Range Plan for Woodland Caribou in Saskatchewan – APPENDICES

DRAFT

Boreal Plain Ecozone – SK2 East Caribou Administration Unit

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Executive Summary

This appendix to the *Range Plan for Woodland Caribou in Saskatchewan Boreal Plain Ecozone (SK2 East Caribou Administration Unit)* provides an overview of the efforts taken in the SK2 East range plan to map disturbance and identify important caribou habitat management areas (CHMAs), as well as the process used to select them. It 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 East range include forestry and associated road networks, mineral exploration, sand and gravel extraction, recreational road networks, annual cropland, communities and permanent highways. In addition to human land uses, wildfire is a natural disturbance process, but is not as prevalent as it is in the SK2 Central, and SK2 West caribou administration units.

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 East range in 2017 was approximately 30.5 per cent undisturbed (i.e., 69.5 per cent undisturbed). Human-caused and wildfire disturbance individually accounted for approximately 26.5 per cent and 4.9 per cent of SK2 East 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.

Six caribou habitat management areas (CHMAs) were identified in the SK2 East 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 (i.e., parks and ecological reserves) and federal lands, have the highest proportion of low habitat potential in the SK2 East.

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 East. 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 East could be expected. Reclamation and restoration of linear features, especially legacy seismic lines, had a large impact on reducing disturbance levels in SK2 East. Most of the gains in disturbance reductions in SK2 East could be realized through reclamation of linear features. Other approaches that were not modelled in SK2 East 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 East 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 East Disturbance Mapping

2.1 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 East 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 2017.

2.2.1 Saskatchewan Data Sources

Human and wildfire disturbance mapping data sources used to create the Saskatchewan Ministry of Environment SK2 East 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 East 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 (1978 to 2017), bush roads and seismic lines.
- The wildfire layer includes all wildfire perimeters for the time period 1978 to 2017. 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 East.

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 East 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 East and so were not included in the SK2 East 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 three other datasets were used:
	  ○ The Saskatchewan Ministry of Environment - Technical Resources branch anthropogenic disturbance mapping using FlySask imagery.
	  ○ The Saskatchewan Ministry of Highways & Infrastructure.
	  ○ 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 East, 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 East Saskatchewan disturbance mapping data sources and considerations.

Disturbance Features	Data Source and Considerations
Linear Features *	
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. • Power lines were not included in the linear feature data set. • In the SK2 East, all power lines follow road corridors • Railways are from Saskatchewan Ministry of Highways and Infrastructure.
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, 1978 to 2017. • 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 6,485 km^2 (i.e., 25.6 per cent of SK2 East; Figure 1). Permanent features (settlements, highways and other major roads) account for 1,495 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 4,990 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 East. Approximately 6,656 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 1,751 km in length, while non-permanent linear features account for 5,524 km² of the total linear disturbance.

2.3.1.2 Area-based Features

The footprint of area-based features is 1,751 km². Permanent area-based features (e.g., settlements, recreation areas, airports, etc.) constitute only 534 km² of the total area-based disturbance. Non-permanent features (e.g., forest harvest blocks less than 40 years of age) account for 1,219 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 East; 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).

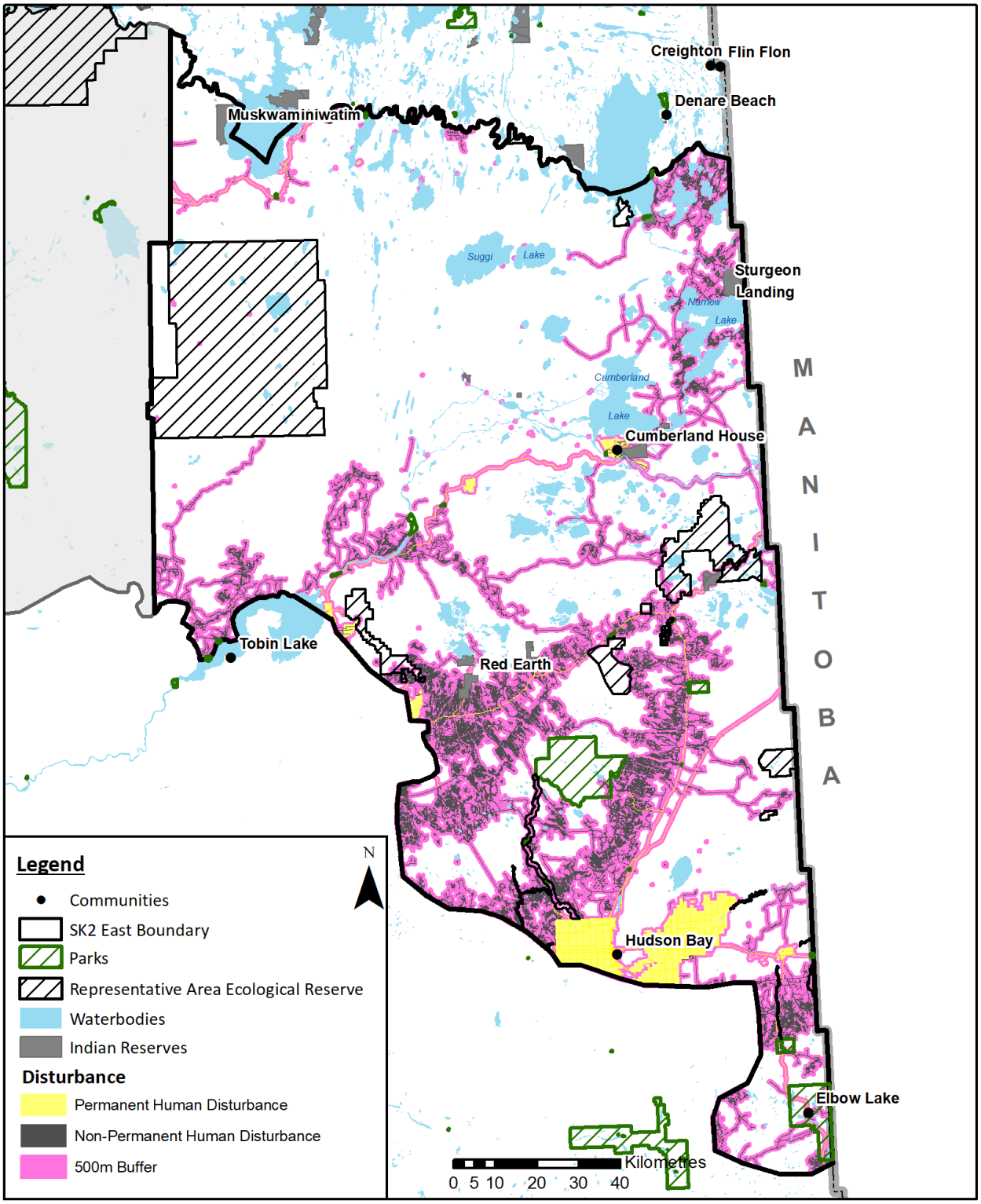

Figure 1. Current human disturbance in the SK2 East caribou administration unit.

Table 2. SK2 East 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 East
Permanent Area-based Features	985	3.9
Permanent Roads	510	2.0
Non-permanent Linear Features	3,680	14.5
Non-permanent Area-based Features	1,311	5.2
TOTAL	6,485	25.6

2.3.3 Wildfire Disturbance

The total area of wildfire disturbance in SK2 East calculated from provincial wildfire perimeter mapping, with waterbodies removed, no human-caused disturbance removed, and allowing for overlap between fires, for the period 1978 to 2017 is 1,824 km^2 (Table 3).

There is considerable overlap between human-caused disturbance and wildfire disturbance. The extent of wildfire as measured between 1978 to 2017 that does not overlap with human-caused disturbance and does not include overlap between fires, and has waterbodies removed is 1,254 km^2 (i.e., Table 4 in main range plan document).

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

Decade	Area Contained within Fire Perimeter Boundaries (km^2)	Area Contained within Fire Perimeter Boundaries (Per cent of SK2 West)
1978 to 1987	868	3.4
1988 to 1997	174	0.7
1998 to 2007	544	2.1
2008 to 2017	238	0.9
40-year TOTAL	1,824	7.2

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 6,485 km^2 or 25.6 per cent of SK2 East. 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 East 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 Environment Canada (2011) methodology identifies that a period of 40 years is required for human-caused or natural disturbance features to no longer be considered in a disturbed condition.

2.4.2 Natural Disturbance

Following Environment Canada (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 Environment Canada (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 7,739 km^2 or 30.5 per cent of SK2 East. Human-caused disturbance accounts for 6,485 km^2 (i.e., 25.6 per cent) of the total non-overlapping disturbance, with wildfire accounting for the remaining 1,254 km^2 (i.e., 4.9 per cent).

3.0 APPENDIX B: Overview of SK2 East Caribou Habitat Management Areas

3.1 Introduction

This appendix describes the rationale and management considerations associated with the caribou habitat management areas (CHMAs) on provincial Crown lands in the SK2 East 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, and 5 describe the area and management considerations for each caribou habitat management area.

3.2 Overview of the Caribou Habitat Management Areas

Section 5.3.1 of the range plan describes the CHMA framework for the SK2 East. Provincial Crown lands within the SK2 East area have been divided into three types of CHMAs: Tier 1, 2 and 3 (Figure 2). 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 East 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 tier 2 areas like CHMA#5 (Figure 2) still have documented 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). Further, this CHMA also represents the continuation of 'The Bog' range (i.e., MB1) that is part of ranges within Manitoba.

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 eight per cent high value habitat potential.

Map overlays of the CHMAs and habitat potential, human-caused disturbance, recent wildfire (1977-2017), and Indigenous traditional knowledge (Mamun and Brook, 2017) are shown in Figures 3-6, 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.

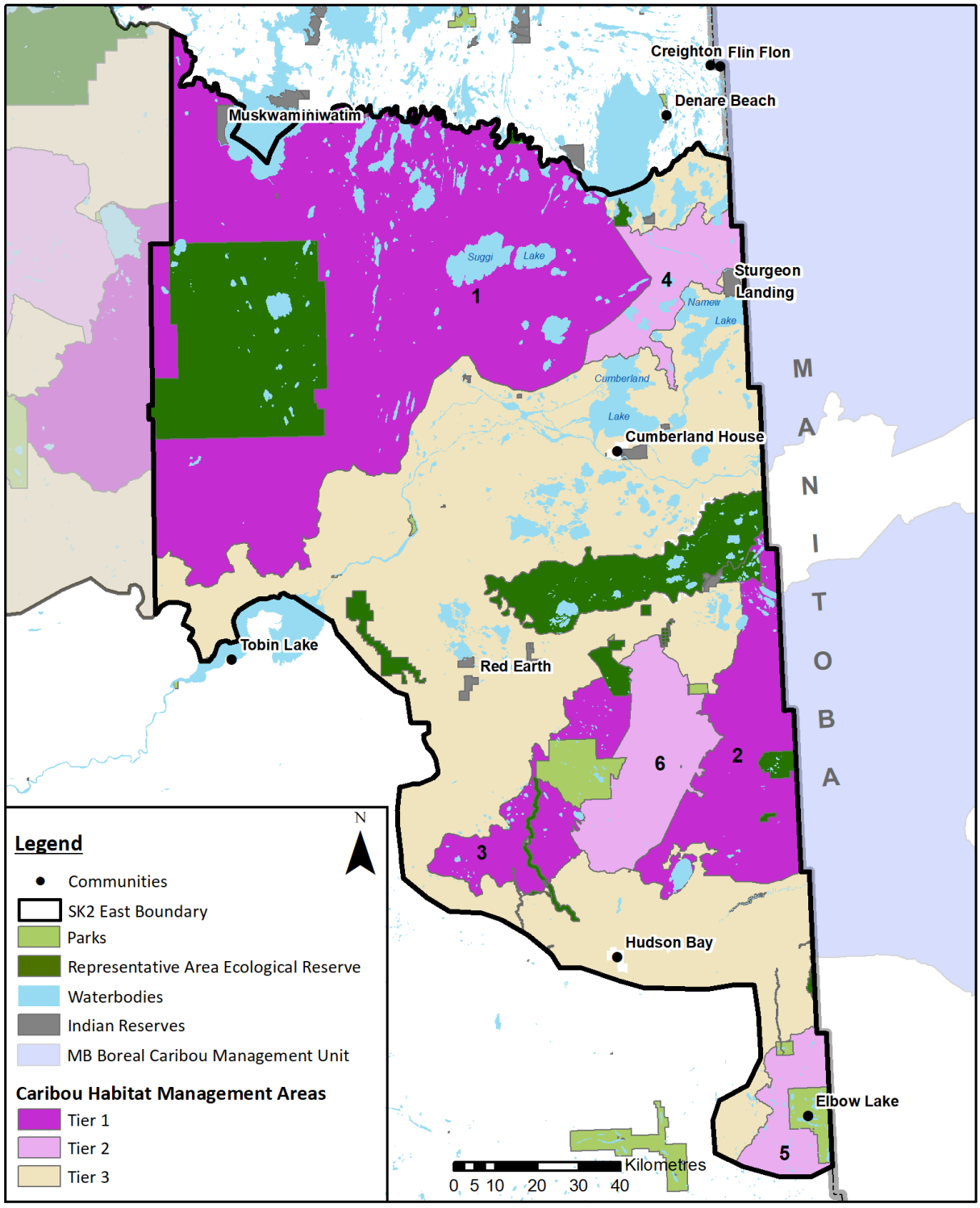

Figure 2. Caribou habitat management areas of the SK2 East caribou administration unit.

