Integrated Range Assessment for Woodland Caribou and their Habitat

Sydney Range 2012

Ministry of Natural Resources and Forestry
Species at Risk Branch

December 2014

Version 1.1

Cite as: MNRF. 2014. Integrated Range Assessment for Woodland Caribou and their Habitat: Sydney Range 2012. Species at Risk Branch, Thunder Bay, Ontario, ix + 68pp.

For a copy of the *Integrated Assessment Protocol for Woodland Caribou Ranges in Ontario* (2014) and the *Delineation of Woodland Caribou Ranges in Ontario* (2014), please email caribou@ontario.ca

Table of Contents

List of Figures

List of Tables

Acknowledgements

This Integrated Range Assessment was a team effort. Science and Information Branch representatives Gerry Racey, Tricia Greer, Glen Brown, and Lyle Walton coordinated the provincial effort including training, standards development and oversight, and were supported by the Species at Risk Branch, Forests Branch, and the Provincial Caribou Technical Committee. The Integrated Range Assessment was supported by other Caribou Conservation Plan Implementation team members; Kevin Green, Lindsay McColm, Lyle Walton, Kevin Downing, Nancy Berglund, and Chris Stratton. Analytical support was provided by Glen Brown, Kevin Downing, Phil Elkie, Kevin Green, and Lyle Walton. The following district, regional and Ontario Parks staff were involved in the provision and review of data, participation in the aerial survey activities, or coordination and oversight of district activities: Christine Apostolov, Lesley Barnes, Renee Bausch, Jim Castle, Pam Dittrich, Lee Gerrish, Doug Gilmore, Christine Hague, Glen Hooper, Gregg Lloyd, John Myshrall, Trevor Park, Robert Partridge, Myles Perchuk, Bruce Ranta, Lori Skitt, Jen Smikalow, Shannon Walshe, and Nadine Thebeau. Thanks to the aerial survey pilots Dan Baron, Pat Dickey, Rob Fletcher, Kevin Grigsby, and Brent Wood from Aviation, Forest Fire and Emergency Services Branch.

Special thanks to the contributions of Dennis Brannen of the Wildlife Branch, Manitoba Conservation, for helping to make this an interagency effort as well as to the involvement of First Nations community members George Land (Wabaseemoong), Darrell Keeper (Pikangikum), Freddie Meeseewapetung and Isiah Pahpasay (Grassy Narrows), and Seymour Owen (Poplar Hill) in aerial survey efforts.

Preface

This Integrated Range Assessment Report is intended to support management decisions leading to the conservation of caribou and their habitat. It describes quantitative analysis and interpretation of four lines of evidence related to risk and range condition. It also documents ecological and management insight of resource managers who are familiar with present and past caribou occupancy and management history within the range. Implementation experience has also been documented where caribou conservation and habitat management activities have been applied.

Caution is warranted in the interpretation of the Integrated Range Assessment results due to the limitations of available data and conditions or circumstances that are not readily integrated in the analysis framework. This caution should be expressed by considering the context and results of the Integrated Range Assessment as a whole and not taking individual lines of evidence or data summaries out of context or interpreting them outside of their intended purpose as described in the *Integrated Assessment Protocol for Woodland Caribou Ranges in Ontario* ('Protocol'). The Protocol describes the specific intent and role for each section of the Integrated Range Assessment Report and its scientific basis.

The quantitative analysis was completed using the best and most current land-base and resource inventory information available for the year in which the winter distribution survey was conducted unless otherwise stated. These data vary substantially across Ontario in terms of availability, year of update, and conditions or standards under which the inventory was completed. Forest inventory data is periodically updated, improved and managed to track changes in forest condition; caribou distribution and recruitment surveys may be conducted during years of good or poor survey conditions and be subject to many extraneous influences; linear feature, and infrastructure data may reflect a wide diversity of physical expressions and biological implications, and roads data used in the analysis may include some older legacy roads for which current vegetative state is unknown or not discerned from the database. This type of variability is quite normal and expected, but presents challenges in interpretation and application of results. Data and analysis uncertainties are explicitly described in each Integrated Range Assessment Report to support thoughtful interpretation of the results within the flexibility provided by Ontario's *Range Management Policy in Support of Woodland Caribou Conservation and Recovery* (Range Management Policy).

