



# Conservation Strategy for Boreal Woodland Caribou in Saskatchewan

# Table of Contents

Executive Summary . . . . .	1
Section 1	
Background . . . . .	2
Management Framework . . . . .	3
Status . . . . .	3
Development of this Strategy . . . . .	4
Species Biology . . . . .	5
Threats . . . . .	8
Habitat . . . . .	10
Section 2	
Management Approach . . . . .	11
Woodland Caribou Conservation Units (WCCU) . . . . .	11
Section 3	
Risk Assessment . . . . .	12
Section 4	
Saskatchewan Woodland Caribou Recovery . . . . .	13
Appendices . . . . .	20
Acknowledgments . . . . .	20
Context . . . . .	20
Management Team . . . . .	21
Literature Cited . . . . .	23

---

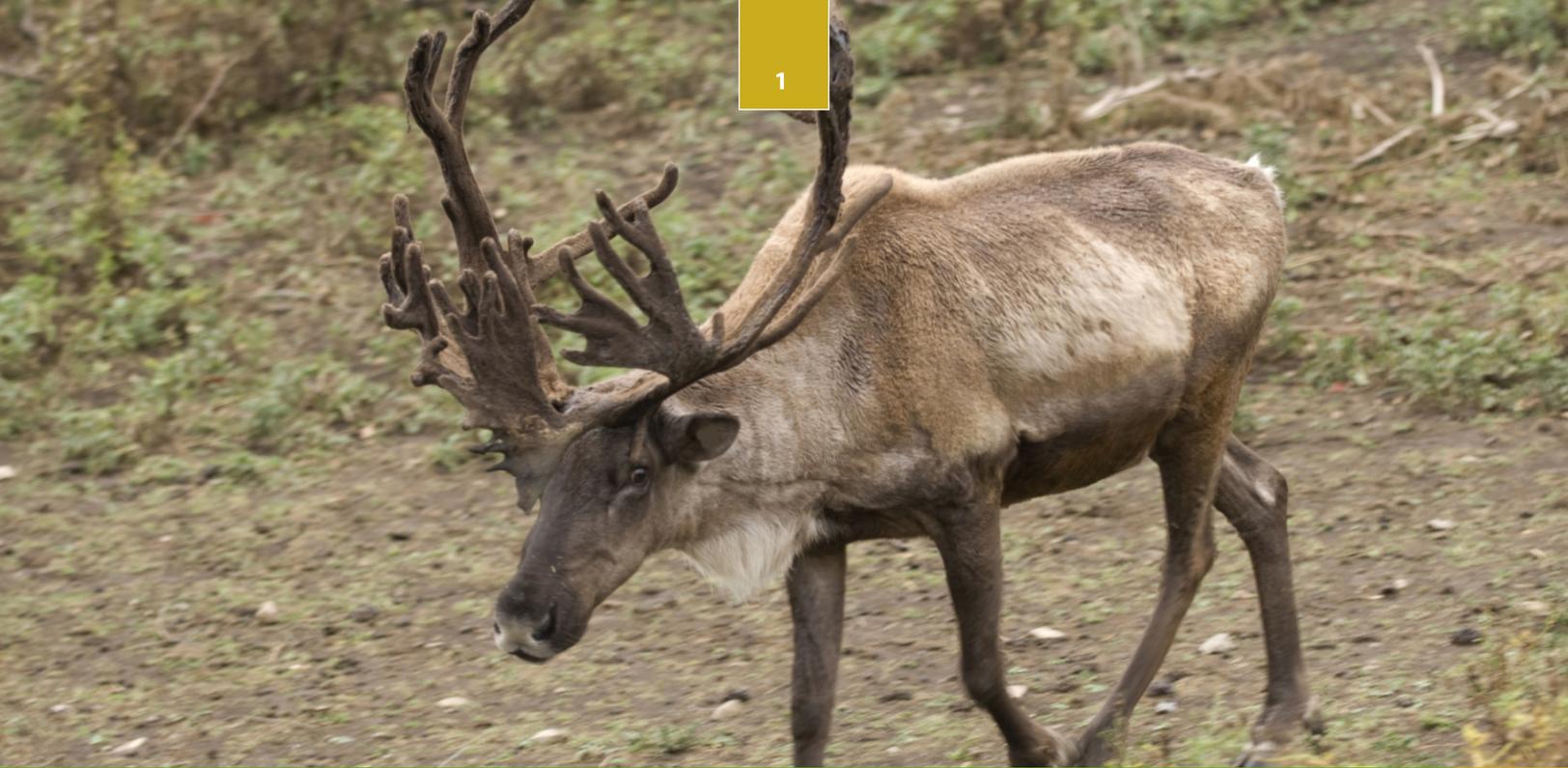
**This publication may be cited as:**

Saskatchewan Ministry of Environment. 2013. Conservation Strategy For Boreal Woodland Caribou (Rangifer tarandus caribou) in Saskatchewan. Saskatchewan Ministry of Environment. Fish and Wildlife Technical Report 2014.

**For copies of this publication, contact:**

Saskatchewan Ministry of Environment  
Fish and Wildlife Branch  
3211 Albert Street  
Regina, Saskatchewan  
S4S 5W6

**You may also find the publication at:** [www.environment.gov.sk.ca/woodlandcaribou](http://www.environment.gov.sk.ca/woodlandcaribou)



## Executive Summary

Woodland caribou (boreal ecotype) is a subspecies of conservation concern because it has been eliminated from much of its range and many remaining populations are threatened, including some in Saskatchewan. Responsibility for management of this woodland caribou in Canada lies primarily with the provincial and territorial governments.

Woodland caribou populations naturally occur at low densities, reproduce slowly and are extremely sensitive to even minor changes in mortality rates. Caribou are very susceptible to predation during the calf-rearing period.

Woodland caribou generally move short distances between adjacent areas of suitable habitat, but do not migrate long distances like the better-known barren-ground caribou. They require large contiguous habitat mosaics composed of lichen-rich treed peatlands, dominated by black spruce and larch, interspersed with upland forest composed of black spruce or jack pine. This allows them to spread out sparsely (0.03-0.05 caribou/km<sup>2</sup>) so that they are both difficult to find and incapable of sustaining a permanent population of predators.

Caribou's specialized habitat requirements make them very sensitive to habitat disturbance. The combined effects of both natural and human disturbances must be considered if woodland caribou are to persist in Saskatchewan. Although natural and human caused disturbances will be considered cumulatively, the effects are not considered equivalent.

Woodland caribou are found in the Boreal Plain, Boreal Shield and Taiga Shield ecozones in Saskatchewan. They have disappeared from the southern edge of their range in the Boreal Plain because of agricultural development and much of the remainder of this ecozone has been fragmented by other human activity. Woodland caribou in the Boreal Plain are at higher risk of loss and have “threatened” status. Populations in the Boreal and Taiga Shield ecozones are less affected by human activities although natural disturbance such as wildfire, may have an impact on spatial and temporal distribution of woodland caribou populations. Woodland caribou are considered to be at low to medium risk in this part of their range. Ecological and land use differences between the southerly (Boreal Plain) and northerly (Boreal and Taiga Shield) ecozones may result in differing management strategies and recovery actions in these areas.

The primary purpose of this conservation strategy document is to guide development of the ensuing recovery activities. The Ministry of Environment's (the ministry) goal is to sustain and enhance woodland caribou populations, and maintain the ecosystems they require, throughout their current range. The ministry will strive to ensure that there will always be sufficient occupied caribou habitat to ensure long-term population viability, to maintain populations of woodland caribou in perpetuity. These efforts will require the cooperation of all those who live, work, invest, or spend their leisure time in Saskatchewan's boreal forest.

# Section 1

## Background

### Introduction

Boreal woodland caribou have been designated as “threatened” under the federal Species at Risk Act (SARA). Human-induced changes to caribou range have resulted in range recession (Trottier 1987), constraints on habitat use and increased mortality in some areas of the Boreal Plain ecozone (Rettie and Messier 1998, Arsenault and Manseau 2010).

The woodland caribou is important to many Aboriginal peoples and is considered to be an important indicator of boreal forest health. It is therefore critically important to ensure the maintenance of woodland

caribou populations from an Aboriginal and Treaty right perspective, to ensure the health of the boreal forest ecosystem and to meet governments' social, economic and ecological commitments.

Recovery and maintenance of woodland caribou in Saskatchewan will require an ecosystem-based approach and recognition that ecological sustainability is the basis of long-term economic and social sustainability. Human activities will need to be managed in a way that will maintain all components and functions of the boreal forest. Caribou will only be able to adapt to the combination of anthropogenic and natural disturbances if their ecological needs are recognized and taken into account.

This woodland caribou conservation strategy may also be considered as a first step in the development of a comprehensive boreal conservation plan: it can act as a basis for management of boreal ecosystems for other species of concern.

### Recovery Goal

The provincial goal is to sustain and enhance woodland caribou populations, and maintain the ecosystems they require, throughout their current range.

### Principles

The conservation strategy is based on these guiding principles:

1. Manage the ecosystems, rather than the species.
2. Use the best available scientific, Aboriginal and community knowledge as a foundation for decision-making.
3. Operate through effective consultation of interested parties.
4. Honour legislation, policies and legal agreements in effect at the time decisions are implemented.
5. Accept that management plans may have to be altered over time in the light of changing circumstances or information.
6. Consider recommendations of the Woodland Caribou Conservation Strategy whenever relevant new legislation, policy and legal agreements are contemplated.



# Management Framework

This conservation strategy is intended to provide direction for developing range plans for woodland caribou conservation and recovery. Range plans form the next phase of the recovery process and will provide specific details on the actions required to implement this conservation strategy.

## Legislative Framework

### *The Wildlife Act, 1997*

Saskatchewan protects “wild species at risk” under The Wildlife Act, 1997. The Saskatchewan Minister of Environment has the authority to prepare and implement a recovery or management plan for any designated species.

### *Species At Risk Act 2003 (SARA)*

Woodland caribou are listed as “threatened” in Schedule 1 of SARA, requiring the development of a national recovery strategy. SARA requires that critical woodland caribou habitat be identified during the recovery planning process as a key element of recovery strategies and action plans. Under SARA, critical habitat is defined as the habitat that is necessary for the survival or recovery of a listed wildlife species (See Habitat section on page 10).

The “Recovery Strategy for the Woodland Caribou, Boreal Population (*Rangifer tarandus caribou*) in Canada” was released in 2012 (Environment Canada 2012), and requires the development of caribou range plans. Range plans are defined as land use plans that show how habitat conditions will be maintained in space and time, to ensure that boreal caribou critical habitat is protected from destruction, and resulting in populations remaining or becoming self-sustaining.