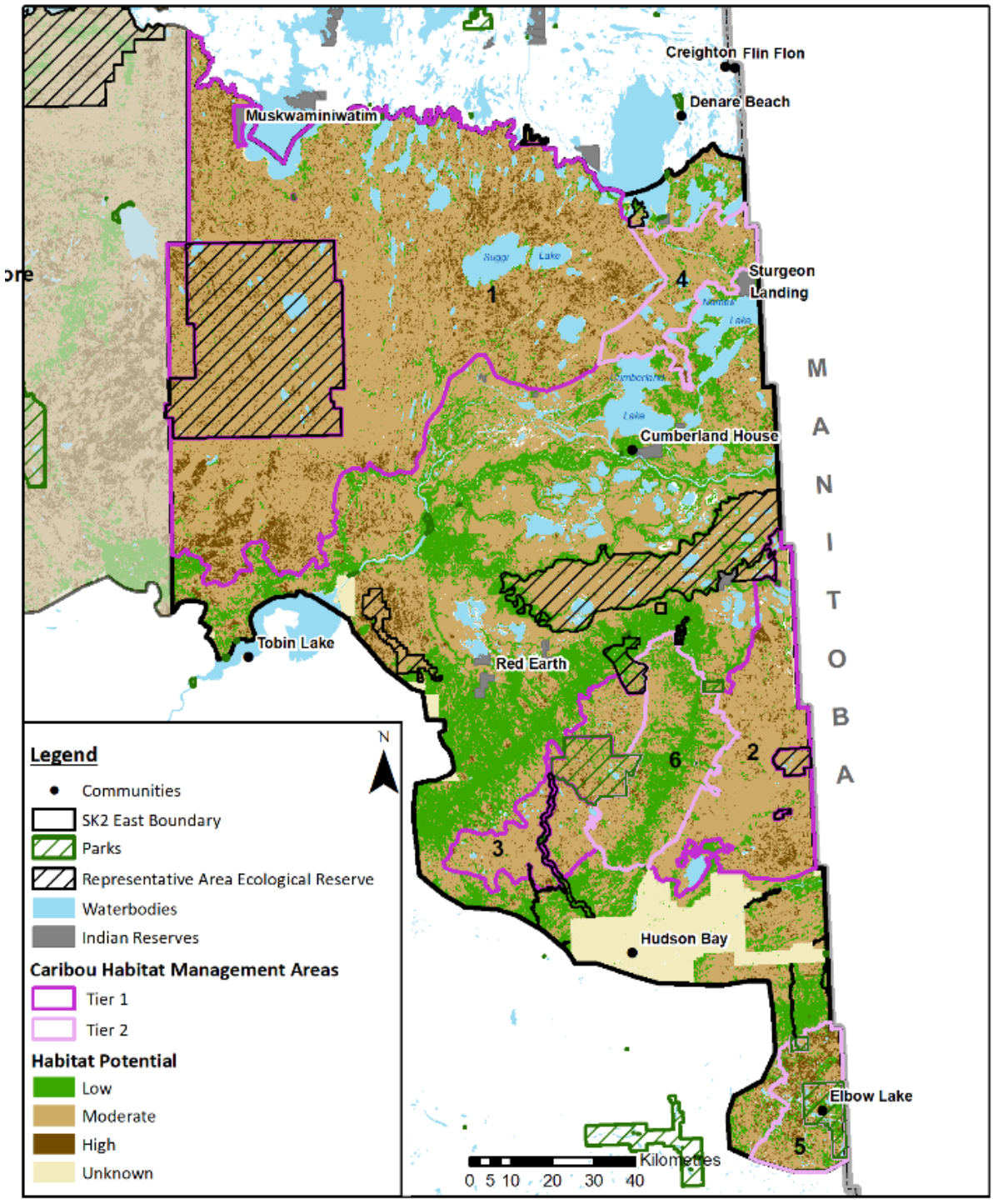

Figure 3. Caribou habitat potential and caribou habitat management areas of the SK2 East caribou administration unit.

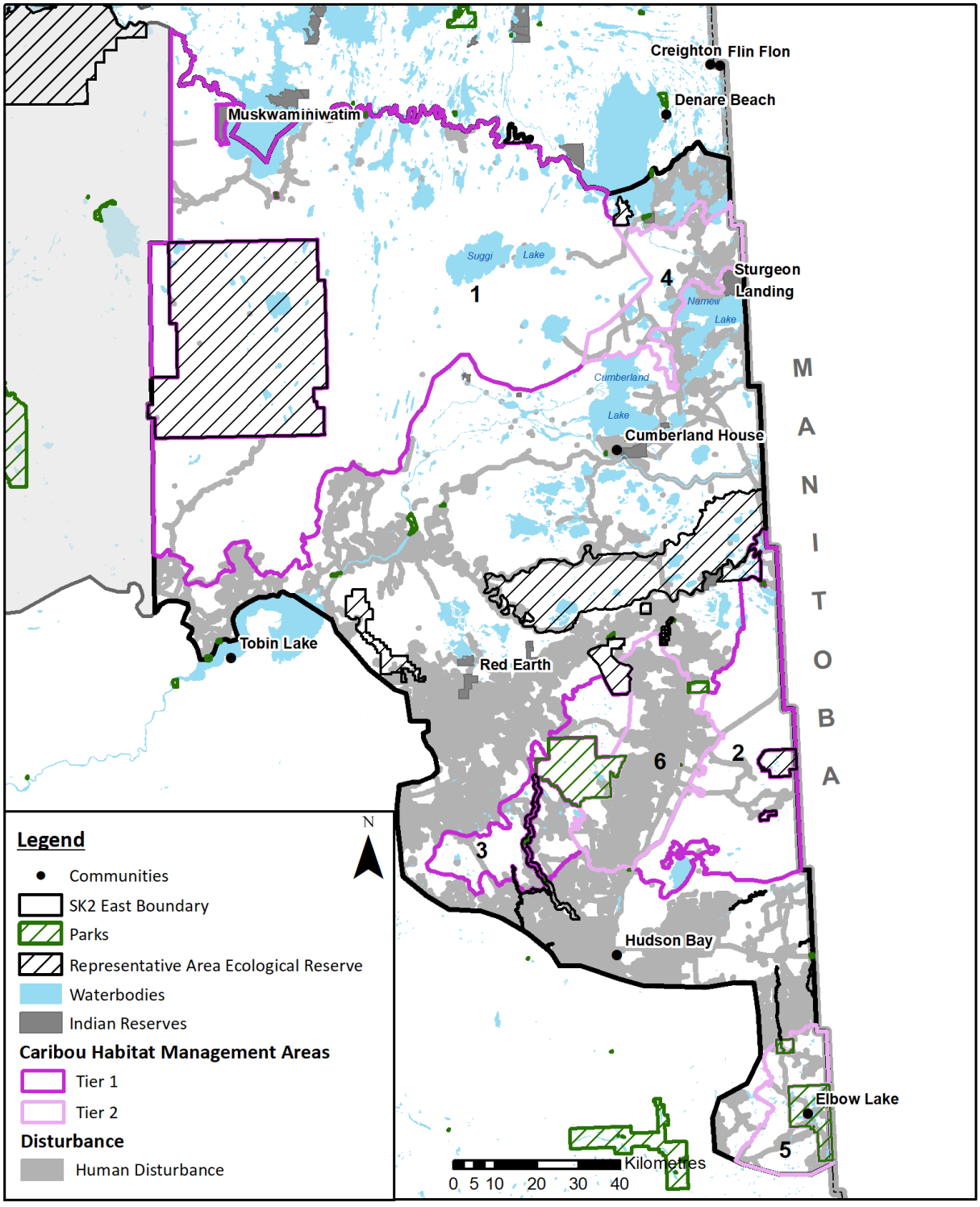

Figure 4. Total human-caused disturbance and caribou habitat management areas of the SK2 East caribou administration unit.

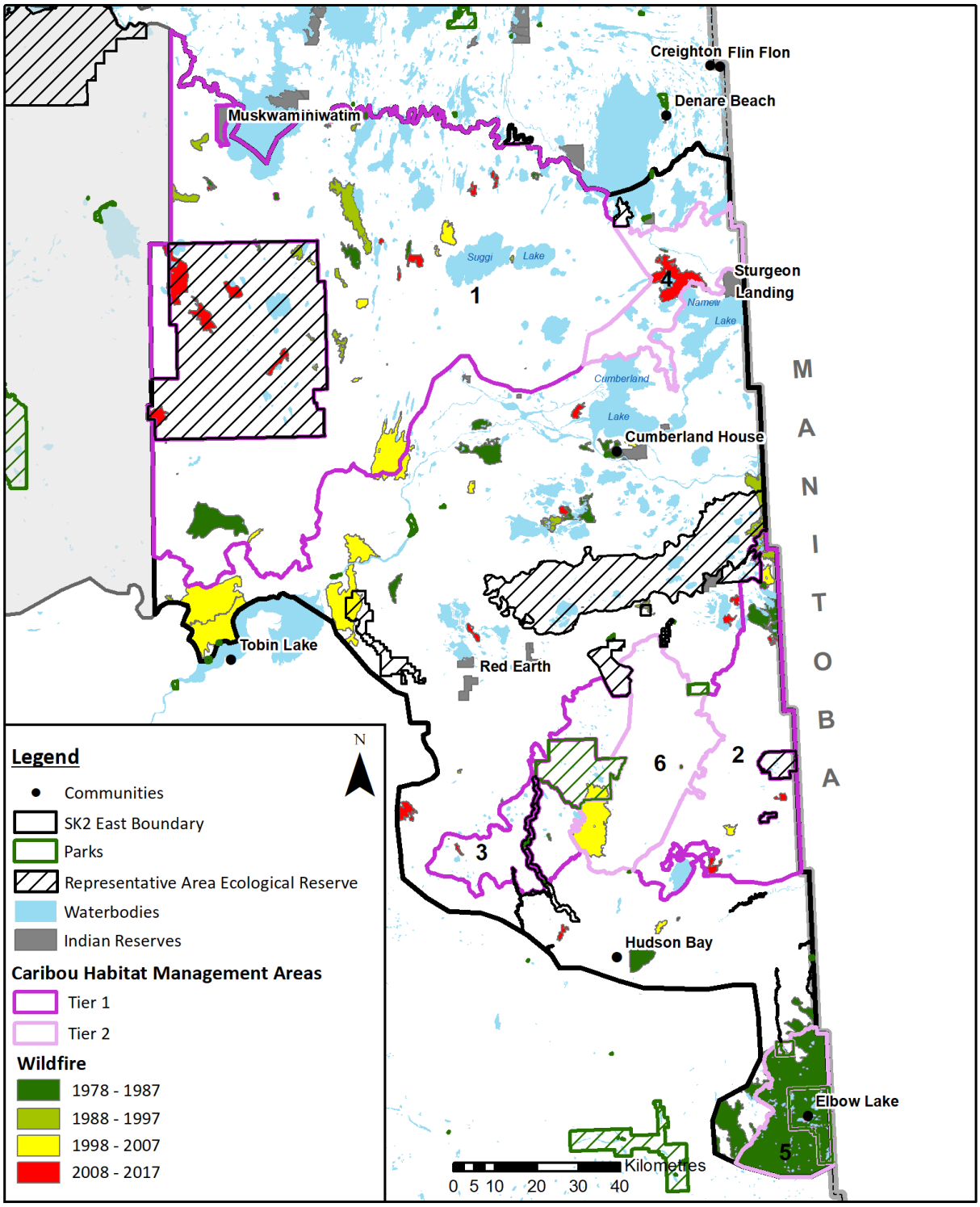

Figure 5. Wildfire disturbance and caribou habitat management areas of the SK2 East caribou administration unit.

