figure 12. SK2 West projected levels of human-caused disturbance 20 and 30 years into the future.

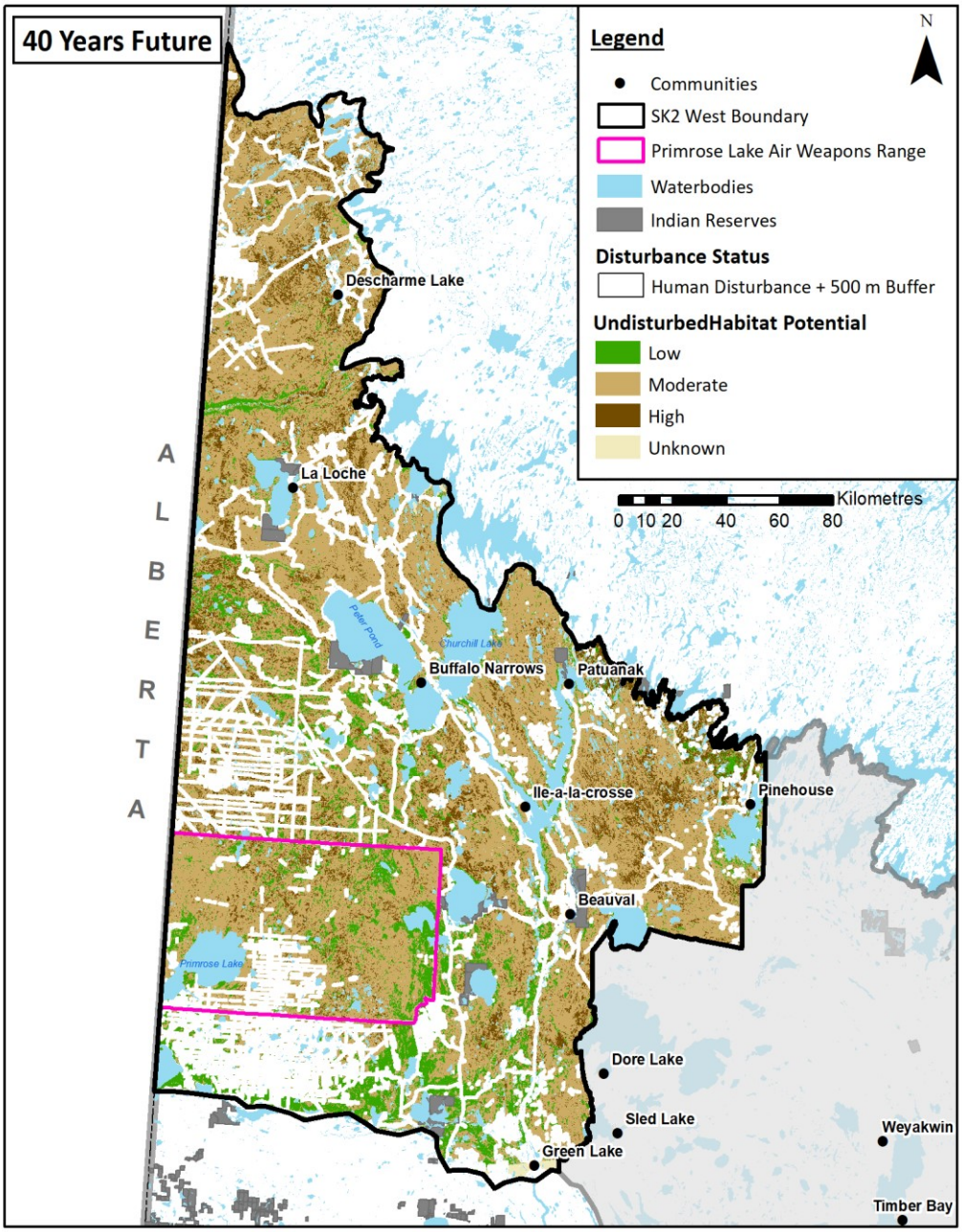

Figure 13. SK2 West projected levels of human-caused disturbance 40 years into the future.

Caribou habitat potential in the SK2 West is shown 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 removed from the landscapes once they reach 40 years of age.