## Status

Woodland caribou are listed as “threatened” under SARA as a result of observed declines in numbers and the area occupied throughout most of their current range. Godwin and Thorpe (2000) reviewed the status of woodland caribou in Saskatchewan and estimated the mid-1990's provincial population to be about 5,000 animals. They recommended a provincial designation of “threatened” because of population decline coinciding with past and current anthropogenic activities, and the additional risk of future disturbances. These declines were attributed to habitat loss and fragmentation, leading to increased predation.

The following observations indicate that southern woodland caribou populations (Boreal Plain) in Saskatchewan are at risk of extirpation:

- The southern margin of woodland caribou range has moved northward over the last century (Trottier 1988b, Arsenault 2003).
- Woodland caribou range on the Boreal Plain has been fragmented and reduced in area by agriculture, forest management, road building, power line construction, etc. (Rock 1992).
- The amount of traffic and general human activity has greatly increased on the Boreal Plain over the past century (Rock, 1992).
- There has been a marked reduction in woodland caribou sightings over the past 50 years (Godwin and Thorpe 2000, Trottier 1988b).
- The abolition of regulated hunting since 1987 has not resulted in a rebound of the woodland caribou population.
- There has been an increase in the number of white-tailed deer (*Odocoileus virginiana*) within woodland caribou range. This increase in the deer population may support larger numbers of predators, potentially resulting in increased predation on caribou. Higher deer numbers could also increase the risk of transmission of brainworm (*Paraphostrogylus tenuis*), or chronic wasting disease to caribou within the area where both species occur.
- Intensive monitoring of caribou productivity in Saskatchewan in the 1990's has shown that their reproductive success on the Boreal Plain was barely sufficient to maintain their numbers (Rettie and Messier 1998). Recent work by Parks Canada and the Saskatchewan Ministry of Environment (Arseneault and Manseau 2010) in a similar area has shown reduced movement of female caribou within groups studied, little or no mixing of groups, and indications of reduced adult survival.
- Climate change is expected to exacerbate the reduction of preferred habitat for caribou through altered habitat succession processes, increased frequency and extent of wildfires related to reduced precipitation and increased temperatures (Dzus 2001).

While these considerations are most relevant to woodland caribou on the Boreal Plain, there are anecdotal reports of fewer caribou on the Boreal Shield. Recently initiated studies of Boreal Shield populations will provide important information, but currently their status remains uncertain.

## Development of this Strategy

In 2002, the provincial Woodland Caribou Management Team (WCMT), composed of representatives from industry, First Nations, government and interest groups, began drafting a woodland caribou conservation strategy for consideration and approval by the Minister of Environment.

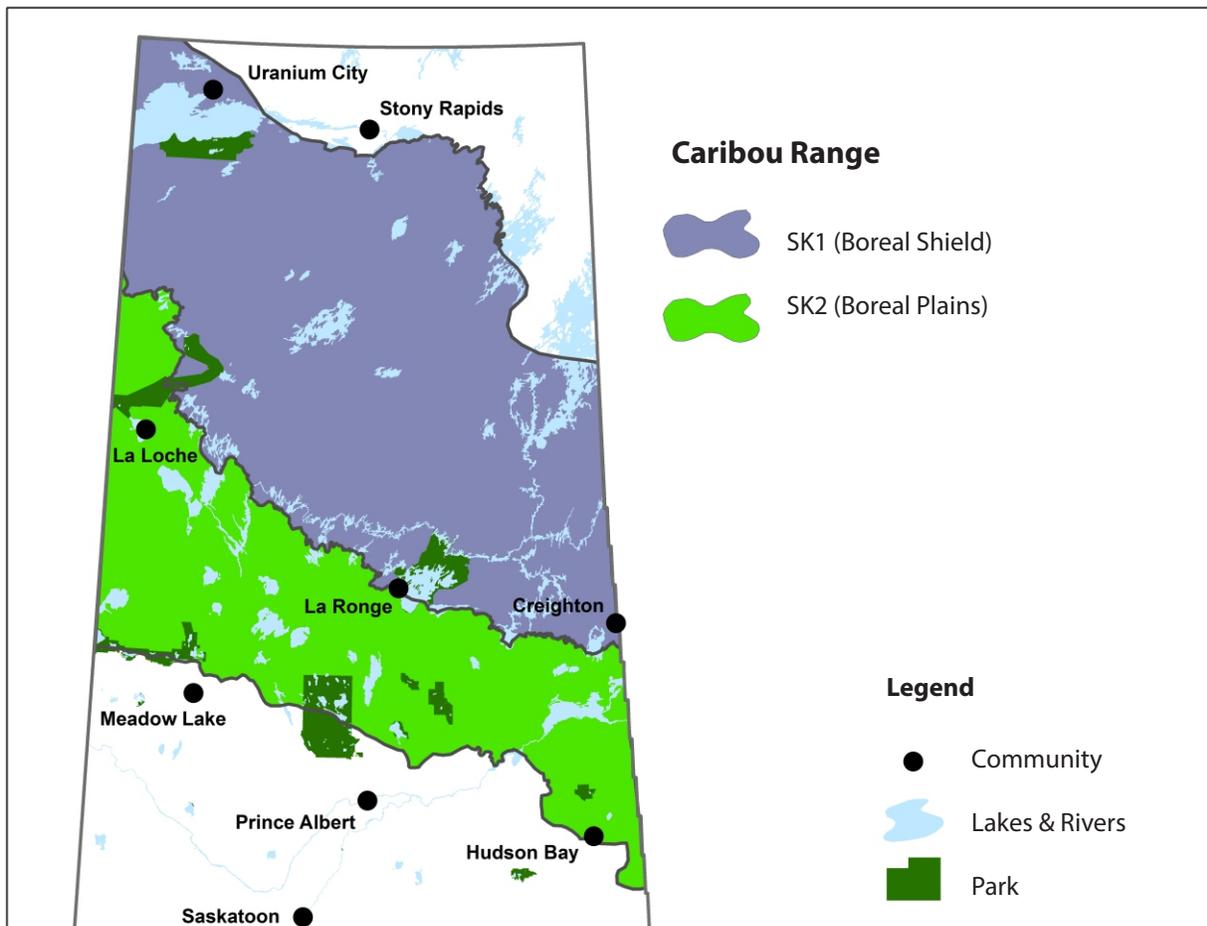
A review of woodland caribou biology, status and range in Saskatchewan was compiled from existing data and earlier reports by Arsenault (2003). The review provided baseline information on the caribou population, a delineation of range, and proposed a framework to assist in development of a woodland caribou conservation strategy.

Woodland caribou spatial data from 1942 to 2006 (tracks, sightings) were compiled for Saskatchewan from a variety of sources including telemetry studies, aerial surveys, incidental sightings and local knowledge. This information, in addition to landscape areas defined by Acton et al. (1998) and peatland

complexes (per Geologic Survey of Canada) was used to identify the historic and current range, at a very broad scale (Figure 1). Two Woodland Caribou Conservation Units (WCCU) have been identified, and will be used for assessment of local status and threats. As more information is collected, the WCCU may be sub- divided for management purposes.

The caribou sightings and location data are biased by the intensity and frequency of observation in any given area, and are subject to update as new information is compiled. Although these data are sparse, they represent the best available overview of woodland caribou distribution in Saskatchewan. Data that define the current and historic range constitute the geographic area that may be occupied by woodland caribou. Areas outside of historic distribution are not critical to woodland caribou conservation.

**Figure 1 - Woodland Caribou Conservation Units (WCCU)**



# Species Biology

## Species Description

Woodland caribou (*Rangifer tarandus caribou*) are medium-sized members of the deer family (Cervidae) living year-round in forested habitat. Adults have a brown body with a cream-coloured neck, mane, tail and rump. Both sexes usually have antlers, but some females have none. Anatomical adaptations to harsh winter conditions include a compact body covered by a well-insulating coat, a blunt well-furred muzzle, heavily furred ears and a short well-furred tail. Long legs and “soft-centered” crescent shaped hooves facilitate movement on ice and through peatlands and snow. A more detailed description is found in Arsenault (2003).

## Biological Considerations

Reliable population estimates for woodland caribou are very difficult to obtain because of their cryptic colouration, clumped distribution and natural occurrence at very low densities (Arsenault 2003). More recently, population size estimates have been produced using genetic analysis from fecal pellets (Hettinga et al 2012); potentially a more reliable and cost effective method than aerial surveys. Woodland caribou population densities reported in Saskatchewan (0.02 – 0.06/km<sup>2</sup>) are typical of those found in other parts of North America (0.03-0.08/km<sup>2</sup>) (see Arsenault 2003). Woodland caribou are the only ungulate species in Saskatchewan that naturally occurs at such low densities. They have a low reproductive capacity, primarily because age at first breeding is later, compared to other ungulates (28-40 months, Bergerud 1974) and twinning is extremely rare (McDonald and Martell 1981, Trottier 1988a). Consequently, woodland caribou recover more slowly from adverse conditions than other ungulates so their populations are more susceptible to decline with repeated disturbances.

Small changes in adult or calf mortality rates can affect long-term viability of a caribou population (Dyer et al. 2001). Annual adult survival of woodland caribou is variable (78-93%), but is usually about 85% (Bergerud 1980a, Rettie and Messier 1998). Between 1990 and the present, there were 189 observations of caribou groups on the Boreal Plain between December and March; of these 14% were calves, 33% were bulls and 53% were cows (Saskatchewan Ministry of Environment, unpublished data). This is consistent with other surveys in Saskatchewan (Brewster 1988, Rock 1988, Trottier 1994), Alberta (Fuller and Keith 1981, Edmonds and Bloomfield 1984, Edmonds 1988, Stewart-Smith et al. 1997), and Manitoba (Brown et al. 2000). Calf survival to one year is highly variable but usually low (30-50%), with most deaths occurring during the first few months of life (Adams et al. 1995, Edmonds 1988, Thomas and Gray 2001). Woodland

caribou populations in late winter or spring with > 15% calves are likely increasing, those with 12-15% calves are likely stable, and those with less than 10% calves are likely in decline (Bergerud 1974, Stuart-Smith et al. 1997). This is dependant on annual adult survival being more than 85% (Dzus 2001, McLoughlin et al 2003). According to Rettie and Messier (1998), caribou in the southern part of their range in Saskatchewan, had low recruitment (28 calves:100 cows).

Woodland caribou tend to gather in small groups (bands), which probably represent distinct social units within a larger population (Trottier 1988b). Group size is variable, depending on season, sex and age. Mean group size calculated from sightings records in Saskatchewan from 1960 to 2005 was 4.23 caribou (n = 928 observations, Saskatchewan Ministry of Environment unpublished data). This is consistent with other studies in Saskatchewan (Brewster 1988, Rock 1988, Trottier 1994), Alberta (Fuller and Keith 1981, Edmonds 1988, Edmonds and Bloomfield 1984), and Manitoba (Brown et al. 2000, Darby and Pruitt 1984, Shoesmith and Storey 1977). Mixed sex and age bands of caribou are relatively sedentary with limited exchange of individuals from one band to another, although there is movement of bulls during the breeding season. Maintenance of genetic variation is particularly important to populations that are fragmented or isolated. Barriers to gene flow may result in long-term deleterious effects on populations (Lacy 1997, Lande 2002).