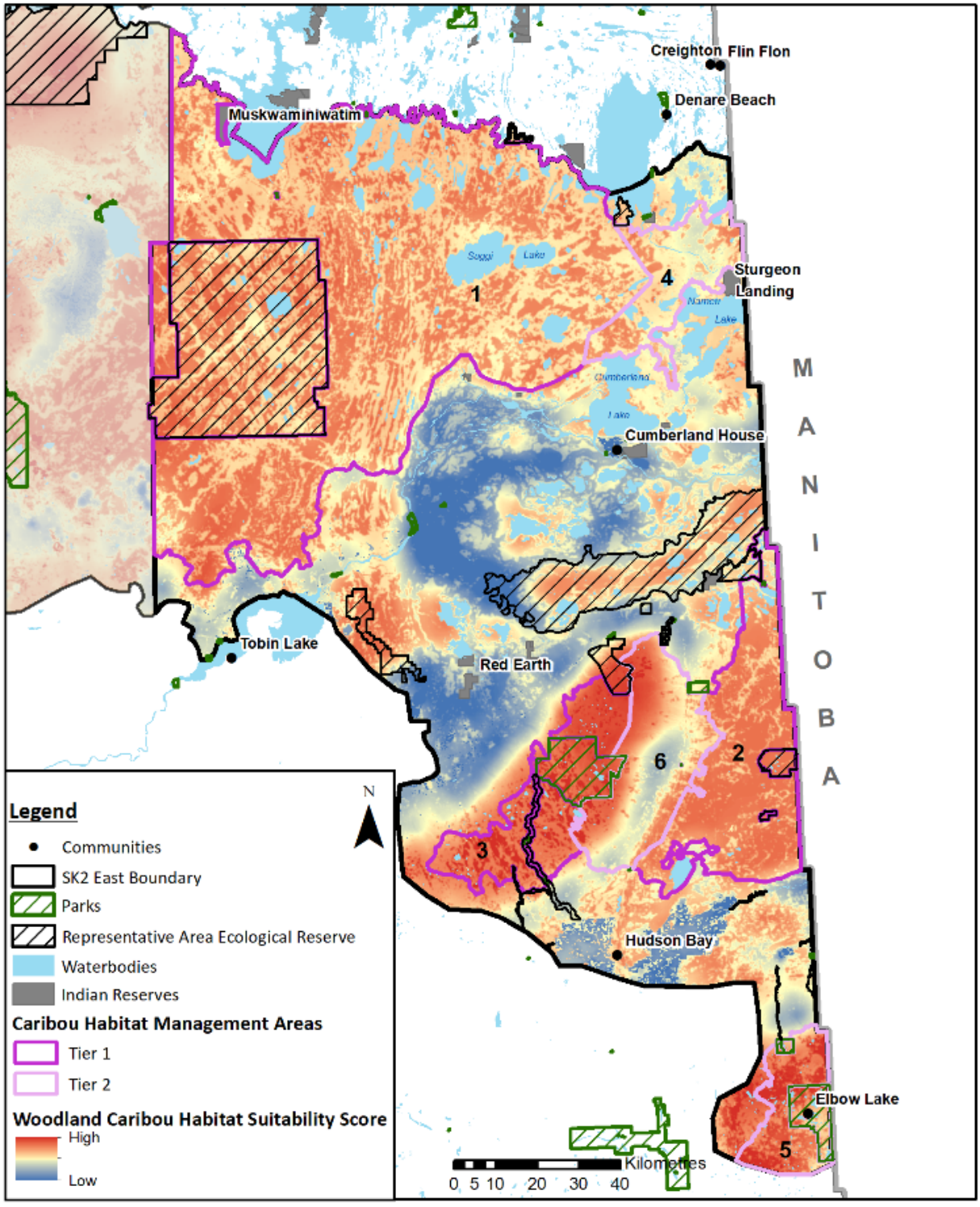

Figure 6. Caribou habitat suitability defined by Indigenous traditional knowledge (Mamun and Brook, 2017) and caribou habitat management areas of the SK2 East caribou administration unit.

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

CHMA	Area Description	Potential Management Concerns
1	The Suggi-Deschambault Lakes complex is well-known for its woodland caribou. The topography varies from large sandy areas and limestone-like dolomite outcrops in the north and west to abundant water-rich lowlands. Numerous sandy jack pine lichen ridges offer ideal winter forage for caribou. It is bounded by the Saskatchewan River Delta on the south, and Big Sandy Lake and Narrow Hills on the west.	Human use and disturbance of this area has been restricted to the northern and western edges. Forestry along the northern, western and eastern portions could result in loss of valuable foraging habitat in the long-term. Mineral exploration currently occurs long the northern edge.
2	The Pasquia Bog is a large water-rich lowland to the east of the Pasquia escarpment. It is well known for caribou and extends into Manitoba. Black spruce muskeg and open bogs dominate the landscape. It is bounded to the north by the Saskatchewan River Delta and to the south by an intrusion of agriculture from boreal forest conversion.	Forestry occurs where conditions permit. There is considerable interest in the exploration and development of peat harvesting operations.
3	The Pasquia Hills area is a perched peatland dominated by black spruce interspersed with narrow ridges of jack pine/black spruce. Many small source lakes are ringed with tamarack. Water spills out of this basin through a few rivers and moderate slopes to the north and west. The slopes are dominated by hardwoods. Caribou have a long reported history of occupancy that continues to the present. Moderate value habitat dominates and is interspersed with high value habitat.	Forest harvesting along the slopes and escarpment that bound this area could isolate caribou from range to the south and southeast. There are several roads and trails throughout that could further fragment critical habitat. Conversion of softwood to hardwood stands after logging could also change the balance among different species to the detriment of caribou.
4	The Sturgeon Weir-Namew area has some recently documented caribou occupancy around and within a chain of source lakes in its southern reaches. The northern half is transected by the Sturgeon-Weir River. Cumberland and Namew Lakes form the southern boundary, Manitoba the eastern, and tier 1 habitat to the west.	Forestry has been prevalent in the northern half for decades although access has mostly been limited to winter trails. The area is somewhat remote with some recreational activity and cottage development where the area contacts Amisk, Maraiche, Saskoba, and Namew Lakes.

Table 4. (*continued*) Descriptive summary of the SK2 East tier caribou habitat management area and potential management concerns.

CHMA	Area Description	Potential Management Concerns
5	The Armit Lake basin is part of a partially dissected peatland in the upper center of the Porcupine Hills. Large stands of black spruce muskeg connect to the Pasquia Bog by strings of mixed black spruce and jack pine. These tracts of forest descend the gradual north slopes of the hills to the lower reaches of meandering creeks, and on to rivers such as the Red Deer and Armit that traverse the Pasquia Bog and feed Red Deer Lake on the Manitoba side. There is a historical record of caribou but no recent sightings.	Agricultural intrusion has been extensive around all sides of the area. Forestry and recreational activity are the main forms of human disturbance that need to be considered.
6	The Pasquia Escarpment ranges from rugged, deeply cleft ravines along the eastern side to long moderately steep slopes to the south. It is considered to be an important connection for caribou between the Pasquia Hills and Pasquia Bog caribou population. There are sufficiently expansive stands of black spruce/jack pine mixed forest on the slopes within this area to foster caribou habitation and movement throughout.	It is heavily disturbed by forestry roads and trails, and logging activity. Hunting and related recreation are also common in this area. Agriculture to the south, a major highway and rail line bordering its eastern side interrupt migration paths for caribou coming and going from the hills.
Tier 3	Tier 3 accounts for almost 50 per cent of the SK2 East area. This large area contains a mix of higher- and lower-value habitats within a broad matrix of moderate - value habitat. 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.	Forest harvesting, road networks and multiple land uses into tier 3 habitat support an increased level of other ungulates and wolves. High densities of linear features has further reduced its value as connective habitat for caribou and potentially increases mortality risk. Areas with undocumented caribou occupancy may also be compromised. Risk of range retraction is also a concern along the southern boundary of the SK2 East. Potential Land Use Concerns: • Historical, current and future forest harvesting and road development. • Mineral exploration and development. • General transportation, access and utilities. • Recreational access. • Peat harvesting

Table 5. The area and disturbance levels associated with habitat potential classes within the caribou habitat management areas of the SK2 East caribou administration unit.

CHMA	Area (km^2)	Per cent of SK2 East	Habitat Potential Class Area (km^2)			Per cent of Individual CHMA Disturbed		
			Low	Moderate	High	Human-caused	Wildfire	Total
TIER 1								
1	7,095	28.0	257.8	5,229	986.3	3.9	4.0	7.9
2	1,471	5.8	80.8	1,165.3	125.1	9.5	4.5	14.0
3	756	3.0	63.2	630.3	43.5	25.8	0.3	26.0
Subtotal	9,322	36.8	401.8	7,024.6	1,154.9	$\bar{x}$ = 6.5	$\bar{x}$ = 3.8	$\bar{x}$ =10.4
TIER 2								
4	648	2.6	62.4	486.7	57.2	31.0	6.3	37.2
5	418	1.7	81.2	225	99.8	27.8	69.6	97.3
6	975	3.8	406.8	524.8	40.8	75.0	5.1	80.1
Subtotal	2,041	8.1	550.5	1,236.4	197.7	$\bar{x}$ = 51.4	$\bar{x}$ = 18.7	$\bar{x}$ = 70.1
TIER 3								
Subtotal	10,401	41.0	3,809.3	5,053.5	301.1	$\bar{x}$ = 41.4	$\bar{x}$ = 2.9	$\bar{x}$ = 44.3
Representative Area Ecological Reserves								
	3,032	12.0	307.4	2,401.8	173.9	na	na	na
Provincial Parks								
	383	1.5	82.0	239.2	37.5	na	na	na

5.0 APPENDIX C: 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
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 6.

Table 6. 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 D: 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 East 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 scenario 1 with extensive reclamation. Scenario 1 projects moderate and increasing forest harvest levels with extensive reclamation of forestry and non-resources related roads. Table 7 reports on the amount of disturbed and undisturbed habitat at decadal periods, with disturbed habitat further stratified into permanent human-caused disturbance, non-permanent human-caused disturbance, fire disturbance and total disturbance[5]. 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 East as a result of forest harvest is shown in Table 8, as well as the total kilometres of linear feature reclamation.

Figures 7, 8, and 9 show changes in the locations of undisturbed habitat over the 50-year time horizon for which the moderate harvest 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 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.