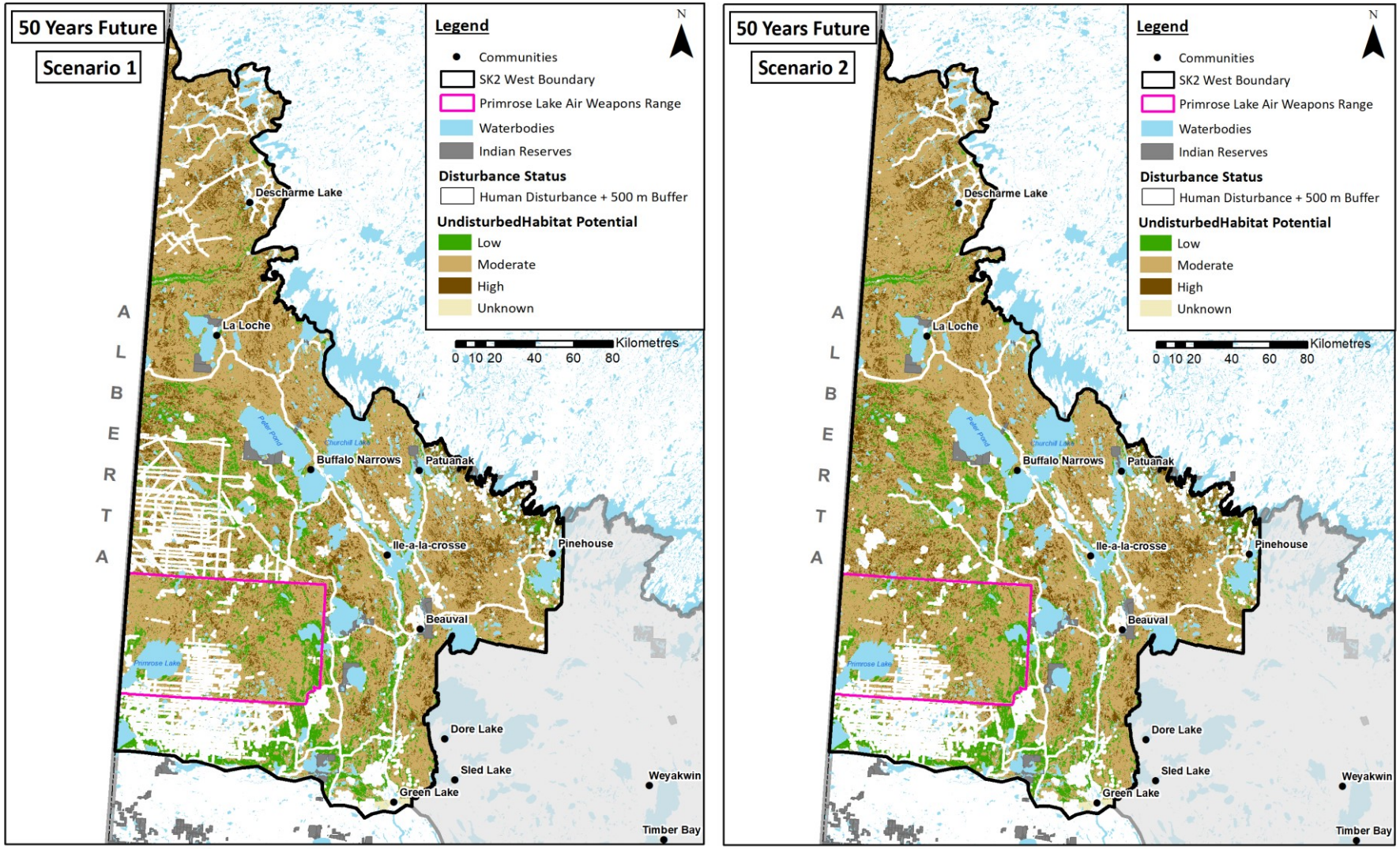

Figure 14. SK2 West projected levels of human-caused disturbance 50 years into the future for scenarios 1 and 2.

7.0 APPENDIX F: Other SK2 West Sensitivity Analyses

7.1 Purpose

This appendix describes methods and results for sensitivity analyses used to support the SK2 West 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 West caribou administration unit.

7.2 Methods

7.2.1 Approach

Scenario analysis allows for 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 West range plan examined major human factors that create or influence the amount and pattern of landscape disturbance in SK2 West. The four major factors examined were:

- forest harvest rate;
- rate of new natural gas development;
- reclamation of forestry and non-resource related linear features; and
- reclamation of oil and gas-related linear features.