## Ecological Considerations

### Indicator Species

Woodland caribou are a valuable indicator of ecosystem integrity because of their requirement for large home ranges that include both wetlands and mature jack pine and black spruce forests (Stewart et al 1992). The onset of caribou decline within an area may signify a problem with ecosystem function. Woodland caribou are considered by some to be an indicator of boreal forest health (Callaghan et al 2011, Thomas and Gray 2002).

### Adaptation Limits

Saskatchewan woodland caribou are a portion of the boreal ecotype population described by Thomas and Gray (2001). Woodland caribou range has retracted from the southern margins of their historic distribution in Saskatchewan (Arsenault 2003) and across Canada (Schaeffer 2003). Because woodland caribou are affected by both anthropogenic and natural disturbances, it will be necessary to take into account the combined effects of all factors in the development of management strategies.

Woodland caribou generally move only short distances (15-80 km) between their summer and winter home ranges, which frequently overlap (Cumming and Beange 1987, Darby and Pruitt 1984, Edmonds 1988, Fuller and Keith 1981, Rettie and Messier 2000b). The ranges of neighbouring bands also often overlap (Stuart-Smith et al. 1997). Movements vary with sex and age (Trottier 1988a). Most woodland caribou populations use the same seasonal ranges (and the movement corridors that link them) from year to year and this makes them more susceptible to predation than migrant populations (Arsenault 2003, Fryxell et al. 1988). Rettie and Messier (2001) found that predation was the main population-limiting factor in central Saskatchewan and predicted that caribou facing intense predation would select ranges that offer the most protection. Predation may therefore severely restrict use of the available range even when it would appear to be sufficient (Rettie and Messier 2001, Rettie and Messier 2000a).

Woodland caribou live in small bands that are widely dispersed, making them less likely to be intercepted by predators. This results in low densities of prey which cannot support a resident population of predators. This strategy works if there is enough contiguous space to support a viable population at typical densities (0.03-0.05 caribou/km<sup>2</sup>), and if the area is not suitable for species such as white-tailed deer and moose, that can sustain a high predator population.

Woodland caribou habitat consists of a mosaic of preferred habitat patches, connected by patches that allow for dispersal and predator avoidance (Akcakaya 2001). Researchers generally agree that woodland caribou are dependant upon mature boreal forest interspersed with peatland complexes (Kelsall 1984, Bradshaw et al 1995, Rettie and Messier 2000a). Though they are not restricted to landscapes dominated by treed peatland complexes, research indicates they prefer lichen-rich treed fens and treed bogs dominated by black spruce and larch with adjacent mature spruce and jack pine dominated stands (Anderson 1999, Bradshaw et al 1995, Brown et al. 2000, Fuller and Keith 1981, James 1999, Rettie 1998, Rettie and Messier 2000a, Stuart-Smith et al. 1997, Trottier 1988b). Woodland caribou avoid recently disturbed or fragmented forest, young forests and shrub-rich habitats (Hillis et al. 1998, Rettie and Messier 2000a).

Lichens are not a nutritious food, but since caribou are adapted to make use of them (Thomas et al. 1996, Trottier 1988a), they can sustain themselves in areas that are unsuitable for other ungulates. This provides a food supply for which there is no competition and protects them from predators. Arboreal and ground lichens can be an important winter food source for woodland caribou, though this is only the case if they have sufficient body reserves of nitrogen to facilitate lichen digestion (Thomas and Kroeger 1981, Thomas et al. 1984, Thomas et al 1996, Trottier 1988a). Lichens

grow very slowly, have limited dispersal mechanisms (Dzus 2001, Scotter 1964), and grow best when canopy closure is less than 70%.

Caribou are not dependent on lichen year round. They can also thrive on other foods, including leaves and other soft parts of woody plants, if these are available. Access to a wide variety of food sources is beneficial, particularly in the face of severe snow conditions, wildfire, or timber harvesting (Bergerud et al 1984, Schaefer and Pruitt 1991, Seip 1991), all of which can affect the availability of food.

### **Social Considerations**

There are compelling social (cultural, demographic and aesthetic) reasons for conserving woodland caribou. From a cultural perspective, the woodland caribou has great significance to many Aboriginal groups. In parts of the boreal forest, woodland caribou was one of two dominant species, and in some areas, the only other ungulate food source beside moose. Aboriginal peoples place great value on being self-sufficient through hunting/subsistence practices (Terrance Lewis, pers. comm. 2005). Although people rely heavily on the more common moose for food, the inability to hunt woodland caribou would affect them socially and spiritually. In the past, where only moose and woodland caribou occurred, people valued the meat of caribou as a change of diet. Being able to find, hunt, and eat caribou meant that they were abundant; a strong indication that the environment was healthy and well, giving the woodland caribou special significance. (Bonnie Hamilton, pers. comm. 2005).

In the Churchill/Foster River area the hide of woodland caribou was traditionally used for many purposes; today the hide is generally used for moccasin tops. While hair, bones and antlers were once used to make a variety of tools and other articles, today these parts are mainly used for artwork. (Bonnie Hamilton, pers. comm. 2005). When available, caribou meat is often smoked and presented as a special treat (Ryan Kay, pers. comm. 2005).

The hide and hair of woodland caribou have unique qualities that are reflected in the kind of art and craft produced. Traditional and contemporary arts and crafts are an important form of cultural expression for aboriginal groups on caribou range. It is one of the ways that people validate their culture in modern times (Terrance Lewis, pers. comm. 2005). Aboriginal peoples have carried ancient traditions into the present, a fact that is proving to be valuable for preserving cultural distinctiveness and in appealing to traditional ways that provide a connection to the land and nature.

Europeans and Asians have become keenly interested in traditional Aboriginal cultures. There is great interest in re-living Aboriginal traditions by visiting communities in North America; sharing in traditional

Aboriginal experiences; inviting Aboriginal people to their countries; studying cultures in order to create real settings, authentic costumes, and to re-enact some of the customs.

Aboriginal peoples have an inherent right to use this species for subsistence purposes. Self-sustaining caribou populations will ensure continued long-term subsistence use of the species and protect treaty rights. The local knowledge (Traditional Ecological Knowledge) helps to inform recovery planning and sharing of local knowledge of woodland caribou helps to improve the ability to effectively manage for this species.

From a demographic perspective, there are approximately 75 communities and 65,000 people (including First Nation Reserves, and provincial/federal park town sites) living in and adjacent to provincial woodland caribou range (Indian and Northern Affairs 2006). This number increases dramatically in spring and summer because of an influx of tourists to resort communities and cabins. Aboriginal peoples comprise about 75% of the population living within caribou range, distributed among 15 First Nations on 45 reserves, and 29 predominately aboriginal (Métis/First Nation) settlements (INAC 2006). Eight predominately non-aboriginal communities (3,700 residents) are located in caribou range while an additional 10 such communities are located along the southern edge of the caribou range. There are also four communities (including three First Nations) located along the northern edge of the range.

Harvest levels are reportedly low (Ryan Kay, pers. comm. 2005), although accurate figures are not known and data are not collected for most communities or First Nations. However, in the 1980s Terry Tobias coordinated a bush harvest study at Pinehouse (Tobias and Kay 1994) that indicated that four caribou were harvested between 1983-1985. In 1976, a four month survey of subsistence use by residents of Southend, Grandmother's Bay, Pelican Narrows and Stanley Mission, researchers reported the use of many kinds of wildlife, but not woodland caribou (Cameco, 1994). While there are numerous references to woodland caribou as one of many wildlife species harvested by people from Aboriginal communities, nothing is reported on actual numbers and significance to subsistence use.

From a broader cultural and aesthetic perspective, the people of Saskatchewan place a high value on woodland caribou. Although no current information is available, Saskatchewan respondents to a survey entitled the "Importance of Wildlife to Canadians" (Filion et al 1993) demonstrated a high level of interest and concern about wildlife, and participation in conservation activities. Caribou are valued as native animals of northern forests, as symbols of wilderness and as indicators of a healthy boreal ecosystem. In a

survey of the value of woodland caribou to Saskatchewan residents, Tanguay et al. (1995) found that citizens of Saskatchewan were willing to pay more to maintain caribou than the average value for all Canadians.

### **Economic Considerations**

A high economic value is placed on natural resources occurring on woodland caribou range and their use is an important contributor to the provincial economy. Sustainable development requires that economic, social and ecological factors be considered in decision making for future developments. The industrial sector is subject to rigorous regulatory review and monitoring on an ongoing basis. Because of the impact that industries have on the ecosystems that caribou in the boreal forest occupy, they have become involved in caribou conservation.

The forest industry has adopted green certification as a means to enhance product choices for consumers, which is only acquired after the practices of the producer have been independently assessed (Hanson et al 2006). Almost all green certification systems have requirements for conservation of biological diversity, including species at risk and maintaining forests with high conservation value.

The Saskatchewan mineral industry and the provincial and federal governments have developed the Mineral Exploration Guidelines for Saskatchewan in 2012. The Guidelines are a living document that currently contains 15 Best Management Practices that address mineral exploration activities in the province including a subsection on Rare and Endangered Species (page 9).

In the absence of range-specific caribou management and protection plans, the Saskatchewan Mining Association (SMA) has developed a Caribou Management/Protection plan designed to meet best practice objectives set forth by several guiding documents. The SMA's Environmental Protection Policy encourages member companies to assess, plan, construct and operate their facilities to ensure the protection of the environment, employees and the public. Commensurate with this commitment, this standard provides member companies with best practice guidelines to minimize adverse effects on biodiversity.

Caribou conservation will only be achieved with the necessary commitment of all stakeholder groups. There may be economic costs associated with maintaining self-sustaining caribou populations across their provincial range, so socioeconomic considerations will be a component of the development and implementation of caribou range plans.

# Threats

The main threats to woodland caribou in Saskatchewan are related to habitat loss and predation, although other threats such as exotic and introduced diseases, mortality associated with vehicle collision and over-harvesting also exist.

Habitat loss may be temporary or permanent, short to long-term, and caused by large-scale disturbances such as wildfire and forest harvesting, or fragmentation of otherwise suitable habitat by roads, trails, cut lines or other linear features. Additionally, functional habitat loss may occur when caribou stop using suitable habitat because of nearby disturbance. Climate change may result in both immediate and long-term changes to habitat availability

## Large-scale Disturbances

Natural and anthropogenic disturbances affect caribou habitat in the short and medium term because of the loss of lichen-rich mature forests that contribute to the winter diet. New growth that follows fire or forest harvesting is of limited value to woodland caribou, because it may provide habitat for other ungulates and their predators.