While the assessment is information intensive, the interpretation of the four quantitative lines of evidence is strongly science-based, relying heavily upon fully documented scientific findings. Specific data sets used in the analysis were selected to represent the most appropriate trade-off between ecological and management relevance.

As this document represents an assessment of the conditions of this caribou range according to the year of the report, it does not consider socio-economic factors. Caribou ranges that are assessed as uncertain or insufficient to sustain caribou should not be interpreted as policy direction to stop sustainable resource management. The Range Management Policy and other planning documents (e.g., forest management guides, caribou best management

practices) provide resource managers with the tools that support sustainable use of Ontario's natural resources while maintaining or improving conditions for caribou.

Managers are encouraged to be fully aware of the scientific assumptions, data and analysis uncertainties and ecological and historical context when considering management actions informed by the Integrated Range Assessment.

Executive Summary

The vision in *Ontario's Woodland Caribou Conservation Plan* is to conserve Woodland Caribou (Forest-dwelling, boreal population; *Rangifer tarandus caribou*) (referred to as caribou herein) within the province to ensure self-sustaining populations in a healthy boreal forest. This vision is set in motion through Ontario's *Range Management Policy in Support of Woodland Caribou Conservation and Recovery* providing the direction needed to conserve and recover caribou in Ontario. The Range Management Approach provides spatial and ecological context for planning and management decisions. This *Integrated Range Assessment Report* is a fundamental component of the Range Management Approach because it provides the information required to identify the level of risk to caribou within a range, will help to support management decisions and lead to conservation of caribou occupying the range. It provides essential historical, ecological and contextual knowledge relevant to the range and its management. It relied on quantitative lines of evidence to identify the level of risk and range condition relative to its ability to sustain caribou.

The Sydney Range is located in northwestern Ontario and is approximately 7,500 km^2 in size. It is understood that the Sydney Range is part of a larger geographic unit for caribou with the neighbouring Owl-Flintstone Range in Manitoba.

The landscape of the Sydney Range is largely characterized as boreal forest with an aggressive fire regime and a high density of lakes with many irregular shorelines. It is primarily dominated by jack pine and black spruce forest with extensive bedrock exposure, shallow soil, and a sub-humid prairie-influenced climate.

Historical occupancy shows that caribou occurred in the western portion of the range. Areas of well documented use include a number of lakes in the southern portion of Woodland Caribou Provincial Park (i.e. Irregular, Sydney, and Aegean lakes), a bog complex associated with the Eagle-Snowshoe Lake chain, as well as the Detour and Upper Medicine Stone Lake area. Human settlement and impacts within the range are relatively extensive and some future developmental activities include forest harvest.

A two-stage (fixed-wing followed by rotary-wing) aerial winter distribution survey for caribou was conducted during February 2012 in which observations of caribou or their signs were recorded. During the rotary-wing flights, caribou were identified as adults, males or females, calves, or unknown age and sex. Data collected during the survey work was used to estimate population state metrics including a minimum animal count (MAC) of 55 caribou, as well as provide an estimate of calf recruitment. An additional aerial survey was conducted during late winter 2013 to further assess calf recruitment to support estimates of population trend. Recruitment rates over the two survey years (14-18 calves per 100 adult females) were lower than expected values thought to support a stable to increasing population trend (28 calves per 100 adult females).

Ten (10) adult female caribou were collared during February 2012. An annual survival estimate of these animals was good based on one biological year of data (91%), and when modelled

with the calf recruitment levels resulted in a geometric mean of λ = 0.98. This estimate suggests the population may be declining, but the metric is close to the point where the population may be considered stable.

A geospatial analysis estimated that 62.7% of the range can be currently characterized by natural and anthropogenic disturbances. The resulting likelihood of stable or increasing population growth is estimated to be 0.2 and at this level it is unlikely that the Sydney Range is capable of sustaining the caribou population.

Analysis of the amount of caribou habitat (which includes refuge habitat and winter habitat) does not align with that expected in a natural landscape. Habitat is fragmented relative to what would be expected in a natural landscape.

The Integrated Range Assessment concludes risk to caribou is high within the Sydney Range and range condition is insufficient to sustain caribou.