Wildfire suppression effectiveness was not included in the management strategies evaluated. 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. Additional fire suppression efforts are not currently considered a viable option to maintain or reduce disturbance levels in the SK2 West.

Other modelling and sensitivity analyses have been conducted as part of the SK2 Central range planning process and so were not modelled in the SK2 West context. It is expected that management actions that were demonstrated to reduce the footprint of forest harvest in SK2 Central, such as natural forest harvest pattern standards and increases in event sizes could also help to reduce disturbance levels in SK2 West (see SK2 Central Range Plan: https://publications.saskatchewan.ca/api/v1/products/101694/formats/112399/download).

7.2.2 Land Use Assumptions

Major assumptions for each land use sector considered in the SK2 West sensitivity analyses are described in Table 12. The location of major land use activities is shown in Figure 15. 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. Any new natural gas development is

likely to occur within and south of Primrose Lake Air Weapons Range. Significant reclamation of oil-related footprints in the north western portion of SK2 West is also currently occurring.

Table 12. Land-use assumptions guiding the SK2 West future scenarios by sector.

Land Use Sector	Assumptions
Forestry	Forestry is expected to remain as one of the dominant land use activities in SK2 West for the coming decades. Rate of forest harvest in SK2 West was one of the key factors that was systematically examined in the sensitivity analyses. Future harvesting will be limited to active forest management areas; minimal to no harvest is expected to occur in the Turnor blocks.
Peat Harvesting	In the past five years, peat harvesting interest in the Saskatchewan Boreal Plain has increased. Several areas in SK2 West 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 has lower mineral potential than the Boreal Shield. Most mineral exploration is expected to be focused in the northern part of SK2 West. Development may occur at Patterson Lake for uranium development. However, the mine footprint is expected to be relatively small and in areas that have already been disturbed as a result of exploration activities. Due to the small footprint this development is not considered in this analysis; however localized effects of developments such as this will be considered through the environmental assessment process.
Oil and Gas Exploration and Development	Existing oil and gas extraction activities are expected to continue in the areas within and south of Primrose Lake Air Weapons Range. Rates of new natural gas development and reclamation of legacy oil and gas roads and seismic lines were two of the key factors that were systematically altered in the sensitivity analyses.
Transportation	SK2 West 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 related to forest harvesting, mineral exploration and oil and gas activities.
Electricity Generation and Transmission	Most power lines currently parallel existing major roads. New major electrical utility transmission corridors are not anticipated.
Settlements	SK2 West 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 West. These activities are anticipated to remain at current levels or increase. The extensive SK2 West road and trail network receives high levels of summer and winter use. Managing future recreational use may be challenging. Effects of changing intensity of recreational activity was not considered in this analysis.