In the longer term, regeneration after wildfire or forest harvesting can renew lichen-rich stands which are of importance to woodland caribou (Euler et al. 1976, Klein 1982, Schaefer and Pruitt 1991). Fire and caribou have coexisted in the boreal forest for thousands of years. The effect of fire on caribou depends on its extent, frequency and the availability of alternative habitat. Fire suppression efforts have been significant on the Boreal Plain and have undoubtedly reduced the annual area burned on average, resulting in more old forest than would be found in a fire-driven ecosystem. Forest management practices that focus on restoring the natural range of variation in disturbance patterns will likely result in more positive responses by caribou, in the longer term.

The effects of fire and human developments in caribou habitat are cumulative and may stress caribou populations beyond their adaptation limits. Where these large-scale disturbances are anthropogenic in origin, it can temporarily reduce the available habitat and contribute to the fragmentation of the landscape, and may lead to caribou range retraction.

## Fragmentation

Fragmentation of the landscape by roads, cut lines and other linear developments discourages or impedes the ability of caribou to make optimum use of the available resources within their range (Jackson 2000, Curatolo and Murphy 1986, Dyer 1999). Disturbances reduce the number of available routes between important

habitats, making the behaviour of the animals more predictable and increasing the risk of predation (Seip 1991, Vors et al. 2006). Developments may reduce the size of important habitat patches, concentrating animals, making it easier for predators to find them.

Most activities that fragment habitat open the canopy and create conditions that attract moose and deer. These, in turn, attract predators, eventually leading to more caribou losses due to predation (Jackson 2000, Lande 1988, Shaffer 1981). Linear developments improve sight lines for predators, allowing them to travel faster and increasing their hunting efficiency. Roads provide humans and predators with access to areas of formerly inaccessible habitat (Bergerud et al. 1984b, Dyer 1999, Edmonds and Bloomfield 1984, Harrington 1996, James 1999, James and Stuart-Smith 2000, Thurber et al. 1994).

Small populations of caribou can become isolated if the landscape is divided by barriers they cannot cross. Such populations are likely to become genetically homogeneous and lack the diversity necessary for long-term survival and eventually leading to local extinctions (Fahrig and Merriam 1985, Fahrig and Merriam 1994, Lande 1988, Saunders et al. 1991).

## Functional Habitat Loss

Functional habitat loss may occur when a disturbance results in caribou moving away from an otherwise suitable area and can be considerably greater than the area originally disturbed (James 1999). Caribou may be displaced by 500 metres or more from roads, seismic lines, recently developed oil well sites or forest harvest (Dyer 1999, Smith et al. 2000). Recreational trail use by snowmobiles and all-terrain vehicles within caribou habitat also has the potential to result in functional habitat loss, especially in areas of high use.

## Climate Change

One of the most consistent predictions of climate models is an increase in frequency and severity of extreme weather events and these changes are already clearly apparent (Hansen et al 2012). This may result in an increase in the frequency of hot, dry summers with an associated increase in the number and severity of fires. There could also be an increase in the frequency of exceptionally heavy rain or snow. The effect of these changes on woodland caribou is unknown, but unlikely to be beneficial.

In the longer term, the increased temperatures already being observed in the boreal forest may result in profound changes to the ecosystem including disruption of the normal patterns of succession, an increase in the proportion of deciduous trees and

expansion of grasslands (Brown and Johnstone, 2012).

In particular, climate change is expected to cause further contraction of woodland caribou range at its southern margin, with an increasing likelihood of predation and disease. At the same time there may be some range expansion along the northern margin but this is expected to be slow because of the sparse nature of taiga soils. On balance, the consequences of climate change are likely to be negative (Griffith et al. 2004) though detailed specific information for Saskatchewan is minimal.

### Exotic and Introduced Disease

Deer in some parts of Saskatchewan are infected by meningeal worm and chronic wasting disease, both of which are lethal to caribou. Neither has yet been found in caribou in Saskatchewan though both pose a threat.

Meningeal worms (*Parelaphostrongylus tenuis*) are carried by white-tailed deer in which they are harmless, but are highly pathogenic to other cervids. They have been identified repeatedly along the eastern border of Saskatchewan. Meningeal worms are thought to be a major factor preventing the establishment of moose, elk and caribou in areas where white-tailed deer are very numerous. Meningeal worms are another reason to ensure that the white-tailed deer population of the boreal forest remains low. This is particularly important, since a warming climate may increase the population of the mollusk intermediate host.

Chronic wasting disease is moving close to caribou range and the infective prion is known to be pathogenic when given to reindeer orally (Mitchell et al 2012). It is therefore virtually certain to affect caribou. While occasional infections in woodland caribou seem likely in the long-term, the fact that this ecotype is sparsely distributed and relatively solitary may ensure that the incidence of the disease remains very low. The main importance of chronic wasting disease in woodland caribou may be as a conduit to the barren ground ecotype.

### Mortality Associated with Vehicle Collisions

Caribou are killed in vehicle collisions (Dyer 1999, Dzus 2001, Johnson 1985) especially where they are attracted to road salt (Brown and Ross 1994), but this is unlikely to be a significant cause of mortality.

### Hunting

Sport hunting of woodland caribou is not permitted and only people with Aboriginal rights may hunt for subsistence. Subsistence hunting does not appear to be widespread in Saskatchewan, but may be locally prevalent where access is convenient and there is a tradition of caribou hunting (Trottier 1988a).

Hunting is a cumulative factor in caribou population change (Rock 1992) and, under natural conditions, caribou populations decline if harvest by humans exceeds 5% (Bergerud 1974). At extremely low densities, much lower levels of hunting could drive a caribou population into a decline (Caughley 1976). Caribou are susceptible to hunting because they lack wariness of people, are curious and are frequently seen in fairly open peatlands (B. Wynes, pers. comm. 2006).

### General Considerations

Anthropogenic activities in caribou range may cause long-term modification of the habitat. If the area is large, and the disturbance is of long duration, it is unlikely that woodland caribou will successfully re-establish themselves on their former range without extensive remediation.

Assessment of caribou population stability must take into account the cumulative effects of all disturbances, regardless of their cause, size or duration. Furthermore, the combined effects of changes to the landscape are not necessarily immediate and may take up to 20 years to manifest themselves as a reduction in the range or number of caribou (Vors et al. 2006).

Although natural and human disturbances must be considered together, their effects are not considered equivalent. Woodland caribou have evolved and adapted to survive on the landscape with the fire cycle for thousands of years, but human disturbance is a relatively new occurrence since 1900. This has resulted in a “medium-high” risk assessment for the Boreal Plain Conservation Unit (Table 1) where there is moderate human disturbance but also active fire suppression. In the Boreal Shield Conservation Unit, where fires are very frequent but human disturbance is low, the risk assessment is “low-medium”.



# Habitat

Natural ecosystems are dynamic, with highly variable disturbance regimes. In Saskatchewan, fire is the key natural disturbance responsible for forest renewal. Other natural disturbances, such as insect and disease outbreaks, floods and blowdown, are also ecologically significant, but typically occur at much smaller scales. This results in a landscape which consists of a mosaic of patches at differing stages of development; not all parts of the mosaic are suitable for caribou at any given time.

Because of these inherent characteristics of the boreal forest, woodland caribou require large contiguous ranges to provide continuity in the supply of food, shelter, calving areas and relative freedom from predators. For this reason, woodland caribou habitat must be defined in such a way that it is both suitable in the short-term and is likely to remain suitable in the foreseeable future. To achieve this, the area of available habitat must be large enough and diverse enough to allow caribou population to accommodate the changes that will inevitably occur (Environment Canada 2012, Racey and Arsenault 2006).

## Caribou Habitat

Caribou require a perpetual supply of large, contiguous areas of suitable year-round habitat where human disturbance does not impede their ability to carry out life processes

Caribou habitat exists on landscapes where a combination of peatland (bog and fen) complexes and mature to old forest (jack pine and black spruce associations) are available. Caribou habitat also includes forest habitats that provide movement corridors, calving and other important sites, as well as future habitats.

Not all the characteristics of calving sites are known but they are probably provided by peninsulas and islands in lakes, rivers or treed peatlands. These must be connected to larger areas that provide high quality caribou habitat (Edmonds and Bloomfield 1984, Kelsall 1984, Racey et al. 1999, Shoesmith and Storey 1977).

The objective is to create or maintain forest landscapes where woodland caribou populations are self-sustaining. If monitoring reveals stable or growing populations, then habitat is likely adequate. If a population is in long-term decline, then habitat may not be adequate and more area or an improvement in habitat quality may be required to meet objectives.



## Section 2

# Management Approach

The plan should focus on conserving the naturally functioning large-scale ecosystems which woodland caribou have traditionally occupied; maintaining the ecological integrity, the natural ecological processes and functions that will sustain the natural dynamics of critical habitat.

Any significant degradation of the ecosystem could endanger other species, and reduce the overall biological productivity of the region. A decline in the biological productivity of the boreal forest could lead to a reduction in its social and economic worth, impacting Aboriginal people and communities and other stakeholders.

### Management of the Landscape

Ecosystem-based management is defined as management that considers the system, as well as the parts, and strives to include all temporal and spatial scales, and stakeholder interests, in decision-making. It requires the maintenance of healthy ecosystems but also accommodates human needs (Haufler et al. 2002). In the case of woodland caribou, the objective of ecosystem-based management is to maintain the complex mosaic of forest that provides habitat. This must incorporate areas at differing stages of development and include mature upland stands as well as wetlands. The commitment of the forest industry to base management on natural disturbance patterns means it may be possible to emulate these patterns and to provide a landscape similar to the natural ecosystem.

### Site Level Management

At the landscape scale, woodland caribou may be able to tolerate well planned development, provided sufficient habitat is available. It may be necessary to provide protection for some areas which provide important features, such as calving habitat or corridors that allow caribou to move from one part of their range to another.

### Protected Areas

Protected areas will complement landscape level management strategies, but are not sufficient to maintain caribou populations. Woodland caribou occur at such low densities that the area required to maintain a viable population is so large that it would be difficult to set aside in perpetuity. The social, economic and political costs would be high, given that a group of 500 woodland caribou require an area of at least 10,000 square kilometres.

### Flexibility

Given the nature of the boreal forest, the measures taken to ensure woodland caribou survival must be adaptable to suit changing conditions. Even with active fire suppression, it is likely that there will be some short-term habitat loss to fires. An effective management plan must provide the flexibility to deal with this.

# Woodland Caribou Conservation Units (WCCU)

In Saskatchewan, woodland caribou are found in two ecologically distinct areas, the Boreal Plain and the Boreal Shield, to the north. There are also considerable differences in the amounts and distribution of anthropogenic and natural disturbances between the two areas. These areas are treated separately and referred to as Woodland Caribou Conservation Units (Figure 1). However, the northern margin of the Boreal Plain gradually merges with the southern margin of the Boreal Shield and it is certain that caribou cross this boundary. The caribou of these conservation units should not be seen as separate populations.