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

Table 7. 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	**69.5**	**17,599**	**30.5**	**7,739**	**5.9**	**1,495**	**19.7**	**4,990**	n/a	n/a	n/a	n/a	4.9	1,254
10	70.5	17,876	29.5	7,462	6.3	1,591	19.8	5,013	2.8	717	17.0	4,296	3.8	955
20	69.9	17,714	30.1	7,624	6.4	1,618	19.9	5,034	2.8	720	17.0	4,314	4.3	1,096
30	70.8	17,937	29.2	7,401	6.5	1,634	19.4	4,920	2.6	667	16.8	4,253	3.9	986
40	69.4	17,594	30.6	7,744	6.5	1,655	20.6	5,228	2.3	582	18.3	4,646	4.0	1,022
50	72.3	18,318	27.7	7,020	6.7	1,685	17.8	4,503	2.3	573	15.5	3,930	4.0	1,022

Table 8. 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)	New Non-Renewable Resource Extraction (km^2)	New Forest Harvest (km^2)
10	812	8.8	340.0
20	1,696.5	3.1	326.8
30	3,082.7	5.1	322.8
40	3,308.8	8.4	321.9
50	4,008.8	9.5	337.8

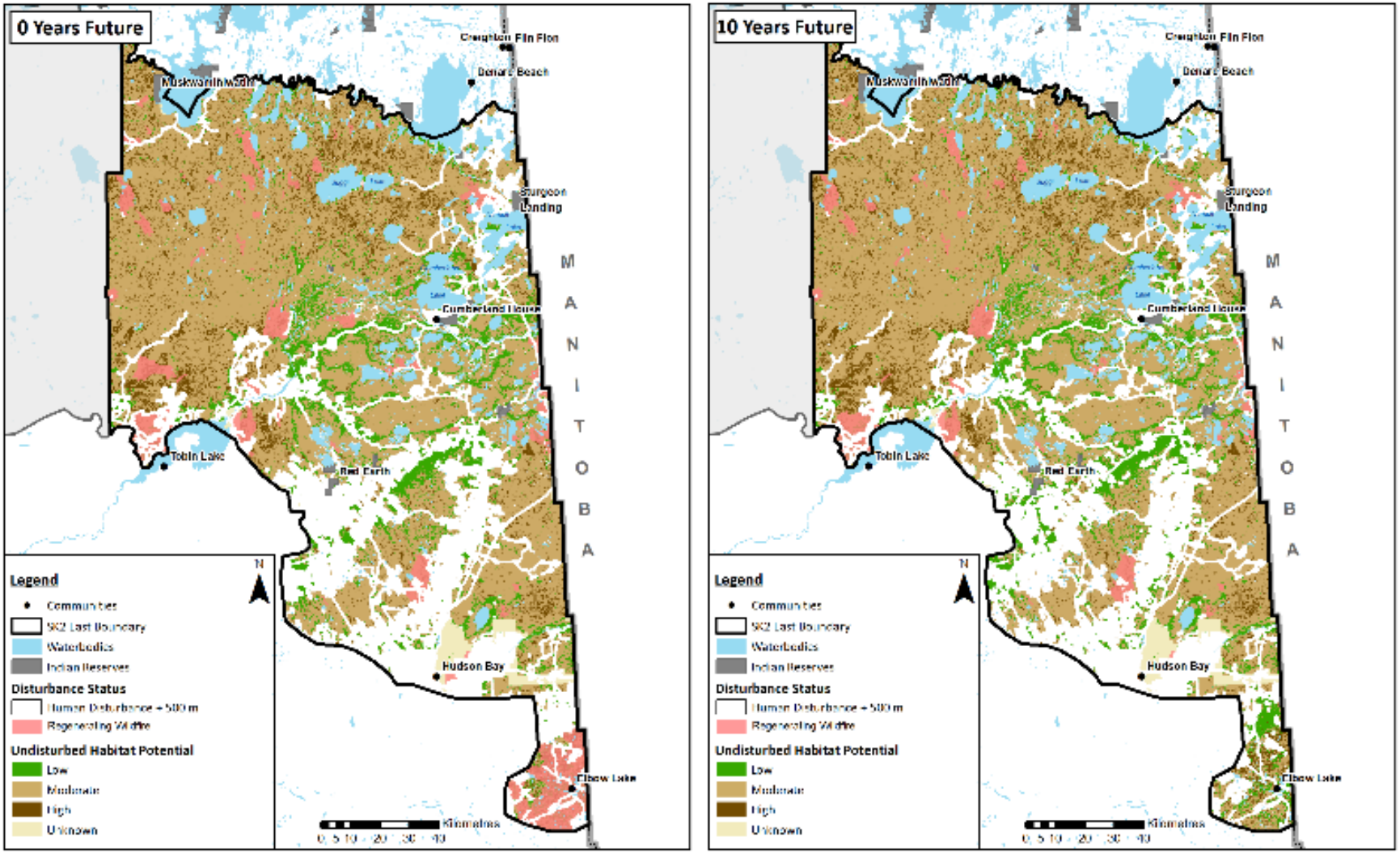

Figure 7. Projected levels of human-caused disturbance 0 and 10 years into the future in the SK2 East caribou administration unit.

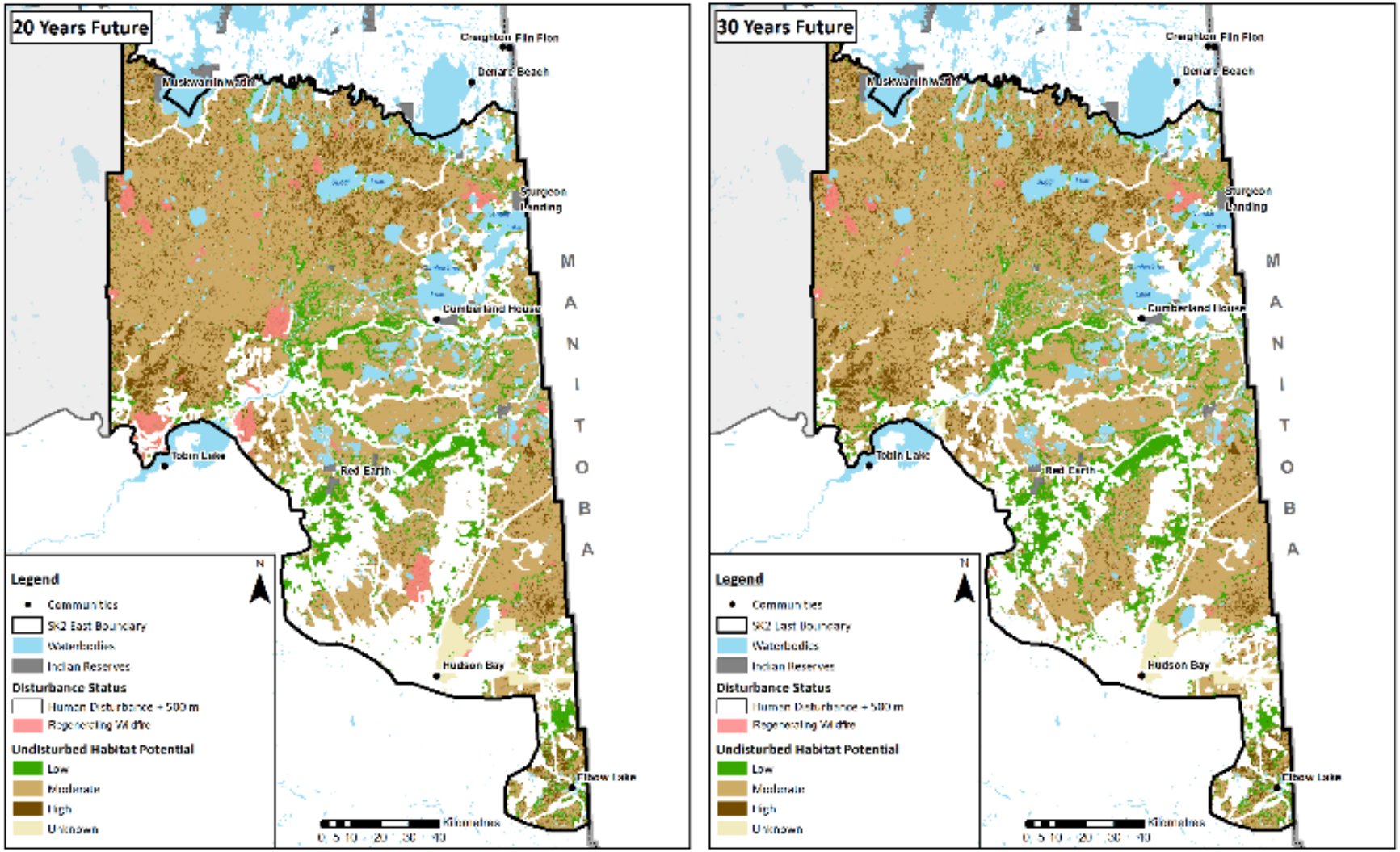

Figure 8. Projected levels of human-caused disturbance 20 and 30 years into the future in the SK2 East caribou administration unit.

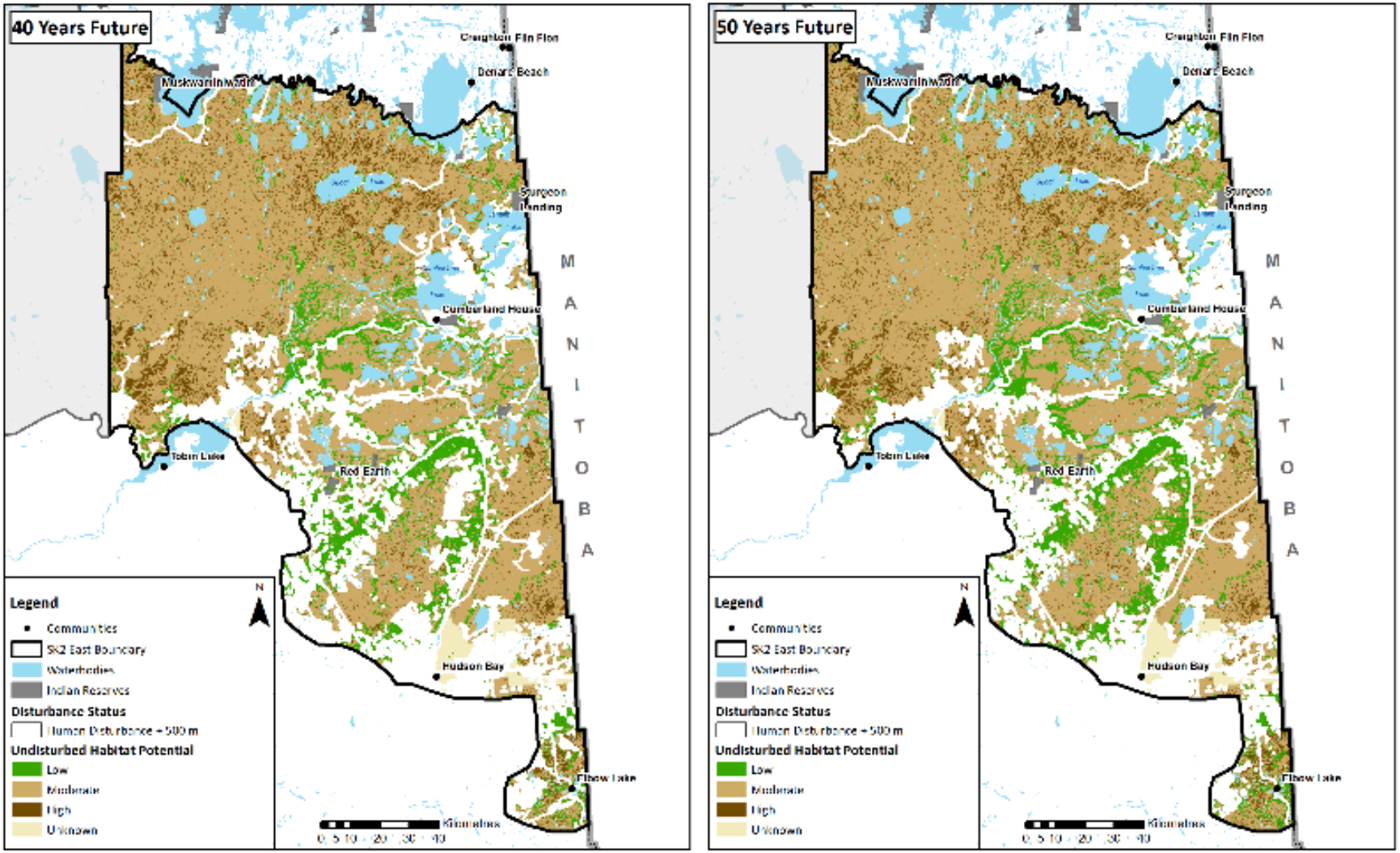

Figure 9. Projected levels of human-caused disturbance 40 and 50 years into the future in the SK2 East caribou administration unit.

7.0 APPENDIX E: Other SK2 East Sensitivity Analyses

7.1 Purpose

This appendix describes methods and results for sensitivity analyses used to support the SK2 East 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 East 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 East range plan examined major human factors that create or influence the amount and pattern of landscape disturbance in SK2 East. The three major factors examined were:

- forest harvest rate;
- rate of new mineral development; and
- reclamation of forestry and non-resource 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 East especially given how small an area is typically affected by wildfire.