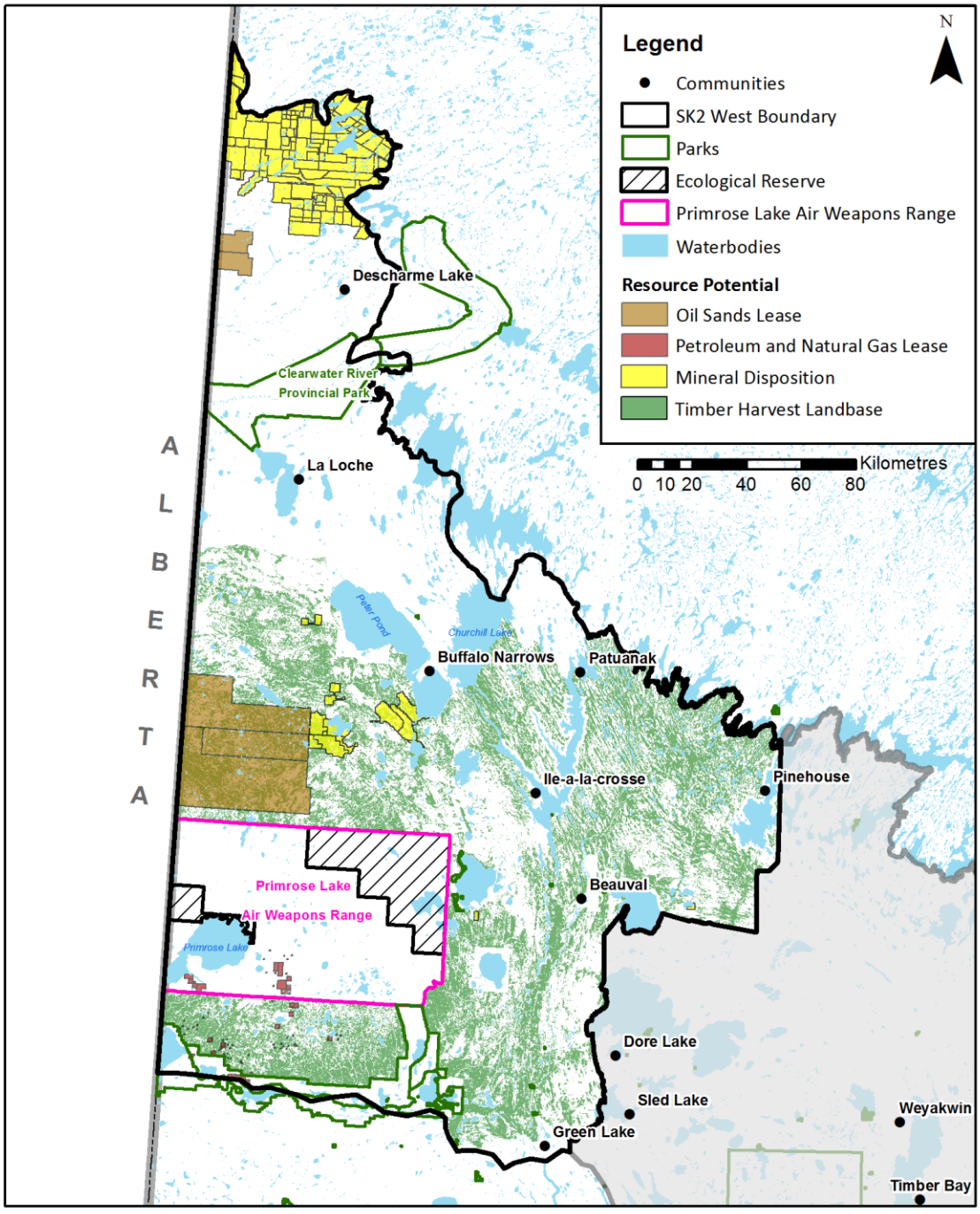

Figure 15. Current land use activities in the SK2 West caribou administration unit.

7.2.3 Sensitivity Analyses

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

- forest harvest levels;
- rate of new natural gas development;
- reclamation of forestry and non-resource related linear features; and
- reclamation of oil and gas-related linear features.

Changes to forest harvest levels and natural gas development will invariably result in changes to disturbance levels in SK2 West. However, the magnitude of change is unknown. Harvest volume schedule is assessed within the SK2 West boundaries. Roads and linear features comprise a significant proportion of the overall human-caused disturbance in SK2 West. Understanding how different road reclamation strategies influence disturbance outcomes is important.

7.2.2.1 Harvest Levels

Two scenarios were developed to assess how changes in harvest levels influences total disturbance levels in SK2 West. Harvest levels were reduced to 20 per cent of the harvest volume schedule for all three of the active forest management agreement areas in the SK2 West (no harvest was expected to occur on the Turnor blocks) and results were compared to the most likely scenarios presented in the main range plan document. Harvest levels were also increased to 100% harvest volume schedule for the three active forest management agreement areas in SK2 West (no harvest was expected to occur on the Turnor blocks).

7.2.2.2 Natural Gas Development

SK2 West contains both oil and gas pools and currently active oil and gas extraction. Peak oil and gas exploration and development in SK2 West occurred between 1990-2011; however, only 19 new wells have been drilled since 2011 and none of them are currently in production and 16 are in the process of being reclaimed. Much of this reduction in natural gas exploration and development has been due to gas market prices; however, this could change in the future. To understand how increases in natural gas development in the future could change disturbance levels, one scenario was examined with historical levels of new natural gas development and compared to a scenario where no new wells were drilled over the 50-year period.

Over the last 50 years, approximately 175 new wells were drilled in SK2 West. Based off of this historical information, an additional 175 new wells were drilled over a 50-year period (35 new wells per decade) and associated access roads established in one scenario. The spatial location of these new wells was limited to within gas pools inside and south of Primrose Lake Air Weapons Range (Figure 16). Disturbance totals were then calculated based on a scenario with no road reclamation and no other

activities occurring on the landscape. These results were then compared to a scenario where no new wells were drilled (i.e., the current situation).