These WCCU form the framework from which to assess caribou status and risks, as well as for recovery and conservation. Differences across the provincial range may require variation in the set of actions needed to conserve woodland caribou within and between conservation units. As more information is collected, the WCCU may be sub- divided to allow for more management options.

## Section 3

# Risk Assessment

Assessing the likelihood of population persistence is an important part of conservation biology (Beissinger and Westphal 1998). Table 1 outlines potential population limiting factors most likely to affect the long-term survival of woodland caribou within the two Woodland Caribou Management Units. Maintaining large functioning mosaics of suitable habitat is the most effective way to meet the needs of a caribou population.

Caribou populations perceived to be at higher risk are those in the Boreal Plain WCCU. This is the portion of woodland caribou range experiencing more anthropogenic impact and resulting cumulative effects on the ecosystem

**Table 1 - Risk analysis for assessing potential for long-term sustainability of woodland caribou in WCCU.**

WCCU	Total WCCU Area (km <sup>2</sup> )	Current Population Trend	Potential Population Limiting Factors	Estimated Risk Level
<b>Boreal Shield*</b>	185,000	unknown	<ul style="list-style-type: none"> <li>Disturbance and increased access related to mining, mineral exploration, transportation and utility corridors</li> <li>Hunting</li> <li>Habitat fragmentation (limited forest harvesting in southern portion of WCCU)</li> <li>Hydroelectric development on Churchill River (e.g. Island Falls Dam, Whitesands Dam)</li> </ul>	low - medium
<b>Boreal Plain</b>	91,000	unknown	<ul style="list-style-type: none"> <li>Habitat fragmentation (oil and gas industry, forest management, mining peat mining, agriculture and forest grazing in southern portion)</li> <li>Hunting</li> <li>Access (trails, roads, utility corridors, seismic lines)</li> <li>Disturbance from high level of recreation (snow mobiles, hunting, ATV use), outfitting and trapping</li> <li>Some bands confined to islands of habitat surrounded by agricultural lands.</li> <li>High predator (bear, wolf) densities when supported by high primary prey (deer, moose) densities</li> <li>Hydroelectric dams (E.B. Campbell Dam (1967) and Francois-Findley Dam (1985)) may have resulted in habitat loss and fragmentation, resulting in isolation and loss of southern populations from this WCCU</li> <li>P. tenuis and CWD have been diagnosed in other ungulates in this unit</li> </ul>	medium - high

\* The Boreal Shield Conservation Unit contains a small portion of the Taiga Shield

# Section 4

## Saskatchewan Woodland Caribou Recovery

This section outlines strategies and context for woodland caribou recovery actions in Saskatchewan. Range plans will be developed to provide direction for habitat recovery implementation. Outcomes will be

tailored to the conditions of the range and population status in question. Table 2 outlines specific recovery strategies and actions.

**Table 2 - Strategies and expected outcomes by management category**

Recovery Category	Priority	Strategy	Threat(s) Addressed	Actions
<b>1. Habitat Assessment and Management</b>	Urgent	<b>1A</b> Delineate habitat for woodland	Habitat loss	<ul style="list-style-type: none"> <li>Rank forest ecosites (McLaughlan et al 2010) for caribou habitat value.</li> <li>Map potential existing and future caribou habitat, based on predicted mapped ecosites.</li> <li>Delineate existing caribou habitat, landscape linkages, and identify priority landscapes for range plan development.</li> <li>Address knowledge gaps required for identifying caribou habitat (e.g. calving/post calving habitat, post disturbance successional pathways, amount and role of exclusions within burns).</li> </ul>
	Urgent	<b>1B</b> Maintain or improve the long term supply of caribou habitat	All	<ul style="list-style-type: none"> <li>Focus effort on managing land use to maintain long term supply of caribou habitat, beginning with the Boreal Plain Conservation Unit.</li> <li>Identify land uses that affect caribou populations through habitat modification.</li> <li>Develop and implement acceptable solutions under the Environmental Code or other guidelines for these activities in consultation with stakeholders, to minimize impacts on caribou habitat and populations.</li> <li>Develop caribou range plans as part of a landscape planning process involving industries, stakeholders, First Nations and Métis.</li> <li>Utilize forest management and other plans to create forest conditions that exhibit desirable habitat characteristics on the appropriate temporal scale.</li> <li>Identify existing and potential sites and conditions that are buffering caribou populations from effects of adjacent activities and habitat change.</li> <li>Evaluate the utility of existing and potential protected areas and identify the required level of protection at various temporal and spatial scales (new protected areas may require compensation to impacted industries). Make recommendations for new protected areas where necessary.</li> <li>Ensure that combined effects of natural and anthropogenic change does not exceed a threshold tolerable to caribou (cumulative effects model).</li> </ul>

Recovery Category	Priority	Strategy	Threat(s) Addressed	Actions
<b>1. Habitat Assessment and Management</b>				<ul style="list-style-type: none"> <li>• Manage for habitat conditions that are similar to and function the same as those occurring on naturally disturbed landscapes, recognizing fire history and the natural range of variation.</li> <li>• Ensure a natural level of connection is maintained between patches of caribou habitat.</li> <li>• Consider the influence of trans-boundary caribou populations in the assessment of risk.</li> </ul>
	Necessary	<b>1C</b> Develop or adopt a cumulative effects model (government in collaboration with industries and other interested parties)	Habitat loss	<ul style="list-style-type: none"> <li>• Conduct research in, and monitor existing impacted woodland caribou habitat to assess the level and threshold of impact.</li> <li>• Develop range plans that accommodate developments at acceptable levels and appropriate spatial and temporal scales. <ul style="list-style-type: none"> <li>— Analyze the associated risk to caribou habitat.</li> <li>— Use the cumulative effects model to predict undesirable spatial and temporal habitat changes related to resource extraction.</li> </ul> </li> </ul>
	Necessary	<b>1D</b> Link Range Plans with Land-use Plans in collaboration with stakeholders and Aboriginal groups	Habitat loss	<ul style="list-style-type: none"> <li>• Assist with integrated land use planning and access management planning.</li> <li>• Caribou recovery actions may restrict or limit some land uses, requiring a strong linkage between caribou recovery planning and land-use planning in order to: <ul style="list-style-type: none"> <li>— Manage potential impacts on wood supply and forestry.</li> <li>— Develop landscape level access management plans for natural resource industries (mining, forestry, tourism, recreation) that designate routes of access, road/trail/seismic line density, construction timing, type of crossing (permanent vs temporary), road surface, use restrictions (speed, season, time of day, users), and decommissioning or abandonment strategies. Incorporate landscape level wilderness planning where access construction is not permitted.</li> <li>— Retain habitat conditions reasonably comparable to those of naturally disturbed landscapes.</li> <li>— Ensure effective coordination between land-use plans (LUPs), Forest Management Plans, and implementation of this conservation strategy. Make the conservation strategy available and present to all LUP committees immediately.</li> <li>— Ensure that zoning for LUPs meet the requirements of this plan.</li> <li>— Incorporate woodland caribou biological and ecological considerations into federal and provincial land use planning initiatives, including the establishment of ecological reserves, provincial or national parks.</li> <li>— Contribute to land-use planning initiatives to manage woodland caribou habitat.</li> </ul> </li> </ul>

Recovery Category	Priority	Strategy	Threat(s) Addressed	Actions
<b>1. Habitat Assessment and Management</b>	Necessary	<b>1E</b> Develop integrated access management plans	Mortality Habitat loss Habitat fragmentation Movement barriers Disturbance	<ul style="list-style-type: none"> <li>Minimize the potential for upsetting the predator-prey balance and dynamics by managing the amount and type of access by: <ul style="list-style-type: none"> <li>Minimizing density, duration and standard of roads and trails (applies to forest management, oil and gas, mineral exploration and extraction, groomed snowmobile trails, outfitting, trapping, agriculture), and striving to operate on frozen ground in critical caribou habitat.</li> <li>Reforesting temporary roads and access to a shrub/tree condition consistent with the rest of the site.</li> <li>Coordinating unavoidable access to areas of caribou habitat so that it occupies the minimum period of time.</li> <li>Minimizing utility corridors by combining them and eliminating them where possible (planning, construction, maintenance).</li> <li>Limiting recreation (snowmobiles, trail riding, hunting, lake access, cottages, camping, hiking, skiing, canoeing) adjacent to caribou habitat and at critical times of the year.</li> <li>Limiting use of road salt in caribou range.</li> <li>Monitoring the effectiveness of such plans with respect to conserving caribou habitat and persistence of caribou populations.</li> </ul> </li> </ul>
	Necessary	<b>1F</b> Establish a reporting system that will identify proposed developments and activities within any WCCU (impacts to be assessed through cumulative effects model)	Habitat loss Habitat fragmentation	<ul style="list-style-type: none"> <li>Develop a protocol to ensure that the level of impact (if any) specific to caribou is appropriately assessed, and measures necessary by the proponent to address the concerns are identified.</li> <li>Develop a protocol for informing the woodland caribou management process of potentially detrimental developments and activities per list of examples.</li> <li>Develop a list of examples of potentially detrimental developments and activities, which currently may or may not have a permit requirement, (see 1E above).</li> </ul>
	Desirable	<b>1G</b> Develop a wildfire suppression plan for caribou range	Habitat loss	<ul style="list-style-type: none"> <li>Where possible, allow wildfires to progress naturally to allow natural regeneration of caribou habitat.</li> <li>Include caribou habitat as a value at risk to be considered in protection priorities for wildfire management to provide temporary fire protection for habitat in short supply, particularly in high-risk areas with high levels of anthropogenic disturbance, and heavily fragmented landscapes (i.e. Identify priority fire protection zones until adjacent caribou habitat areas achieve the characteristics necessary to sustain or encourage self-sustaining populations, where feasible).</li> </ul>
	Desirable	<b>1H</b> Evaluate the long-term effects of climate change on woodland caribou population status, and its effect on caribou habitat and use	Habitat loss	<ul style="list-style-type: none"> <li>Establish population and habitat benchmarks so changes can be assessed accurately.</li> </ul>