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 East 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 East (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 East sensitivity analyses are described in Table 9. The location of major mineral, peat, and petroleum dispositions and leases is shown in Figure 10. The location of future forest harvesting will occur on the productive forest land base (shown in green in Figure 11), with specific locations determined through detailed forest estate modelling. The locations

of future mineral developments are expected to occur in the high mineral resource assessment category[1] areas in the northern portion of SK2 East (Figure 10).

Table 9. Land-use assumptions guiding the SK2 East future scenarios by sector.

Land Use Sector	Assumptions
Forestry	Forestry is expected to remain as one of the dominant land use activities in SK2 East for the coming decades. Rate of forest harvest in SK2 East 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 East are currently under harvest lease or have been identified for peat exploration. Our scenarios assume that most of the areas currently identified as current or 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 ecozone. Most mineral exploration interest is assumed to continue to be focused in the northern part of SK2 East.
Transportation	SK2 East has a well-developed all-season road network, including several paved highways and a rail line. 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, and mineral exploration and development.
Electricity Generation and Transmission	Most power lines currently parallel existing major roads. New major electrical utility transmission corridors are not anticipated.
Settlements	SK2 East 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 East. These activities are anticipated to remain at current levels or increase. The extensive SK2 East 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.

[1] This data shows the mineral potential areas of Saskatchewan. The methodologies used to determine the ranking system of low to high mineral potential areas define 6 as being high mineral potential and 1 as being low (Saskatchewan Geological Survey, 2021)

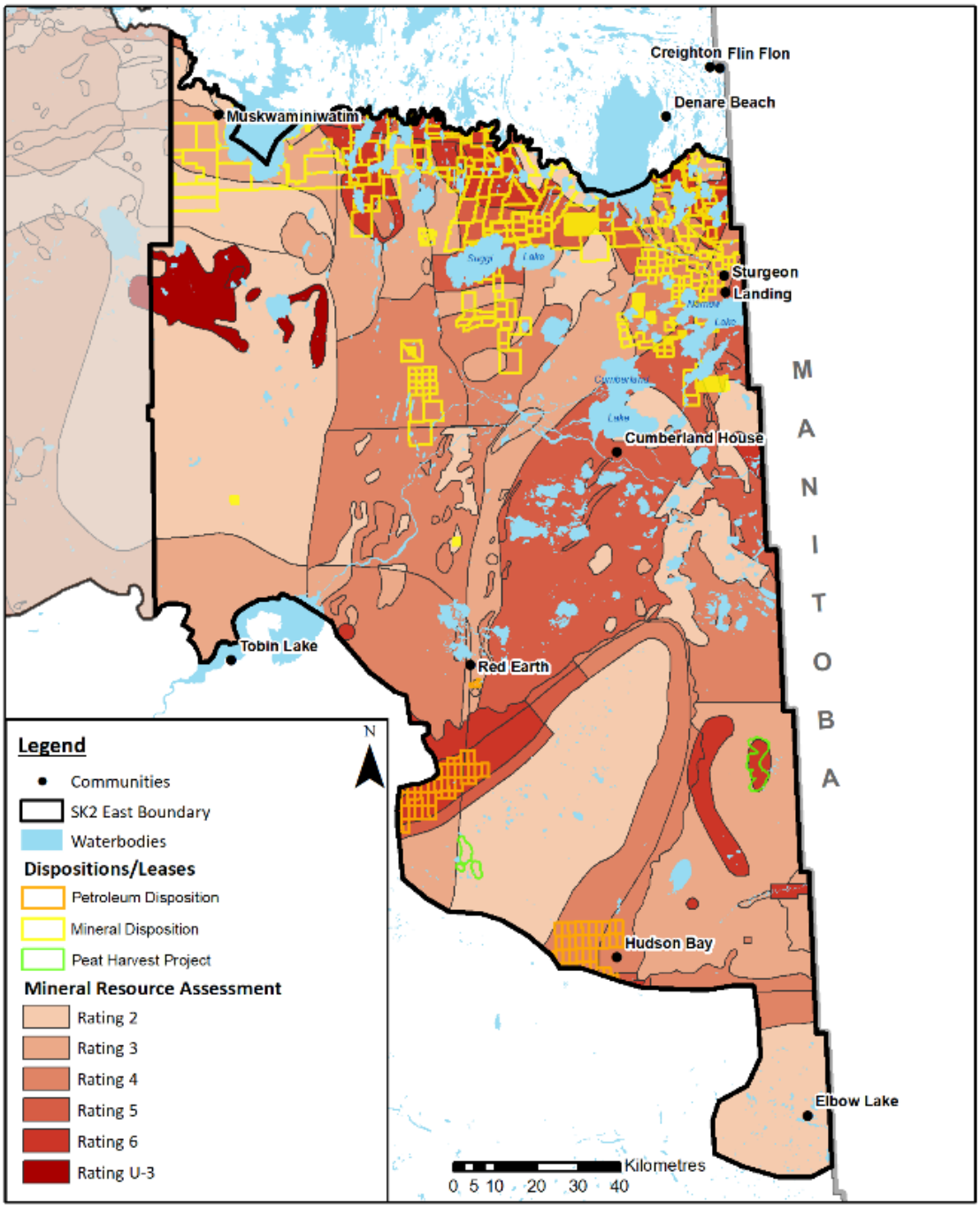

Figure 10. Current mineral, peat, and petroleum dispositions and leases in the SK2 East caribou administration unit.

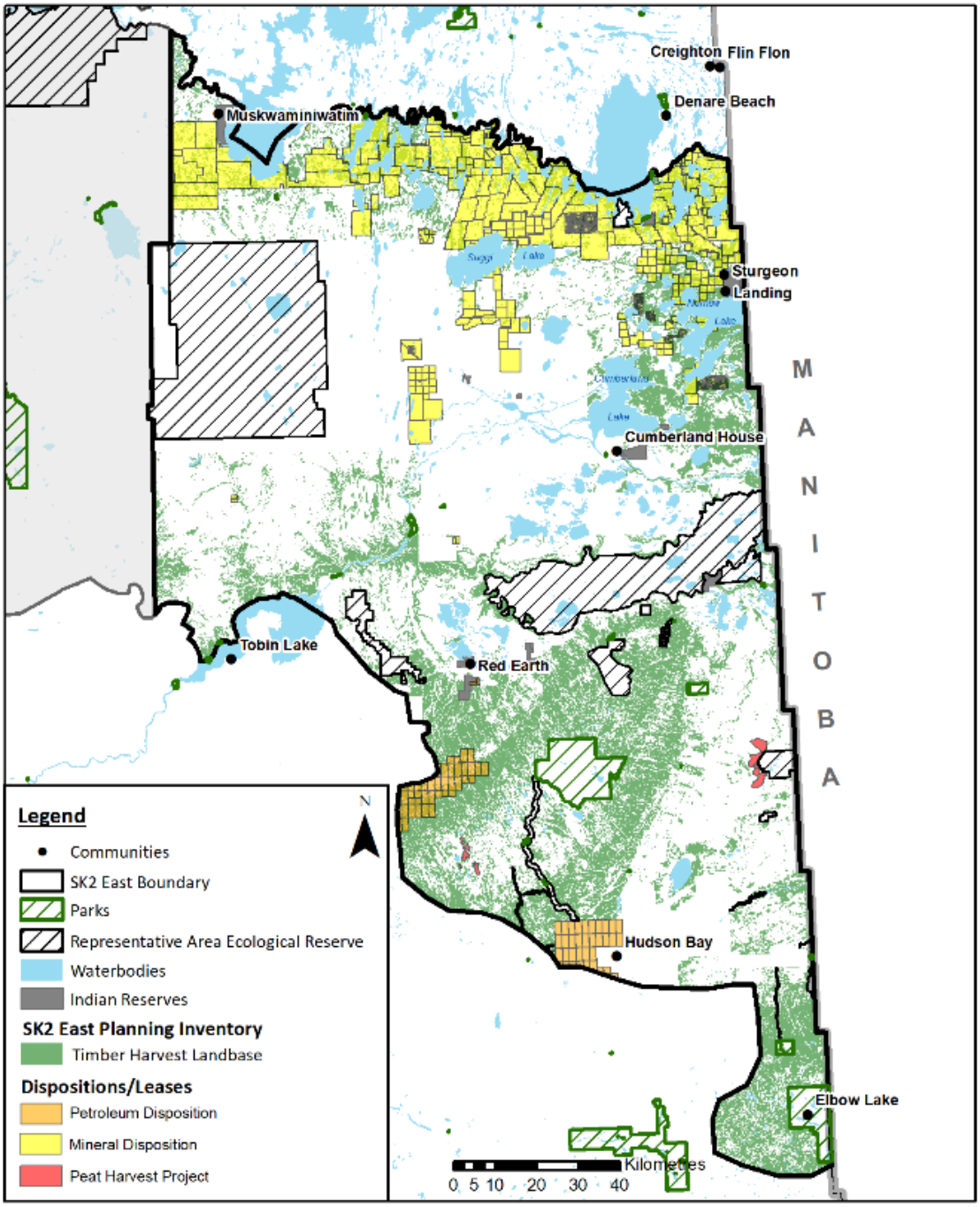

Figure 11. Overview of land use allocations and dispositions in the SK2 East.

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 three key assumptions from the most-likely scenario:

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

Changes to forest harvest levels and mineral development will invariably result in changes to disturbance levels in SK2 East. However, the magnitude of change is unknown. Harvest volume schedule is assessed within the SK2 East boundaries. Roads and linear features comprise a significant proportion of the overall human-caused disturbance in SK2 East. 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 influence total disturbance levels in the SK2 East. Harvest levels were reduced to 20 per cent of the harvest volume schedule for Pasquia-Porcupine timber supply area and down to 2 per cent in the North East timber supply area (TSA). Results were compared to the moderate harvest with moderate growth scenario presented in the main range plan document. Comparisons were also made with a maximum harvest level scenario whereby the harvest volume schedule was set to 100 per cent for the Pasquia-Porcupine TSA and up to 30 per cent of the harvest volume schedule for the portion of the North East TSA that falls within the SK2 East. Thirty-four per cent harvest volume schedule in the North East TSA represents the record level historic high harvest volume in this timber supply area.

7.2.2.2 Mineral Development

Three scenarios were examined to understand how changes in the rate and amount of new mineral and other developments would impact disturbance levels in SK2 East. Each scenario reflected increasing amounts of mineral development in SK2 East: (the following scenarios represent a progression of increasing activities from scenario one to three.

- Scenario 1 presumes one new silica sand mine site, one new base metal processing site, three new base metal extraction sites, and two new peat harvest sites
- Scenario 2 presumes one new silica sand mine sites, two new base metal processing sites, five new base metal extraction sites, and two new peat harvest sites.
- Scenario 3 presumes three new silica sand mine sites, three new base metal processing sites, eight base metal extraction sites, two new peat harvest sites and one new oil shale development.
- The estimated disturbance footprint for each type of new development is listed in Table 10 below. While it is expected that new roads would be required to access each additional development site, they have not been included in the estimates below. The spatial location of

presumed new developments was limited to areas within mineral resource assessment ratings 4 to 6 (Figure 10).

Table 10. Estimated disturbance footprint area of potential new mineral development types in the SK2 East caribou administration area.

Mineral Development Type	Estimated Disturbance Footprint (km^2)
Silica sand mine site	17
Base metal processing site	3
Base metal extraction site	1.5
Peat harvest site	2.4
Oil shale site	100

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 1978 to 2017 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 East (Table 11). 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 which represents a slightly more conservative reclamation strategy than scenario 1 since no roads that are the responsibility of the Crown would be reclaimed. Scenario 3 represented no forestry and non-resource road reclamation occurring over the 50-year period of the range plan.

Table 11. 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.	Extensive
2	Only roads that are owned by forest license holders are reclaimed, unless they intersected a new harvest block.	Moderate
3	No forestry nor non-resource use roads are reclaimed. All roads that are currently on the landscape remained on the landscape.	None

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 Pasquia-Porcupine TSA and 2 per cent for North East TSA) resulted in a two per cent reduction in human-caused disturbance levels in SK2 East compared to the most-likely harvest levels. By 50-years into the future, elevated harvest levels (i.e., 100 per cent harvest volume Pasquia-Porcupine TSA and up to 30 per cent for the portion of the North East TSA that falls into the SK2 East) 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 Mineral Development

Most mine sites and associated access roads have a relatively small disturbance footprint at the scale (i.e., SK2 East) that this disturbance assessment is occurring at. However, disturbance levels increased as new mineral and peat developments increased. By year 50, disturbance levels increased by 0.8 per cent, 1.0 per cent, and 1.6 per cent from current levels for low, moderate and high mineral and peat development scenarios.