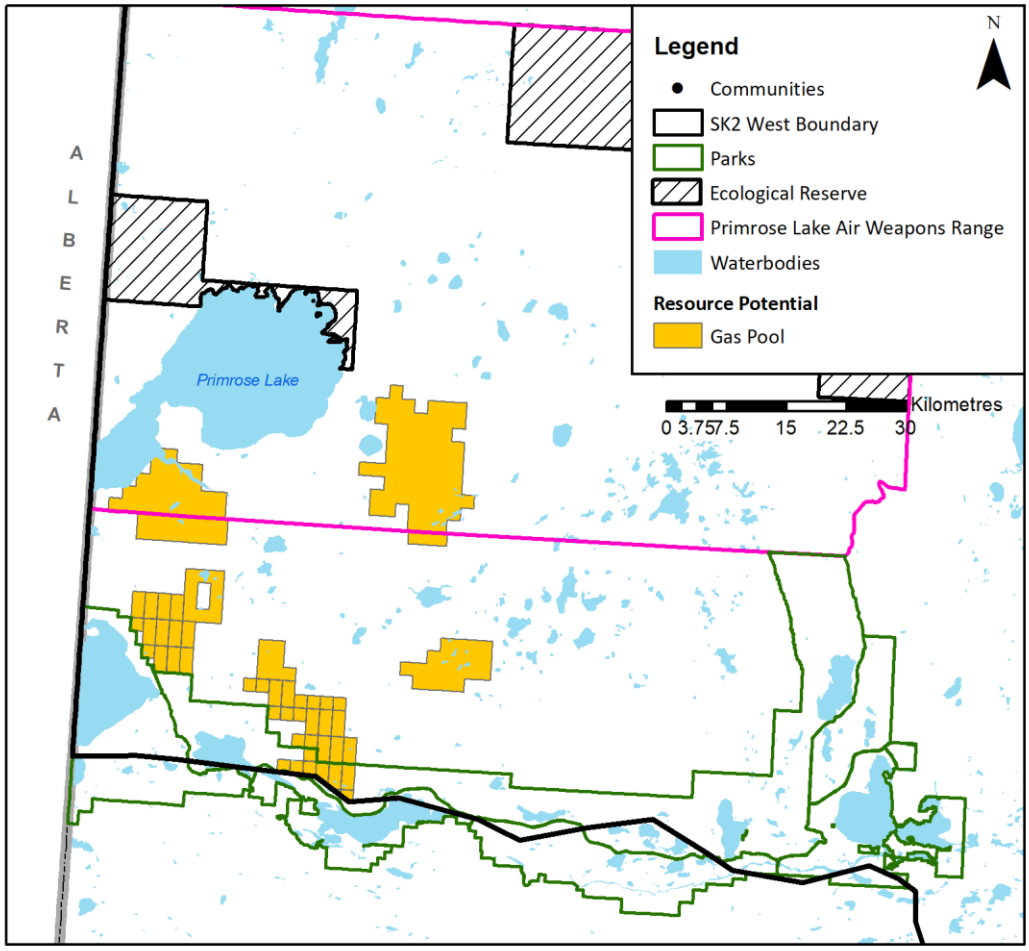

Figure 16. Gas pools in the SK2 West caribou administration unit.

7.2.2.3 Forestry and Non-resource Road Reclamation

Modelling road dynamics was the most challenging part of the spatial analysis. Two factors required consideration: the age/status of existing forestry-related roads and the amount and location of future forestry roads. To approximate the age of existing roads, the non-permanent road layer was intersected with 1977 to 2016 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.

Three scenarios were examined to understand how changing levels of forestry and non-resource road reclamation would influence disturbance levels in SK2 West (Table 13). These scenarios assumed that all reclamation work on these roads starts between 2019 and 2029 and that the roads would be fully restored 40 years after work begins. In scenario 1, all class 2-6 roads were reclaimed by year 50, unless they intersected a new harvest block. In scenario 2, only roads that are currently owned by forest license holders are reclaimed – this is a slightly more conservative reclamation strategy than scenario 1 since no roads that are the responsibility of the Crown would be reclaimed. Scenario 3 has no forestry and non-resource road reclamation occurring over the 50-year period and represents a worst-case scenario (i.e., no current non-permanent road would be removed from the landscape).

Table 13. Reclamation scenarios for forestry-related linear features.