Recovery Category	Priority	Strategy	Threat(s) Addressed	Actions
<b>1. Habitat Assessment and Management</b>	Desirable	<b>1I</b> Contribute to forest insect/disease management planning	Habitat Loss	<ul style="list-style-type: none"> <li>Mitigation of impact on boreal caribou habitat.</li> </ul>
<b>2. Population Assessment and Monitoring</b>	Urgent	<b>2A</b> Analyze genetic variation in and among caribou populations	<p>Identification of populations</p> <p>Effect of range reduction on genetic variation</p>	<ul style="list-style-type: none"> <li>Conduct a broad-based assessment of the level of connectivity between populations of caribou to in order to delineate populations and establish conservation units for future management.</li> <li>Conduct landscape level genetic analyses based on fecal-DNA to assess the distribution and spatial organization of caribou. To understand long term demographic history and the effects of range reduction (and reduced habitat connectivity) on gene flow and genetic variation.</li> <li>Make connections with caribou population in the Northwest Territories, Manitoba, and Alberta.</li> </ul>
	Urgent	<b>2B</b> Assess caribou population demographics and trends, beginning with high risk areas	Significant population decline	<ul style="list-style-type: none"> <li>Monitor and report on population trends using the best available science and/or information.</li> <li>The best indicator of conservation strategy success is a positive population trend. (e.g. trend surveys, telemetry, Non-invasive genetic sampling). <ul style="list-style-type: none"> <li>Annual adult survival should &gt;85% (5 year running average) and should not fall below 80% in any year.</li> <li>Annual late winter (March) calf recruitment should not fall below 15% in any year.</li> <li>Population size should be stable or increasing as measured by the intrinsic rate of population increase (<math>r</math>), where <math>r &gt; 1.0</math> (measured over 5 year periods).</li> </ul> </li> <li>Develop and conduct trend surveys of caribou populations in representative and prioritized study areas.</li> <li>Periodically survey caribou populations beginning in high risk areas.</li> </ul>
	Urgent	<b>2C</b> Establish and promote a formal program for collection of track, sighting and telemetry data	<p>Significant population decline</p> <p>Information gaps</p>	<ul style="list-style-type: none"> <li>Monitor range occupancy and changes in distribution.</li> <li>Monitor changes in connectivity of populations.</li> <li>Promote awareness of woodland caribou in northern communities.</li> <li>Ensure reporting of caribou tracks and sightings during wildlife aerial surveys.</li> <li>Ensure reporting of caribou tracks and sightings by industry and the public.</li> </ul>

Recovery Category	Priority	Strategy	Threat(s) Addressed	Actions
<b>2. Population Assessment and Monitoring</b>	Desirable	<b>2D</b> Discourage white-tailed deer population increases in caribou range	Excessive predation on caribou  Fatal parasites  Increases of alternate prey	<ul style="list-style-type: none"> <li>Periodically assess white-tailed deer population size and range overlap with caribou.</li> <li>Conduct research to determine if, and at what level, deer populations pose a threat to caribou by attracting increased wolf predation.</li> <li>Conduct research to determine effectiveness of various techniques to minimize increases in deer density in caribou habitat.</li> <li>Investigate forest harvesting strategies that help to maintain forest buffers between caribou habitat and recently disturbed areas.</li> <li>Increase deer hunting success/opportunities in the forest to reduce deer populations (See strategy 2F).</li> </ul>
	Desirable	<b>2E</b> Monitor health and condition of woodland caribou	Significant population decline  Fatal parasites	<ul style="list-style-type: none"> <li>Monitor health and body condition of individual caribou using biological samples from various sources (non-invasive DNA collection, subsistence harvest, captures for research, road-kills, natural deaths).</li> <li>Monitor the incidence of, and take action to curb the potential spread of meningeal (brain) worm (<i>Parelaphostrongylus tenuis</i>) and CWD.</li> </ul>
	Necessary/ Exploratory	<b>2F</b> Regulate sympatric ungulates and their predators	Excessive predation on caribou  Fatal parasites	<ul style="list-style-type: none"> <li>Manage land use to reduce human-caused range extensions of other ungulates (supporting higher predator numbers) into caribou ranges, (see 2D above).</li> <li>Explore the practicality, long-term effectiveness, positive and negative effects of predator regulation to achieve caribou recovery.</li> <li>Establish a protocol for determining if and when predator and/or alternate prey regulation will be implemented to protect a local caribou population.</li> <li>Identify biologically effective and socially acceptable methods of predator regulation.</li> <li>Implement temporary predator/alternate prey regulation where local caribou populations are at risk of extirpation and where habitat improvements are underway.</li> </ul>

Recovery Category	Priority	Strategy	Threat(s) Addressed	Actions
<b>3. Stewardship and Communication</b>	Necessary	<b>3A</b> Encourage collaborative conservation with caribou range communities, subsistence users, other jurisdictions, and the general public	Lack of knowledge  Lack of involvement  Poor communication  Significant population decline	<ul style="list-style-type: none"> <li>Foster local stewardship of woodland caribou by involving caribou range communities, subsistence users, and the general public in research and population monitoring. Inform them of the rationale for local conservation actions through the range planning teams.</li> <li>Promote community knowledge and understanding of woodland caribou and boreal forest ecology, both to promote respect for the animals, and to generate support for implementation of recovery strategies and associated range plans.</li> <li>Encourage community participation through stewardship, education to:               <ul style="list-style-type: none"> <li>initiate community based monitoring of caribou distribution and harvesting.</li> <li>collect samples from hunter-killed caribou for DNA analysis (e.g. baseline genetic profile, genetic connectivity).</li> </ul> </li> <li>Harmonize inter-jurisdictional management of trans-boundary caribou populations.</li> <li>Engage with First Nations/Métis' regarding traditional/contemporary caribou harvest levels and strategies.</li> </ul>
<b>4. Legislation and Policy</b>	Urgent	<b>4A</b> Collaborate with industries and stakeholders to develop acceptable solutions under the Environmental Code or best management practices for maintaining caribou habitat	Habitat loss  Disturbance	<ul style="list-style-type: none"> <li>Develop an access management plan to minimize the amount, type and duration of access, and to ensure reclamation of access to tree/shrub condition rather than grass.</li> <li>Use wildlife-friendly silviculture (e.g. site preparation that does not discourage wildlife movement).</li> <li>Minimize exploration and development “footprint”.</li> <li>Minimize duration and timing of activities during late winter and calving (March 31 – July 31).</li> <li>Use EA process to mitigate effects of developments on woodland caribou habitat.</li> <li>Develop a policy on peat mining based on investigation of long-term effects on caribou habitat.</li> <li>Restrict new trail development in caribou habitat, pending development of an access management plan.</li> <li>Develop government policy using an integrated branch to branch, ministry to ministry approach to ensure consistency.</li> </ul>

Recovery Category	Priority	Strategy	Threat(s) Addressed	Actions
5. Research	Necessary	<b>5A</b> Investigate methods of population estimation	Significant population decline  Habitat connectivity  Health and condition	<ul style="list-style-type: none"> <li>Determine if collection and analysis of fecal DNA is a logistically and economically viable technique to estimate woodland caribou population size, to monitor range occupancy, and to assess pregnancy rates, genetic connectivity between populations, and genetic status within a population.</li> <li>Evaluate the use of caribou track locating as a means of estimating population distribution and habitat use.</li> </ul>
	Necessary	<b>5B</b> Maintain caribou habitat value	Habitat connectivity	<ul style="list-style-type: none"> <li>Evaluate the success of reforestation and linear corridor restoration in maintaining caribou habitat in a state suitable for caribou but not for other ungulates.</li> <li>Determine the forest development stage which represents functional recovery from anthropogenic disturbance.</li> </ul>
	Urgent	<b>5C</b> Collaboration with external partners	Lack of knowledge	<ul style="list-style-type: none"> <li>Encourage funding partnerships with industry to apply to caribou recovery, population monitoring, and research.</li> <li>Ensure research contributes to caribou conservation within an adaptive management framework.</li> </ul>

## Conservation Strategy Implementation

Woodland caribou populations and habitat will be evaluated periodically to determine the success of management practices. Proposed major developments that require an environmental assessment would trigger reassessment of risk. Conservation strategy implementation will occur through range plans, beginning with the Boreal Plain.

### Range Plans

Under the [Recovery Strategy for the Woodland Caribou, Boreal population \(\*Rangifer tarandus caribou\*\) in Canada](#), the province is responsible for developing range plans for caribou recovery. A range plan is a focused and detailed land use plan that demonstrates how the habitat condition within a given range will be managed over time and space to ensure that critical habitat for caribou is protected from destruction, so that each local population will become self-sustaining over time.

Range plans will evaluate the current status of caribou habitat and will provide specific direction for activities affecting caribou habitat, to ensure integration of caribou conservation on the planning landscape. Range plans must be flexible, responsive to new evidence on caribou populations and boreal ecology. They must be able to accommodate changes in the social and industrial needs of the region, and respond to natural disturbances such as wildfire. The plan must be adaptable to unforeseen situations without compromising the long-term goal. Range plans will be developed with the involvement of affected industries, First Nation and Métis communities and interested stakeholders.

## Acknowledgments

Saskatchewan Ministry of Environment wishes to thank the members of the Woodland Caribou Management Team and Working Group for their contributions to the development of this document.

We greatly appreciate the contributions of the biologists, technicians, First Nations and Métis' people, industries, and agencies that collected and reported caribou data over the years, and enabled the assessment of woodland caribou range and distribution in Saskatchewan.

## Context

The Woodland Caribou Working Group (WCWG) under the direction of the Saskatchewan Woodland Caribou Management Team (WCMT) prepared this document. Management strategies presented in this document were based on biological science, and where available, supported by local and traditional knowledge. The strategies are intended to enable the protection of existing boreal woodland caribou populations and to prevent them from further decline in Saskatchewan. To the extent practical, declining populations will be restored to a self-sustaining level. The contents of this document may not represent the official positions of all organizations represented on the WCMT or the views of all the individuals involved in preparation of this document. Recovery actions to achieve the goals and objectives of this conservation strategy are subject to the priorities, budgetary constraints and certain regulatory and legal considerations of participating agencies and organizations. The goals, objectives and recovery prescriptions may be modified in the future to accommodate new objectives or information.