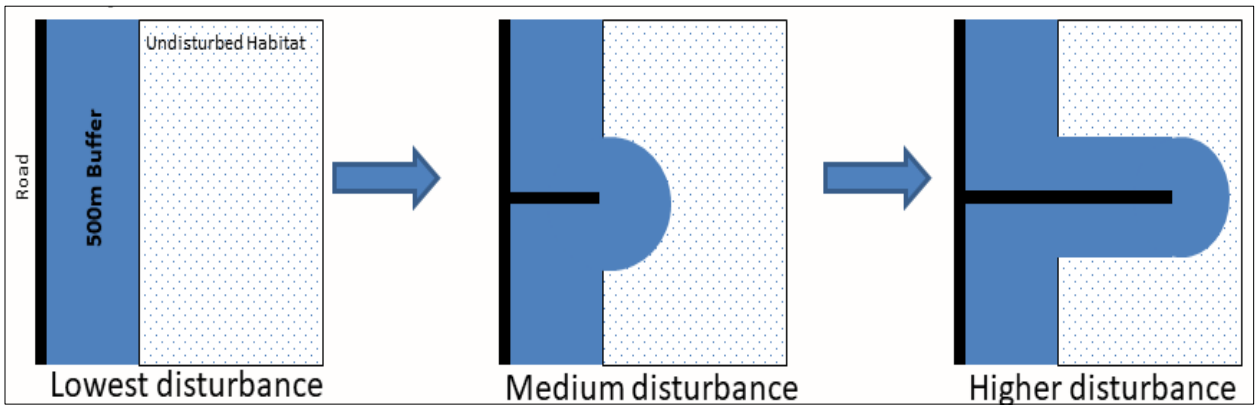

Figure 11. Illustration of how new road placement within buffers can reduce habitat disturbance.

7.3.3 Forestry and Non-Resource Road Reclamation

Reclamation of forestry and non-resource related roads resulted in reductions of disturbance levels overall. Three scenarios were examined to understand the impact of road reclamation on disturbance levels in SK2 East. Increased road reclamation efforts resulted in reduced disturbance levels by year 50. The most aggressive road reclamation scenario had disturbances levels that were 3 per cent lower than the second most aggressive reclamation scenario. If no roads are reclaimed, disturbance levels were approximately 4.6 and 7.1 per cent higher than the moderately aggressive and aggressive scenarios, respectively. The benefits of road reclamation were not typically realized until near the end of the 50-

year scenario period. This lag period was due to the assumption that roads would not be changed from disturbed to undisturbed caribou habitat prior to 40 years after reclamation started.

7.4 Summary

- Reduced forest harvest levels resulted in gains in disturbance reductions in SK2 East. The highest forest harvest levels modelled would likely result in SK2 East exceeding the 65 per cent undisturbed habitat threshold.
- Due to their small footprint at the landscape-scale, increasing amounts of mineral and peat harvest developments resulted in small increases in disturbance levels in SK2 East.
- Road reclamation results in some of the biggest reductions in disturbance levels in SK2 East, thereby allowing for other disturbances to occur on the landscape while still not exceeding the 65 per cent undisturbed threshold.

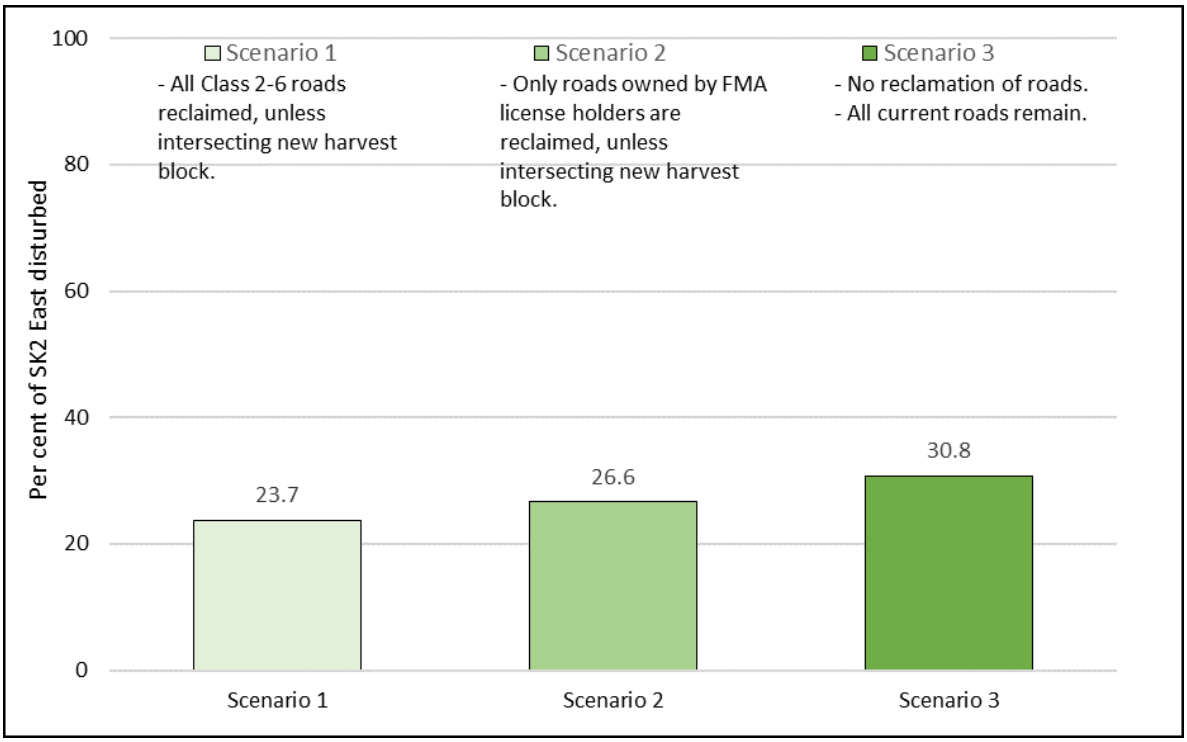

Figure 12. Landscape disturbance levels resulting from the sensitivity analysis associated with forestry and non-resource road reclamation.

8.0 APPENDIX F: Examples of legislation describing protection and conservation measures.

8.1 Important Provincial Statutes

Saskatchewan has at least 14 statutes that are relevant in affording protection of habitat and species on provincial lands (e.g., Table 14 of the *Draft Range Plan for Woodland Caribou in Saskatchewan: Boreal Plain Ecozone – SK2 East Caribou Administrative Unit*). Of these statutes, *The Provincial Lands Act, 2016* works in conjunction with *The Environmental Management and Protection Act, 2010* and *The Forest Resources Management Act* to provide strong legislative authorities for future land use arising from woodland caribou range plans.

8.2 Regulatory Habitat Protection and Conservation Examples

Saskatchewan's legislation provides considerable protection and conservation measures for both habitat and species. Various parts, sections, schedules, and clauses of legislation outline the primary mechanisms by which habitat or species may be protected, managed, or conserved on provincial Crown lands. Sections illustrating specific measures relevant to woodland caribou conservation identified in *The Forest Resources Management Act*, *The Environmental Management and Protection Act, 2010*, *The Provincial Lands Act, 2016*, and *The Wildlife Act, 1998* are presented in Tables 12, 13, 14, and 15. The sections have been selected as examples of being the most relevant, least duplicative and cover the authority, responsibility, compliance, and protection of both habitat (e.g., land) and species. For brevity, the associated regulations and *Saskatchewan Environmental Code* have been omitted.

Table 12. Examples of specific legislative sections describing protection and conservation measures of habitat (land) in *The Forest Resources Management Act*.

The Forest Resources Management Act	
Section	**Description**
3	**Purpose** The purpose of this Act is to promote the sustainable use of forest land for the benefit of current and future generations by balancing the need for economic, social and cultural opportunities with the need to maintain and enhance the health of forest land.
5	**Minister's responsibilities** The minister is responsible for all matters not by law assigned to any other minister, ministry, branch or agency of the Government of Saskatchewan relating to the acquisition, promotion, conservation, development, enhancement, maintenance, management, protection and utilization of forest resources.
6	**Powers of minister** The minister…may: (c) specify terms governing the harvesting, …of forest products.; (e) control the use of pesticides on land within the provincial forest; (h.1) specify requirements and procedures for the treatment, … and disposal of infected material; (i.1) specify activities on forest land that are required to be registered with the ministry; (i.3) develop or establish standards or requirements respecting any matter governed by this Act; and (j) do any thing the minister considers necessary to conserve, develop, enhance, maintain, manage, protect and utilize forest products on forest land in a sustainable manner. (4) … the minister may approve criteria, … as an alternative to those set out in the code if the minister is satisfied that: (a) those alternative criteria, … provide an equivalent or better level of protection to Crown resource lands or forest products on Crown resource lands; and (b) it is in the public interest to do so.
7	**Power to enter into agreements** (1) The minister may enter into agreements … for the purposes of … (a) the protection, on any land, of forests, trees or other arboraceous vegetation from damage…; (b) the protection of watersheds; (c) the renewal and reclamation of all components of a forest ecosystem; (d) the acquisition, promotion, conservation, development, enhancement, maintenance, management, protection and utilization of forest resources; (i) the location, … closure, management and reclamation of roads, road allowances and rights of way within the provincial forest;
12	**Provincial forests** (1) The Lieutenant Governor in Council, by regulation, may designate any Crown resource land as a provincial forest to be managed in a sustainable manner for the purposes of conserving, developing, enhancing, maintaining, managing, protecting and utilizing the forest resources on that land. (2) All lands designated as provincial forest are withdrawn from disposition, sale, settlement or occupancy except pursuant to the authority of this Act and the regulations.
17	**Forest products Crown property** (1) All forest products, including forest products resulting from renewal, are property of the Crown. (2) … no person shall harvest or acquire any right or property in any forest product except in accordance with this Act, the regulations or the code.

Table 12. (*continued*) Examples of specific legislative sections describing protection and conservation measures of habitat (land) in The Forest Resources Management Act.

The Forest Resources Management Act	
Section	**Description**
20	**Designations by the minister** Subject to the regulations, the minister, in any licence respecting the harvesting of forest products, may set out the following: (a) the size of harvest areas; (b) harvest methods; … (e) conditions governing location, construction and use of roads; (f) any other terms that the minister considers appropriate.
24	**Import controls** No person, without the written authority of the minister, shall import any thing into Saskatchewan that, in the minister's opinion, could cause the spread of insects or diseases harmful to Saskatchewan's forests, trees or other arboraceous vegetation.
27	**Renewal activities** A licensee shall carry out renewal activities in accordance with the regulations and the terms of the licensee's licence.
38	**Forest management plans and operating plans** (1) Subject to subsection (1.1), before commencing any activity authorized by a forest management agreement, the licensee shall submit to the minister for approval: (a) a forest management plan for the full term of the agreement; and (b) a five-year operating plan.
46	**Preparation of plans** (1) A licensee who holds a term supply licence shall prepare the forest management plan and the operating plan in accordance with: (a.1) the code; (a.2) if the plan is a development within the meaning of *The Environmental Assessment Act*, the requirements of that Act;
47	**Activities to conform to plans** (1) The operations of a licensee who holds a term supply licence are to conform to: (a) the approved forest management plan, … and (b) the approved operating plan, …
49.3	**Approval or refusal of plan re forest product permit** (2) The minister shall review a plan … and: (a) approve the plan if, in the minister's opinion, the plan complies with this Act and it is in the public interest to do so; or (b) refuse to approve the plan if the minister is not satisfied that: (i) the plan complies with this Act; or (ii) it is in the public interest to approve the plan.
49.4	**Activities to conform to plans** (1) … a licensee who holds a licence respecting a forest product permit shall ensure that the operations of the licensee conform to the approved operating plan, including any terms imposed …
50.1	**Changes to approval** (1) The minister may cancel, amend, alter or suspend any approved operating plan or any licence other than a licence issued with respect to a forest management agreement, in whole or in part, if: (a) the … operating plan or licence has resulted or will result in a contravention of any Act or regulation or any other law;
56	**Minister may establish roads** (1) … the minister may construct roads within a provincial forest and may: … (c) by order, close the whole or any specified part of those roads.