Scenario	Roads Reclaimed	Level of Road Reclamation
1	All class 2-6 roads are reclaimed, unless they intersected a new harvest block.	High
2	Only roads that are owned by Forest Management Area license holders are reclaimed, unless they intersected a new harvest block.	Moderate
3	No forestry and non-resource use roads are reclaimed. All roads that are currently on the landscape remained on the landscape.	None

7.2.2.3 Seismic Line Reclamation

Oil and gas exploration prior to the 2000's in SK2 West has resulted in a footprint of legacy seismic lines between Dillon Lake and Meadow Lake Provincial Park. Post 2000's, oil sands exploration occurred in the northern portion of SK2 West at the former Oil Sands Quest site. As future natural gas wells were modelled within areas that had previously been explored and the oil sands exploration sites are undergoing reclamation, no new seismic or geophysical lines were projected. Additionally, as new and existing natural gas wells were located in the gas pools, the seismic lines south of the Primrose Lake Air Weapons Range were maintained.

Varying levels of reclamation for the existing seismic lines were examined in two different scenarios. Scenario 1 presumed oil and gas-related infrastructure and linear features located in the northwest

portion of SK2 West to be reclaimed by the end of the 50-year scenario period. Scenario 2 saw a smaller footprint reclaimed, as only the footprint in the far northwest was restored.

7.3 Results

Results of the sensitivity analyses are described below. As the outcomes for the three (final scenarios) are presented in the main document, they will not be repeated here.

7.3.1 Harvest Levels

By 50 years into the future, lowered harvest levels (i.e., 20 per cent of the harvest volume schedule for all three forest management agreement areas) resulted in a two per cent reduction in human-caused disturbance levels in SK2 West compared to the most-likely harvest levels. By 50-years into the future, elevated harvest levels (i.e., 100 per cent harvest volume schedule for all three forest management agreement areas) resulted in a 10.5 per cent increase in human-caused disturbance levels in SK2 West compared to the most-likely harvest levels.

7.3.2 Natural Gas Development

After all new wells were added in the areas within and south of Primrose Lake Air Weapons Range, there was less than a one per cent increase in disturbance levels compared to a situation when no new wells are added. Placement of new wells is important and in this scenario, new wells were typically placed within buffers of already disturbed areas (e.g., buffers around existing seismic lines, buffers around forest harvest blocks, buffers around roads) and therefore large increases in total disturbance levels were not observed (see Figure 17 for how placement of new road disturbances can help to control disturbance levels in already disturbed areas). By locating new disturbance within the existing footprint, overall disturbance levels may only incrementally increase however this strategy also results in little to no opportunity for reclamation as roads remain in service.

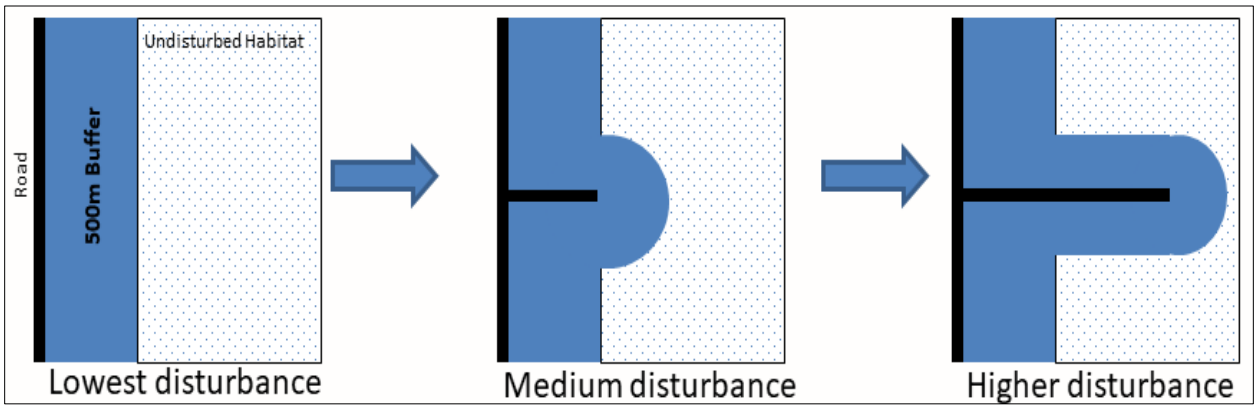

Figure 17. Illustration of how new road placement within buffers can reduce habitat disturbance.