# Woodland Caribou Management Team

Gigi Pittoello (co-chair) <sup>a</sup>	Saskatchewan Ministry of Environment, Fish and Wildlife
Tim Trottier (co-chair) <sup>a</sup>	Saskatchewan Ministry of Environment, Fish and Wildlife
Al Arsenault <sup>ab</sup>	Saskatchewan Ministry of Environment, Fish and Wildlife
Marcy Bast	SaskPower Corporation
Rhys Beaulieu <sup>b</sup>	Saskatchewan Ministry of Environment
Cliff Buettner	Prince Albert Grand Council
Clint Chernoff	Saskatchewan Wildlife Federation
Seth Cherry	Prince Albert National Park
Brian Christensen <sup>b</sup>	Weyerhaeuser Saskatchewan Ltd, Forestlands
John Daisley <sup>a</sup>	Weyerhaeuser Saskatchewan Ltd, Forestlands
Kent England <sup>a</sup>	Saskatchewan Mining Association
Peter Flood <sup>a</sup>	Saskatchewan Environmental Society
Dan Frandsen <sup>b</sup>	Prince Albert National Park
Dana Fairlie <sup>bc</sup>	SaskPower Corporation
Ryan Kay <sup>ab</sup>	Federation of Saskatchewan Indian Nations
Sarah Kemp de Gerada	Métis Nation of Saskatchewan
Travis Kiel	Tolko Industries Ltd.
Dave Knight	Sakâw Askiy Management Inc.
Ed Kowal <sup>b</sup>	Saskatchewan Ministry of Environment, Fish and Wildlife
Larry Kratt <sup>bc</sup>	Nexen Canada Inc.
Terrance Lewis <sup>b</sup>	Agency Chiefs Tribal Council
Dorothy MacAuley <sup>bc</sup>	Saskatchewan Northern Affairs
Pat Mackasey	Saskatchewan Ministry of Environment, Forest Service
Russell Roberts <sup>b</sup>	Kitsaki/Zelensky Limited Partnership
Roger Nездoly	Mistik Management Ltd.
Wayne Pepper	Nature Saskatchewan
Clifford Ray	Northern Saskatchewan Trappers Association
Phil Reeves <sup>bc</sup>	Saskatchewan Mining Association
Colleen Rickard <sup>b</sup>	Canadian Parks and Wilderness Society
Murray Rogers	Saskatchewan Ministry of Energy and Resources
Vern Studer	Saskatchewan Trappers Association
Hal Stupnikoff	Saskatchewan Outfitters Association
Rob Tether	Saskatchewan Ministry of Environment, Fish and Wildlife
Lorne Topley <sup>b</sup>	Saskatchewan Wildlife Federation
Gord Vaadelanda	Canadian Parks and Wilderness Society
Bob Wasylyk	Mee-Too's Forest Products Ltd.

a Woodland Caribou Working Group member

b Former Woodland Caribou Management Team member

c Observer status

# Woodland Caribou Management Team Terms of Reference

## Purpose

At the request of the Minister of Saskatchewan Environment, the Woodland Caribou Management Team (WCMT) was charged with development of a woodland caribou conservation strategy. The Woodland Caribou Management Team (WCMT) and Woodland Caribou Working Group (WCWG) developed this provincial conservation strategy within the framework of existing legislation, policies and legal agreements. The purpose of the provincial strategy is to maintain woodland caribou and their habitats in the Boreal Shield, and to ensure viability of woodland caribou populations in the Boreal Plain.

## Role of the Woodland Caribou Management Team

The WCMT role was to consider the input of all interested parties in development of a woodland caribou recovery action plan. The WCMT was responsible for reviewing and approving the strategies developed by the Woodland Caribou Working Group (WCWG), and to collectively submit the recommendations for woodland caribou conservation compiled in this document to the Minister of Saskatchewan Environment.

## Role of the Woodland Caribou Working Group (WCWG)

At the direction of the WCMT, the WCWG was responsible for preparing the draft recovery action plan using scientific and technical information, and community knowledge. The WCWG was to keep the WCMT informed of work progress through regular WCMT meetings. The WCWG was to be led with full time commitment of a member of the WCWG, and part time participation of any WCMT member or person they delegate.

## Role of the Chair

The Chair role was to ensure meetings were conducted in an orderly manner, according to the agenda. The Chair was also responsible for scheduling meetings, providing agendas, circulating minutes to members, ensuring that the team met timelines for project completion, and that minutes were taken properly and accurately.

## Role of the Facilitator

The Facilitator, although not required, was to remain neutral and lead discussion in which the chair was obligated to participate.

## WCMT Membership

WCMT membership consisted of:

- Representatives of provincial (Saskatchewan Environment, Saskatchewan Northern Affairs, Saskatchewan Industry and Resources) and federal governments (Parks Canada).
- Representatives of Aboriginal (i.e. First Nations, Métis') organizations, industry, small business, and interest groups that may potentially be impacted by woodland caribou recovery planning, and/or those who have an impact on woodland caribou and/or caribou habitat.
- Members were responsible for keeping the group they represented, informed of progress of the project.
- Designated alternates were to be kept up-to-date by their respective permanent WCMT member.
- Observers were welcome to attend meetings, but were not part of the discussions until the meeting chair invited their participation.
- Observers could request in advance, to address an area of concern with the WCWG or WCMT.

## Commitment

The WCMT was expected to:

- Work within the framework of existing legislation, policies and legal agreements.
- Meet regularly, up to four times per year.
- Have the WCWG meet more often, usually between WCMT meetings.
- Have a full complement of members or their alternates attend meetings.
- Review and comment on material prepared by the WCWG.
- Keep groups informed of progress of the project, through members representing them.
- Maintain communication with land use planning groups.

## Literature Cited

- Acton, D.F., G.A. Padbury, and C.T. Stushnoff. 1998. The ecoregions of Saskatchewan. Canadian Plains Research Center, University of Regina. 205 pp.
- Adams, L.G., F.J. Singer, B.W. Dale. 1995. Caribou calf mortality in Denali National Park, Alaska. *J. Wildl. Manage.* 59(3):584-594.
- Akçakaya, H.R. 2001. Linking population-level risk assessment with landscape and habitat models. *The Science of the Total Environ.* 274(2001):283-291.
- Anderson, R.B. 1999. Peatland habitat use and selection by woodland caribou (*Rangifer tarandus* caribou) in northern Alberta. M.Sc. Thesis, Environ. Biol. And Ecol. Dept. of Biological Sciences, Univ. of Alberta, Edmonton. 49 pp.
- Arsenault, A.A. 2003. Status and Conservation Management Framework for Woodland Caribou (*Rangifer tarandus* Caribou) in Saskatchewan. Fish and Wildlife Technical Report 2003-3. 40pp.
- Bergerud, A.T. 1974. Decline of caribou in North America following settlement. *J. Wildl. Manage.* 38(4):757-770.
- Bergerud, A.T. 1980. A review of the population dynamics of caribou and wild reindeer in North America. Pp 556-581 in E. Reimers, E. Gaare, and S. Skjenneberg, eds. *Proc. 2nd Internat. Reindeer/Caribou Symposium*, Trondheim, Norway. 799 pp.
- Bergerud, A.T., R.D. Jakimchuk, and R.D. Carruthers. 1984b. The buffalo of the north: caribou (*Rangifer tarandus*) and human developments. *Arctic* (37(1)):7-22.
- Beissinger, S.R. and M.I. Westphal. 1998. On the use of demographic models of population viability in endangered species management. *J. Wildl. Manage.* 62(3):821-841.
- Bradshaw, C.J.A., D.M. Hebert, A.B. Rippin, and S. Boutin. 1995. Winter peatland habitat selection by woodland caribou in northeastern Alberta. *Can. J. Zool.* 73:1567-1574.
- Brewster, D. 1988. Status of woodland caribou and moose populations near Key Lake in northern Saskatchewan. *Sask. Parks, Rec. and Cult., Wildl. Br. Tech. Rep.* 88-1. 25 pp.
- Brown, C. and Johnstone, J.F. (2012) Once burned, twice shy: Repeat fires reduce seed availability and alter substrate constraints on *Picea mariana* regeneration. *Forest Ecology and Management* 266: 34-41.
- Brown, W. K. and I. Ross., 1994, Caribou-vehicle collisions: A review of methods to reduce caribou mortality on Highway 40, west-central Alberta. Alberta Environmental Protection and Alberta Transportation and Utilities. 69 pp.
- Brown, K.G., C. Elliot, and F. Messier. 2000. Seasonal distribution and population parameters of woodland caribou in central Manitoba: implications for forestry practices. *Rangifer*, Special Issue No. 12:85-94.
- Callaghan, C., Virc, S. and Duffe, J. 2011. Woodland caribou, boreal population, trends in Canada. *Canadian Biodiversity: Ecosystem Status and Trends 2010*, Technical Thematic Report No. 11. Canadian Councils of Resource Ministers. Ottawa, ON. iv + 36 p.  
<http://www.biodivcanada.ca/default.asp?lang=En&n=137E1147-0>.
- Cameco Corporation. 1994. McArthur River Project, Environmental Impact Statement: McArthur River-Key Lake Socio-Economic Study Report. Appendix 3. Volumes 1 & 2.
- Canadian Wildlife Service/Statistics Canada. 1993. The Importance of Wildlife to Canadians: a statistical compendium for Saskatchewan in 1991. Environment Canada. 270 pp.
- Caughley, G. 1976. Wildlife management and the dynamics of ungulate populations. Pp. 183-146 in T. H. Croaker (ed.) *Applied Biology*. Vol. 1. Academic Press. New York.
- Curatolo, J.A. and S.M. Murphy. 1986. The effects of pipelines, roads and traffic on the movement of caribou, *Rangifer tarandus*. *Can Field Nat.* 100:218-225.
- Darby, W.R. and W.O. Pruitt Jr. 1984. Habitat use, movements and grouping behaviour of woodland caribou, *Rangifer tarandus* caribou, in southeastern Manitoba. *Can. Field Nat.* 98:184 - 190.