Table 12 (*continued*) Examples of specific legislative sections describing protection and conservation measures of habitat (land) in The Forest Resources Management Act.

The Forest Resources Management Act	
Section	**Description**
57	**Construction of roads** (1) … no person shall clear any forest land for the purpose of constructing a road, trail or other right of way, except with prior authorization from the minister or in accordance with the regulations.
58	**Closure of roads** (1.1) … if the minister considers it necessary for the purposes of managing or protecting forest resources, the minister may close, by order, or require any person responsible for the construction or maintenance of the road to close, any road within a provincial forest. (2) If a road is closed … no person shall operate a vehicle on that road, and no person shall be a passenger in or on a vehicle that is on that road, …
61	**Damage prevention and repair** (1) An officer may make an order requiring any person to stop harvesting or to stop any activity … that: … (b) the person has done or is doing anything that: (i) has damaged, is damaging or is likely to damage Crown resource land or forest products on Crown land; … (4) During the period of the officer's order, the minister may make an order: … (b) directing the person to take any action the minister considers appropriate to repair the damage or prevent further damage;
62	**Forest remediation order** 1(1) If … activities being carried out on Crown resource land are being carried out in contravention of this Act, the regulations or the code and may cause, are causing or have caused damage to Crown resource lands or forest products on Crown resource lands, the minister may issue a forest remediation order… (3) … the minister may, in a forest remediation order, require a person to whom the forest remediation order is directed to do all or any of the following: (a) investigate the situation; (b) lessen or prevent further damage to the Crown resource land or forest products; (c) remedy the damage; (d) restore the Crown resource land or forest products to a condition satisfactory to the minister; (g) cease or suspend any activity for a period specified in the order or permanently; (4) A forest remediation order may specify: (a) the method or procedures to be used in carrying out the measures required by the order …; and (b) the period within which any measure required by the order is to be commenced …
63	**Duty re designated insects and diseases** 1(1) Every person who owns, occupies or controls any land that is designated land shall take measures to remove, dispose of, control and prevent the spread of all designated insects or diseases on that land.
78	**Administrative penalty** (1) The minister may assess a penalty in the prescribed amount against any person if the person: … (c) harvests forest products in contravention of the terms of a licence, an approved plan or the code;

Table 12 (*continued*) Examples of specific legislative sections describing protection and conservation measures of habitat (land) in The Forest Resources Management Act.

The Forest Resources Management Act	
Section	**Description**
79	**Offences and penalties** (1) No person shall: (a) harvest forest products except in accordance with this Act, the regulations and the code; (d) fail to comply with the terms of any licence or plan approved pursuant to this Act, the regulations or the code; (2) Any person who contravenes any provision of this Act, the regulations or the code is guilty of an offence and liable on summary conviction: (a) in the case of an individual, to a fine not exceeding $250,000, to imprisonment for a term not exceeding five years or to both; (b) in the case of a corporation, to a fine not exceeding $1,000,000.
80	**Additional powers of court** (1) In addition to any penalty imposed on a person … the court …, may make an order doing any one or more of the following: (a) prohibiting the person from doing any act or engaging in any activity that, in the opinion of the court, may result in the continuation of the offence; (b) directing the person to take any action the court considers appropriate to: (i) repair any damage to any Crown resource land or forest products on Crown land that resulted from the commission of the offence; or (ii) prevent any damage to any Crown resource land…
99	**Regulations** (1) The Lieutenant Governor in Council may make regulations: (g) governing the alteration or disturbance of any forest vegetation on Crown land;… (r) respecting tree preservation and the renewal, reforestation or reclamation of Crown resource land or portions of Crown resource land;

Table 13. Examples of specific legislative sections describing protection and conservation measures of habitat (land) in *The Environmental Management and Protection Act, 2010*.

The Environment Management and Protection Act, 2010	
Section	**Description**
3	**Responsibilities and powers of minister re the environment** (2) …, the minister may: (a) create, develop, adopt, co-ordinate and implement policies, strategies, objectives, guidelines, programs, services and administrative procedures or similar instruments respecting the management, protection and use of the environment; (b) sponsor, undertake and co-ordinate planning, research and investigations respecting the environment; (c) establish a system of monitoring the quality of the environment and collect, process, correlate, store and publish data on: (i) the quality of the environment; and (ii) activities that have or may have an adverse effect; … (g) provide information to the public on: (i) the quality and use of the environment; (ii) the quantity of any substances or things in the environment; and (iii) any activity that has an adverse effect; (3) The minister shall recommend to the Lieutenant Governor in Council the adoption of a code. (5)…at the request of a person proposing to engage in an activity governed by this Act, the minister may approve criteria, terms, conditions or requirements submitted by that person as alternatives to those set out in the code if the minister is satisfied that: (a) those alternative criteria, terms, conditions or requirements provide an equivalent or better level of safety or protection to human health and the environment; and (b) it is in the public interest to do so.
5	**Preparation of report** (2) The minister shall ensure that a report is prepared every two years, to be known as the State of the Environment Report, concerning the current condition of the environment in Saskatchewan and the relationships between the condition of the environment and the economy of Saskatchewan. (3) The minister may use any environmental indicators that the minister considers relevant in the preparation of a report. (4) The report must: (a) present baseline information on the environmental indicators…; (c) identify, and present analyses, respecting how the environment is changing; and (d) identify emerging concerns for the environment.
8	**Prohibition on discharges** (1) No person shall discharge or allow the discharge of a substance into the environment in an amount, concentration or level or at a rate of release that may cause or is causing an adverse effect…
10	**Duty to take immediate action** … any person who owns or occupies land respecting which a report is filed … shall, as soon as possible, take all reasonable emergency measures consistent with public safety: (a) to repair or remedy any undue risk; or (b) to reduce or mitigate danger to life, health, property or the environment that results or that may reasonably be expected to result from the discharge of the substance.
14	**Corrective action plan** (1) If a site assessment discloses that the site is an environmentally impacted site, the person required to conduct the site assessment … shall prepare a corrective action plan that satisfies any prescribed requirements or any requirements set out in the code.

Table 13. (*continued*) Examples of specific legislative sections describing protection and conservation measures of habitat (land) in *The Environmental Management and Protection Act, 2010*.

The Environment Management and Protection Act, 2010	
Section	**Description**
16	**Minister's consideration of corrective action plan** (1) The corrective action plan … must be immediately submitted to the minister for review after it has been prepared. (2) If the minister is not satisfied with the corrective action plan, the minister may require that the person preparing the corrective action plan resubmit it with any changes that the minister may direct.
22	**Registry** (1) The minister shall establish an environmentally impacted sites registry. (2) The registry is to contain the following documents that are accepted or received by the minister: (a) notices of site condition; (b) corrective action plans; (c) site assessments; (d) environmental protection orders;…
38	**Offences under Part** …(4)… no person shall directly or indirectly: (a) alter or cause to be altered the configuration of the bed, bank or boundary of any river, stream, lake, creek, marsh or other watercourse or water body; (b) remove, displace or add any sand, gravel or other material from, in or to the bed, bank or boundary of any river, stream, lake, creek, marsh or other watercourse or water body; or (c) remove vegetation from the bed, bank or boundary of any river, stream, lake, creek, marsh or other watercourse or water body. (5) A person may engage in an activity mentioned in subsection (4) if expressly authorized to do so pursuant to: (a) this Act or the regulations;…
49	**Prohibition respecting abandonment of waste** No person shall discard or abandon or cause to be discarded or abandoned or allow to be discarded or abandoned, any waste other than: (a) in a waste management works for which a permit has been issued…
55	**Immediate environmental protection orders** (1) …, if the minister is satisfied that a person is doing any thing or carrying out any activity that may cause or is causing an immediate or significant adverse effect, the minister may issue an immediate environmental protection order that is directed to a person requiring that person: (a) to immediately cease or suspend doing the thing or carrying out the activity identified in the order; and (b) to do any other thing that the minister considers appropriate, …
56	**Environmental protection orders** (1) If the minister is satisfied that a person is doing any thing or carrying out any activity that may cause or is causing an adverse effect, the minister may issue an environmental protection order against a person responsible directing that person to take any measures that the minister considers necessary to remedy, minimize, mitigate or prevent the adverse effect. … (6) An environmental protection order may specify: (a) the method or procedures to be used in carrying out the measures required by the order and the manner in which those methods or procedures are to be carried out; and (b) the period within which any measure required by the order is to be commenced and the period within which the order or any portion of the order is to be complied with.

Table 13. (continued) Examples of specific legislative sections describing protection and conservation measures of habitat (land) in *The Environmental Management and Protection Act, 2010*.

The Environment Management and Protection Act, 2010	
Section	**Description**
84	**Offences** (1) No person shall: … (c) fail to comply with an order of the minister issued pursuant to this Act or the regulations; or (d) fail to comply with any provision of this Act, the regulations or the code. (2) … every person who contravenes a provision of this Act, the regulations or the code, for which no penalty is otherwise provided, is guilty of an offence and liable on summary conviction to: (a) a fine not exceeding $1,000,000 for each day or part of a day during which the offence continues; (b) imprisonment not exceeding three years; or (c) both that fine and imprisonment.
85	**Additional order from convicting court** In addition to or instead of any penalty imposed pursuant to this Act, the convicting court, having regard to the nature of the offence and the circumstances surrounding its commission, may make an order doing one or more of the following: (c) directing the convicted person to repair, mitigate or minimize any damage to the environment that resulted from the commission of the offence in a manner and within the period specified by the order, or to restore or reclaim any property that has been damaged as a result of the commission of the offence in a manner and within the period specified by the order; (d) requiring the convicted person to take steps to prevent any damage to the environment that may result from the commission of the offence in a manner and within the period specified by the order;…

Table 14. Examples of specific legislative sections describing protection and conservation measures of habitat (land) in *The Provincial Lands Act, 2016*.

The Provincial Lands Act, 2016	
Section	**Description**
2-1	**Minister's responsibilities** (1) The minister is responsible for all matters … relating to the administration of provincial land. (2) For the purpose of carrying out the minister's responsibilities, the minister may do all or any of the following: (a) create, develop, adopt, coordinate and implement policies, strategies, objectives, guidelines, programs, services and administrative procedures or similar instruments respecting the administration of provincial land; (b) sponsor, undertake and coordinate planning, research and investigations respecting provincial land; (d) subject to the regulations, conduct public hearings or inquiries, or appoint a person to conduct public hearings or inquiries, respecting the use, management, establishment or enlargement of any ecological reserve or the revocation of a designation of any ecological reserve;…
2-2	**Administration of provincial land** (2) The minister may: (a) establish a planning area; and (b) prepare a land use plan for the purpose of coordinating policies, programs and activities to guide existing and potential uses of provincial land…
2-4	**Rights only acquired in accordance with this Act or the regulations** (3) Any disposition issued pursuant to this Act or the regulations with respect to provincial land is not binding on the Crown until the minister signs the disposition.
2-6	**Leases, permits, licences, easements and other dispositions** (1) Subject to the regulations, the minister may issue any or all of the following dispositions on any terms and conditions that the minister considers appropriate: (a) a lease of any provincial land; (b) a permit with respect to any provincial land; (c) a licence with respect to any provincial land; (d) an easement over, under or through any provincial land;…
2-7	**Categories and uses of vacant provincial land** (1) The minister may establish categories of vacant provincial land and permissible uses for those categories of provincial land, including restricting the activities that may be conducted on any identified parcel of vacant provincial land or any category of vacant provincial land. (2) … the minister shall issue an order that specifies the nature of the restriction and the land to which the restriction applies.
2-12	**Amendment or cancellation of authorization, consent or disposition** … , if the minister is satisfied that any person has obtained an authorization, consent or disposition by misrepresenting or failing to disclose any material fact, the minister may: (a) amend or correct the authorization, consent or disposition; or (b) cancel the authorization, consent or disposition.
2-16	**Amendment of terms and conditions or withdrawal of land from or cancellation of disposition** (2) … ,if the minister is of the opinion that it is in the public interest to do so, the minister may amend a disposition,

Table 14. (*continued*) Examples of specific legislative sections describing protection and conservation measures of habitat (land) in *The Provincial Lands Act, 2016*.