7.3.3 Forestry and Non-resource Road Reclamation

Reclamation of forestry and non-resource related roads resulted in reductions of disturbance levels overall. Figure 18 shows that scenario 1 resulted in the largest reduction in disturbance levels in SK2 West, followed by scenario 2 and there was essentially very little change in disturbance levels compared to current levels under Scenario 3. The benefits from the analyses were not realized until 50 years into the future.

7.3.4 Seismic Line Reclamation

The results of the two scenarios that examined oil and gas seismic line reclamation are presented in the main document and will not be repeated here.

7.4 Summary

- Reduced forest harvest levels resulted in small gains in disturbance reductions in SK2 West.
- New gas development had relatively little effect in increasing disturbance levels in SK2 West. This was likely due to placement of new gas wells within already disturbed areas or 500-m buffers around disturbed areas. While new gas development does not significantly increase disturbance, it does prevent restoration of areas and therefore does not allow for a reduction in disturbance levels.
- Extensive reclamation of oil and gas linear features resulted in relatively large gains in disturbance reduction in SK2 West (not shown in appendices, but results provided in the main range plan document).
- Similar to oil and gas linear feature reclamation, reclamation of forestry and non-resources related road reclamation also significantly reduced disturbance levels in SK2 West.

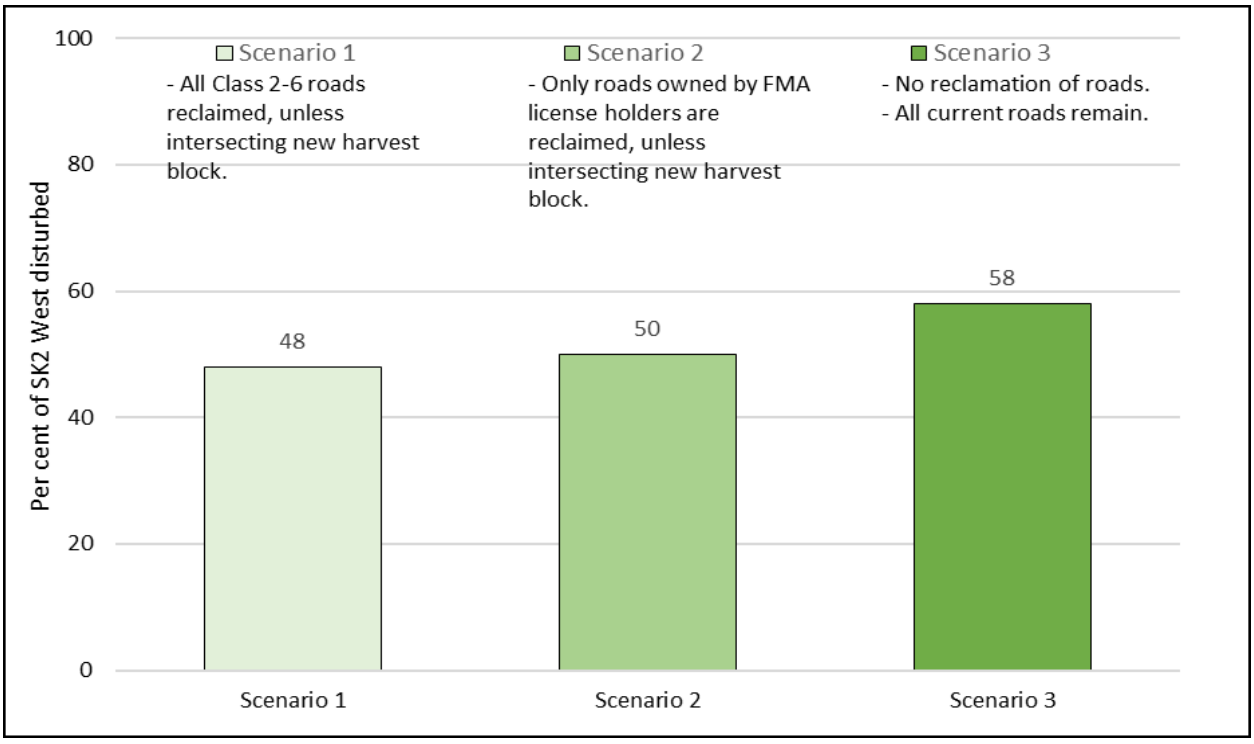

Figure 18. Landscape disturbance levels resulting from the sensitivity analysis associated with forestry and non-resource road reclamation.

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