- Dyer, S.J. 1999. Movement and distribution of woodland caribou (*Rangifer tarandus caribou*) in response to industrial development in northeastern Alberta. M.Sc. Thesis, Dept. Environmental Biology and Ecology, Univ. of Alberta.
- Dyer, S.J., J.P. O'Neill, S.M. Wasel, and S. Boutin. 2001. Avoidance of industrial development by woodland caribou. *J. Wildl. Manage.* 65(3): 531-542.
- Dzus, E. 2001. Status of the woodland caribou (*Rangifer tarandus caribou*) in Alberta. Alberta Environment, Fisheries and Wildlife Management Division, and Alberta Conservation Association, Wildlife Status Report No. 30, Edmonton, AB. 47 pp.
- Edmonds, E.J. 1988. Population status, distribution, and movements of woodland caribou in west central Alberta. *Can. J. Zool.* 66:817-826.
- Edmonds, E.J. and M. Bloomfield. 1984. A study of woodland caribou (*Rangifer tarandus caribou*) in west central Alberta, 1979-1983. Alberta Energy and Nat. Resour., Fish and Wildl. Div. Rep., Edmonton. 203 pp.
- Environment Canada. 2012. Recovery Strategy for the Woodland Caribou, Boreal population (*Rangifer tarandus caribou*) in Canada. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa xi + 138 pp.
- Euler, D.L., B. Snyder, and H.R. Timmerman. 1976. Woodland caribou and plant communities on the Slate Islands, Lake Superior. *Can. Field Nat.* 90:17-21.
- Fahrig, L and G. Merriam. 1985. Habitat connectivity and population survival. *Ecology* 66:1762 – 1768.
- Fahrig, L. and G. Merriam. 1994. Conservation of fragmented populations. *Conserv. Biol.* 8:50-59.
- Filion, F.L., E. Dewors, P. Boxall, P. Bouchard, R. Reid, P.A. Gray, A. Bath, A. Jacquemot and G. Legare. 1993. The Importance of Wildlife.
- Fryxell, J.M., J. Greever, and A.R.E. Sinclair. 1988. Why are migratory ungulates so abundant? *Am. Nat.* 131: 781-798.
- Fuller, T.K. and L.B. Keith. 1981. Woodland caribou population dynamics in northeastern Alberta. *J. Wildl. Manage.* 45(1):197-213.
- Godwin, G.F. 1986. Fertility and twinning in Canadian reindeer. Pp 145-158 in Proc. 4th Intern. Reindeer/Caribou Symposium, Whitehorse, Yukon, Canada. Nordic Council for Reindeer Research, Harstad, Norway.
- Godwin, B. and J. Thorpe. 2000. Status of the woodland caribou (*Rangifer tarandus caribou*) in Saskatchewan. *Sask. Environ. and Resour. Manage., Fish and Wildlife Br.* 44 pp.
- Griffith, B., D.C. Douglas, D.E. Russell, and R.G. White. 2004. Differential effects of summer and winter warming on caribou habitats and population characteristics. Session 22 presentation at The Wildl. Soc. 11th Annual Convention, Sep. 20, 2004.
- Hanson, E., R. Fletcher, B. Cashmore, and C. McDermott. 2006. Forest Certification in North America. Oregon State University Extension Service. 12 pp.
- Hansen, J., M Sato and R. Ruedy. 2012. Perception of Climate Change. *Proceedings of the National Academy of Sciences of the United States of America*, Early Edition vol. 109 no. 37. 2415-2423. doi/10.1073/pnas.1205276109.
- Harrington, F.H. 1996. Human impacts on George River caribou. *Rangifer Special Issue No. 9*:277-278.
- Haufler, J.B., R.K. Baydack, H. Campa III, B.J. Kernohan, C. Miller, L.J. O'Neil, and L. Waits. 2002. Performance measures for ecosystem management and ecological sustainability. Technical Review 02-1. The Wildlife Society. Bethesda, MD. 31 pp.
- Hettinga, P. N., M. Manseau, A. N. Arnason, D. Cross, K. Whaley, P. J. Wilson. 2012. Estimating size and trend of the North Interlake woodland caribou population using fecal-DNA and capture-recapture models. *Journal of Wildlife Management* DOI: 10.1002/jwmg.380.
- Hillis, T.L., F.F. Mallory, W.J. Dalton, and A.J. Smiegelski. 1998. Preliminary analysis of habitat utilization by woodland caribou in northwestern Ontario using satellite telemetry. *Rangifer special Issue No. 10*: 195-202.
- Indian Northern Affairs Canada. 2006. [www.ainac-inac.gc.ca/index-eng.asp](http://www.ainac-inac.gc.ca/index-eng.asp).
- Jackson, S.D. 2000. Overview of transportation impacts on wildlife movements and populations.. Pp 7-20 in Messmer, T.A. and B. West, Eds. *Wildlife and Highways: Seeking Solutions to an Ecological and Socio-economic Dilemma*. The Wildlife Society.
- James, A.R.C. 1999. Effects of industrial development on the predator-prey relationship between wolves and caribou in northeastern Alberta. Ph.D. thesis. Univ. of Alberta, Edmonton. 70 pp.

- James, A.R.C. and A.K. Stuart-Smith. 2000. Distribution of caribou and wolves in relation to linear corridors. *J. Wildl. Manage.* 64(1):154-159.
- Johnson, D.R. 1985. Man-caused deaths of mountain caribou in southeastern British Columbia. *Can. Field. Nat.* 99(4):542-544.
- Kelsall, J.P. 1984. Status report on the woodland caribou, *Rangifer tarandus caribou*, in Canada in 1982. Committee on the Status of Endangered Wildlife in Canada. 99 pp.
- Klein, D.R. 1982. Fire, lichens and caribou. *J. Range. Manage.* 35:390-395.
- Lacy, R.C. 1997. Importance of genetic variation to the viability of mammalian populations. *J. of Mammal.* 78:320-335.
- Lande, R. 1988. Genetics and demography in biological conservation. *Science* 241:1455-1460.
- McDonald, J.E. and A.M. Martell. 1981. Twinning and post-partum activity in barren-ground caribou. *Can. Field Nat.* 95(3):354-355.
- McLoughlin, P.D., E. Dzuz, B. Wynes and S. Boutin. 2003. Declines in Populations of Woodland Caribou to Canadians: Highlights of the 1991 Survey. Canadian Wildlife Service, Environment Canada, Ottawa. *J. Wildl. Manage.* 67(4): 755-761
- Mitchell GB, Sigurdson CJ, O'Rourke KI, Algire J, Harrington NP, et al. (2012) Experimental Oral Transmission of Chronic Wasting Disease to Reindeer (*Rangifer tarandus tarandus*). *PLoS ONE* 7(6): e39055. doi:10.1371/journal.pone.0039055  
Natural Resources Canada. 2011. [canadaforests.nrcan.gc.ca/indicator/independent-certification](http://canadaforests.nrcan.gc.ca/indicator/independent-certification) accessed June 6, 2011.
- Racey, G., D. and A. A. Arsenault. 2007. In search of a critical habitat concept for Woodland Caribou, boreal population. *Rangifer Special Issue* 17:29-37.
- Racey, G., A. Harris, L. Gerrish, T. Armstrong, J. McNichol and J. Baqker. 1999. Forest management guidelines for the conservation of woodland caribou: a landscape approach. MS draft. Ontario Ministry of Natural Resources, Thunder Bay, Ontario. 69 pp.
- Reed, J.M., P.D. Doerr, and J.R. Walters. 1986. Determining minimum population sizes for birds and mammals. *Wildl. Soc. Bull.* 14:255-261.
- Rettie, W.J. 1998. The ecology of woodland caribou populations in central Saskatchewan. Ph.D. Thesis, Dept. of Biology, Univ. of Saskatchewan, Saskatoon.
- Rettie, W.J., and F. Messier. 1998. Dynamics of woodland caribou populations at the southern limit of their range in Saskatchewan. *Can. J. Zool.* 76(2):251-259.
- Rettie, W.J., and F. Messier. 2000a. Hierarchical habitat selection by woodland caribou: it's relationship to limiting factors. *Ecography* 23:466-478.
- Rettie, W.J., and F. Messier. 2000b. (draft submitted to *J. Wildl. Manage.*) Range use and movement rates of woodland caribou in Saskatchewan.
- Rettie, W.J., and F. Messier. 2001. Range use and movement rates of woodland caribou in Saskatchewan. *Can. J. Zool.* 79:1933-1940.
- Rock, T.W. 1992. A proposal for the management of woodland caribou in Saskatchewan. *Sask. Nat. Resour., Wildl. Br. Tech. Rep.* 92-3. 28 pp.
- Saunders, D.A., R.J. Hobbs and C.R. Margules. 1991. Biological consequences of ecosystem fragmentation: a review. *Conserv. Biol.* 5:18-32.
- Shaffer, M.L. 1981. Minimum population sizes for species conservation. *BioScience* 31:131-134.
- Schaeffer, J.A. 2003. Long-term range recession and the persistence of caribou in the taiga. *Conserv. Biol.* 17(5):1435-1439.
- Schaeffer, J.A. , and W.O. Pruitt, Jr. 1991. Fire and woodland caribou in southeastern Manitoba. *Wildl. Monogr.* 116:1-39.
- Scotter, G.W. 1964. Effects of forest fires on the winter range of barren-ground caribou in northern Saskatchewan. *Can. Wildl. Serv. Wildl. Manage. Bull. Ser 1, No. 18.* 111 pp.
- Seip, D.R., 1991. Predation and caribou populations. *Rangifer Special Issue No. 7:*46-52.
- Shoesmith, M.W. and D.R. Storey. 1977. Movements and associated behaviour of woodland caribou in central Manitoba. *Man. Dept. Renew. Resour. and Transp. Serv. Research MS Rep* 77-15. 24 pp.
- Smith, K.G., E.J. Ficht, D. Hobson, T.C. Sorensen, and D. Hervieux. 2000. Winter distribution of woodland caribou in relation to clear-cut logging in west-central Alberta. *Can. J. Zool.* 78:1433-1440.
- Stuart-Smith, A.K., C.J.A Bradshaw, S. Boutin, D.M. Hebert, and B. Rippin. 1997. Woodland caribou relative to landscape patterns in northeastern Alberta. *J. Wildl. Manage.* 61(3):622-633.

- Tanguay, Mark R., Wiktor L. Adamowicz, and Peter C. Boxall. 1995. An Economic Evaluation of Woodland Caribou Conservation Programs in Northwestern Saskatchewan. Dept. of Rural Economy, U. of Alberta. 58pp.
- Thomas, D.C. and D.R. Gray. 2001. Updated COSEWIC status report on "Forest-dwelling" woodland caribou, caribou des bois, *Rangifer tarandus caribou*. Draft report to Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 115 pp.
- Thomas, D.C. , and P. Kroeger. 1981. Digestibility of plants in ruminal fluids of barren-ground caribou. *Arctic* 34:321-324.
- Thomas, D.C., E.J. Edmonds, and W.K. Brown. 1996. The diet of woodland caribou populations in west-central Alberta. *Rangifer Special Issue* 9:337-342.
- Thomas, D.C., P. Kroeger, and D. Hervieux. 1984. In vitro digestibilities of plants utilized by barren-ground caribou. *Arctic* 37:31-36.
- Tobias, T.N. and J. J. Kay. 1994. The Bush Harvest in Pinehouse, Saskatchewan, Canada. *Arctic* Vol. 47 No. 3. P. 207-221.
- Trottier, T.W.P. 1987. Status of Woodland Caribou in Saskatchewan, 1985: A Preliminary Assessment. Proceedings of the Workshop on Endangered Species in the Prairie Provinces. Occasional Paper No. 9. 7pp.
- Trottier, T.W.P 1988a. The natural history of woodland caribou (*Rangifer tarandus caribou*). Sask. Parks, Rec. and Cult., Wildl. Br., Wildl. Pop. Manage. Information Base. 88-WPM-10.
- Trottier, T.W.P. 1988b. A survey of woodland caribou occurrences in Saskatchewan, 1960-1987. Sask. Parks, Rec. and Cult., Wildl. Br., Wildl. Pop. Manage. Information Base. 88-WPM-9.
- Trottier, T.W.P. 1994. Status of woodland caribou and moose populations near Key Lake in northern Saskatchewan. Sask. Env. and Resour. Manage. Wildl. Br. tech. Rep. 94-4. 21 pp.
- Vors, L.S., J.A. Schaefer, and B.A. Pond. 2006. Woodland caribou extirpation and landscape disturbance in Ontario. 11th North Amer. Caribou Conference, Jasper.