The Provincial Lands Act, 2016	
Section	**Description**
2-19	**Liability continues** The cancellation of a disposition by the minister, or the termination of a disposition by a disposition holder, does not: … (b) relieve the disposition holder of any outstanding debt or other obligation owing to the Crown with respect to the disposition.
2-23	**Minister's consent required re certain improvements** (1) A disposition holder who intends to construct or alter an improvement on provincial land shall obtain the written consent of the minister before commencing the construction or alteration.
2-24	**Restoration of provincial land—removal of improvements or other property, etc.** … (2) A disposition holder shall restore the provincial land that is the subject of his or her disposition to a condition satisfactory to the minister… (3) If the minister believes the disposition holder has not satisfactorily restored the provincial land, the minister may issue a written order to the disposition holder requiring the disposition holder to restore the provincial land in the manner and within the period set out in the order.
3-1	**Ecological reserves designated** The Lieutenant Governor in Council may make regulations designating, as an ecological reserve, any provincial land that sustains or is associated with unique or representative parts of the natural environment, …
3-2	**Ecological reserves not to be transferred, assigned, etc.** … no ecological reserve, and no right, title, interest or estate in an ecological reserve, shall be granted, assigned or otherwise disposed of pursuant to any other Act or law.
3-3	**Entry or activity re ecological reserves** The Lieutenant Governor in Council may make regulations: (a) prescribing the circumstances and conditions under which an ecological reserve may be entered, …; (c) respecting the activities that may be conducted on an ecological reserve;
4-6	**Damage prevention and repair order** (1) An officer may make an order requiring any person to stop any activity on provincial land if the officer believes, … that the person has done or is doing anything to alter provincial land in a manner contrary to this Act, the regulations or the terms and conditions of a disposition.

Table 14. (*continued*) Examples of specific legislative sections describing protection and conservation measures of habitat (land) in *The Provincial Lands Act, 2016*.

The Provincial Lands Act, 2016	
Section	**Description**
4-7	**Minister's order** (2) … the minister may make an order requiring a person to do all or any of the following: (a) to cease or suspend the doing of an act or cease failing or neglecting to do an act; (b) to comply with this Act, the regulations or the terms and conditions of a disposition; (c) to do or refrain from doing any other thing that the minister considers necessary. 3) … the minister may require a person who is the subject of the order to do all or any of the following: (a) to lessen or prevent further damage to provincial land specified in the order; (b) to remedy the damage to provincial land specified in the order; (c) to restore the provincial land specified in the order to a condition satisfactory to the minister; … (f) to cease or suspend any activity for a period specified in the order or permanently; 4) The minister's order may specify: (a) the method or procedures to be used in carrying out the measures required by the order …; and (b) the period within which any measure required by the order is to be commenced…
7-1	**Offences** (1) No person shall: … (e) abandon property on provincial land; (f) make any alteration to provincial land without a disposition, authorization or a minister's written consent; … (h) enter or conduct an activity on an ecological reserve contrary to this Act, the regulations or a permit issued pursuant to the regulations; … (3) Every person who contravenes any provision of this Act or the regulations is guilty of an offence and liable on summary conviction: (a) for a first offence: (i) in the case of an individual, to a fine of not more than $100,000; and (ii) in the case of a corporation, to a fine of not more than $500,000; and (b) for a second or subsequent offence: (i) in the case of an individual, to a fine of not more than $100,000 for each day or part of a day during which the offence continues; and (ii) in the case of a corporation, to a fine of not more than $500,000 for each day or part of a day during which the offence continues.
9-1	**Regulations** The Lieutenant Governor in Council may make regulations: …(d) prescribing the conditions that a plan respecting the long-term use of provincial land must satisfy;… (n) establishing an ecological reserve or enlarging any ecological reserve;
10-5	**Ecological reserves continued** …, Crown land designated as an ecological reserve in accordance with The Ecological Reserves Act on the day before section 1-1 of this Act comes into force is continued as an ecological reserve and: (a) may be dealt with as if it were designated as an ecological reserve pursuant to this Act; and (b) any conditions or restrictions placed on the activities that may be conducted on the ecological reserve are deemed to have been made in accordance with this Act.

Table 15. Examples of specific legislative sections describing protection and conservation measures of species in *The Wildlife Act, 1998*.

The Wildlife Act, 1998	
Section	**Description**
2	**Interpretation** "wild species at risk" means any native wild species that have been designated and listed by the Lieutenant Governor in Council…
9	**Agreements** Subject to the regulations, the minister may enter into an agreement with any person, Indian band or government for any of the following purposes: (a) protecting, managing, conserving, reintroducing or encouraging the propagation of wildlife and wild species and protecting, managing and conserving their habitats; (b) establishing and promoting programs respecting public safety, education about wildlife or wild species or other conservation-oriented programs;…
17	**Amendment, suspension or cancellation of licence** (2) The minister may amend, suspend or cancel a licence or cancel a person's licence and prohibit that person from applying for or obtaining a licence where, in the opinion of the minister: … (b) the person has contravened any provision respecting firearms, hunting or the protection of wildlife or wild species at risk of any other Act, Act of the Parliament of Canada or regulation made pursuant to any other Act or Act of the Parliament of Canada; (c) it is necessary for the protection of wildlife or wild species at risk; or (d) it is in the public interest to do so.
21	**Licence Required** (2) … no person shall conduct surveys, research or other activity to detect or observe any species, wild species or wild species at risk, or assess the habitat of any species, wild species or wild species at risk, for a commercial, scientific, academic, or other purpose prescribed in the regulations without a licence issued by the director.
45	**Protection of Wild Species at Risk Interpretation of Part** "designated species" means any extirpated, endangered or threatened native wild species designated and listed in the regulations…
48	**Minister determines wild species to be at risk** 41) The minister may determine any of the following: (a) whether or not a wild species is to be classified as extirpated, endangered, threatened or vulnerable; (b) whether or not a wild species at risk is to be reclassified or is to be deleted from the list mentioned in section 49; (c) whether or not a wild species is to be added to the list …
49	**Designation and listing of wild species** (1) Where the minister determines that a wild species is to be classified as extirpated, endangered, threatened or vulnerable, the Lieutenant Governor in Council may, by regulation, designate and list the wild species as: (a) extirpated; (b) endangered; (c) threatened; or (d) vulnerable.

Table 15. (*continued*) Examples of specific legislative sections describing protection and conservation measures of species in *The Wildlife Act, 1998*.

The Wildlife Act, 1998	
Section	**Description**
50	**Recovery plans** (1) Subject to the regulations, the minister may prepare and implement a recovery plan to protect each designated species. (2) A recovery plan may identify any of the following: (a) the needs of and threats to any designated species or its habitat; (b) the viable status needed for recovery of any designated species; (c) the options for the recovery of any designated species; (d) the costs and benefits of the options mentioned in clause (c); (e) a course of action or a combination of actions for the recovery of any designated species. (3) A recovery plan may include provisions respecting: (a) one or more designated species; and (b) ecosystem management. (4) The minister may determine the priority with which any recovery plan or any portion of a recovery plan will be implemented. (5) The factors that the minister may take into consideration when determining the priority to be assigned to a recovery plan or any portion of a recovery plan include: (a) whether scientific evidence indicates that the designated species mentioned in the recovery plan is naturally becoming extirpated; (b) whether it is technically or economically feasible to recover the designated species; and (c) the status of the designated species elsewhere. (6) The minister may, to the extent possible, prepare a recovery plan in co-operation with other jurisdictions where the designated species is also found.
51	**Activity prohibited** (1) … no person shall do any of the following: (a) kill, injure, possess, disturb, take, capture, harvest, genetically manipulate or interfere with or attempt to do any of those things to any designated species; (b) export or cause to be exported from Saskatchewan any designated species; (c) traffic in any designated species.
74	**Offences and penalties – Part IV** (1) Any person who contravenes a provision of Part IV or the regulations with respect to wildlife for which no monetary penalty is specified is guilty of an offence and liable on summary conviction to a fine of not more than $100,000.
75	**Offences and penalties – Part V** 75(1) Any person who contravenes any provision of Part V or the regulations with respect to wild species at risk for which no monetary penalty is specified is guilty of an offence and liable on summary conviction: (a) in the case of an individual: (i) for a first offence, to a fine of not more than $5,000; and (ii) for a second or subsequent offence, to a fine of not more than $10,000; (b) in the case of a corporation: (i) for a first offence, to a fine of not more than $20,000; and (ii) for a second or subsequent offence, to a fine of not more than $50,000.

Table 15. (*continued*) Examples of specific legislative sections describing protection and conservation measures of species in *The Wildlife Act, 1998*.

The Wildlife Act, 1998	
Section	**Description**
83	**Regulations** (1) The Lieutenant Governor in Council may make regulations: … (b) constituting any area of the province as an area for protecting, propagating, perpetuating, managing, harvesting, controlling or regulating wildlife or wild species at risk or protecting, controlling or managing habitat; (c) respecting the management, control and protection of any of the areas constituted in accordance with clause (b) and the wildlife, wild species at risk or habitat in those areas, and regulating hunters, trappers and other persons in those areas; (d) respecting the protection, management, regulation and use of any wildlife, wild species at risk or habitat; … (viii) the delivery of any wildlife or wild species at risk taken for the purposes of management or research of wildlife or wild species at risk; (kk) respecting programs of land use as to the preservation, maintenance and restoration of habitat and public access to land; (ll) respecting co-operative programs to maintain the habitat of wildlife or wild species at risk and public access to land; (pp) respecting the designation and listing of wild species at risk, including the establishment, maintenance, amendment and distribution of the list; (qq) respecting programs to prepare status reports with respect to wild species at risk and to prepare and implement recovery plans; (rr) respecting emergency provisions to designate and list wild species at risk and protect their habitats; (ss) respecting the monitoring, assessment and reporting of the status of wild species at risk;

9.0 Literature Cited

Environment Canada, 2011. Scientific assessment to support the identification of critical habitat for woodland caribou (*Rangifer tarandus caribou*), boreal population, in Canada. Ottawa, ON. 115 pp. plus appendices.

Environment Canada, 2012. Recovery strategy for the Woodland Caribou (*Rangifer tarandus caribou*), Boreal population, in Canada. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa, ON. xi+138 pp.

Environment and Climate Change Canada. 2015. Anthropogenic disturbance footprint within boreal caribou ranges across Canada - As interpreted from 2015 Landsat satellite imagery. Environment and Climate Change Canada data. Ottawa, ON.

Environment and Climate Change Canada, 2016. *Species at Risk Act* Guidelines. Range Plan Guidance for Woodland Caribou, Boreal Population. *Species at Risk Act:* Policies and Guidelines Series. Environment and Climate Change Canada, Ottawa, ON. 26 pp.

Government of Saskatchewan. 2012. Saskatchewan forestry road network data standards. 4th Ed. (draft) Ministry of Environment, Forest Service Prince Albert, SK. Unpublished Internal Report. 18 pp.

Mamun, A.A. and R. Brook. 2017. Characterizing, mapping and modelling aboriginal traditional knowledge about woodland caribou in Saskatchewan in support of range planning - Final report to the Saskatchewan Ministry of Environment. University of Saskatchewan, Saskatoon, SK. 119 pp.

McLaughlan, M.S., Wright, R.A., and R.D. Jiricka. 2010. Field guide to the ecosites of Saskatchewan's provincial forests. Saskatchewan Ministry of Environment, Forest Service. Prince Albert, SK. 343 pp.

Roddy, D. (Ed.) 2013. Woodland caribou habitat workshop. Unpublished internal report. Saskatchewan Ministry of Environment. Saskatoon, SK. 22 pp.

Thomas, D.C. and H.J. Armbruster. 1996. Jasper National Park caribou habitat study. Environmental Conservation Ecological Research. Canadian Wildlife Service. Ottawa, ON. 82 pp.

Saskatchewan Geological Survey. 2021. Saskatchewan mineral resource assessment. Saskatchewan Mining and Petroleum GeoAtlas. Accessed June 23, 2021.