1.0 Overview

The Ministry of Natural Resources and Forestry (MNRF), then the Ministry of Natural Resource (MNR), adopted a Range Management Approach as directed by *Ontario's Woodland Caribou Conservation Plan* (CCP) (MNR 2009a). An *Integrated Range Assessment Report* (IRAR) is a major component of the Range Management Approach and will help to inform subsequent management decisions. This assessment evaluates habitat conditions, population trends, and cumulative impacts and relates these to measurable indicators of population health or habitat status. The Range Management Approach sets the spatial and ecological context for planning and management decisions within an adaptive management framework. The general components and mechanisms involved in the Integrated Range Assessment are described in the *Integrated Assessment Protocol for Woodland Caribou Ranges in Ontario* ('Protocol', MNRF 2014a) and are directed by the *Range Management Policy in Support of Woodland caribou Conservation and Recovery (Range Management Policy',* MNRF 2014b).

The Sydney Range and the adjacent Owl-Flintstone Range in Manitoba share common management and caribou conservation interests. Ontario recognizes that there is a benefit in collaborating on information sharing, and reporting on range condition. This Integrated Range Assessment demonstrates this collaborative approach in presenting data and discussing the management implications associated with a shared geography.

The year of the report represents when the winter distribution survey was completed; three subsequent years of recruitment surveys were conducted; disturbance assessment included data current as of the winter distribution survey; habitat assessment data included the best available information for the range.

2.0 Range Description and Delineation

The delineation of ranges within the Continuous Distribution of caribou in Ontario includes areas that are currently not occupied by caribou. Ontario's Range Management Approach provides an adaptive and transparent framework for defining, assessing and documenting risk to caribou. This framework accounts for the dynamic nature of boreal forest landscapes and the ability of caribou to tolerate some temporary or permanent disturbance within a range.

The Sydney Range is a small range in Ontario with a total area of approximately 7,500 km^2 (Figure 1). It neighbours the Berens and Churchill Ranges as well as the Manitoba border where it shares a common boundary with the Owl-Flintstone Caribou Range in Manitoba. The two ranges are generally accepted to function as one large range. It is believed that caribou in both these ranges utilize similar habitat types and share some level of connectivity across the provincial border. The proximity and a desire to collaborate on shared caribou conservation issues influenced the delineation of the Sydney Range. The Sydney Range was based on documented caribou occupancy at the south end of Woodland Caribou Provincial Park (WCPP), caribou move between Ontario and Manitoba, as well as historical occupancy patterns south of Red Lake (MNRF 2014c). The spatial extent of the Sydney Range is likely too small to support an independent and sustainable population of caribou, and therefore will

be considered to be ecologically inter-dependent, upon the ecological integrity of the Owl-Flintstone Range.

The towns of Red Lake, Balmertown, and Cochenour are situated in the northeastern corner of the range and are associated with human infrastructure and a long industrial development history; this portion of the range is considered to be highly and indefinitely disturbed. The town of Ear Falls is in the southeastern corner of the range. The remainder of the range is affected by widespread disturbances, temporal in nature, largely driven by fire and forest harvest (Figure 2, Figure 3, and Figure 4).

Portions of Kenora, Whiskey Jack, Red Lake, and Trout Lake Forest Management Units (FMUs) are within the Sydney Range. The western portion of the Sydney Range is comprised of WCPP and Eagle-Snowshoe Conservation Reserve.

The range is entirely within ecoregion 4S, specifically ecodistricts 4S-1 and 4S-2. It is characterized as having a high density of medium and small-sized lakes, extensive jack pine and black spruce, abundant bedrock exposure with shallow and coarse soils, and a prairie boreal climate affecting a portion of the range.

Minimal caribou movement has been documented across the Gammon River system with its deep and fine textured soils, high concentrations of mixedwood, and high moose densities, possibly contributing to a partial, natural barrier to movement. This system forms the northcentral and northwest boundary of the range shared with the Berens Range.

The eastern boundary largely follows the ecodistrict boundary between 4S-2, 3S-2, and 3S-5. The southern boundary of the Sydney Range is delineated as the southernmost extent of current modelled ecological capability for caribou and land identified as having a reasonable chance of caribou re-occupancy if habitat was managed for that outcome. This decision was influenced by the existence of the Werner Lake Road. The western boundary is administrative and follows the Ontario-Manitoba border.

Figure 1. Location of Sydney Range within the Continuous Distribution of caribou in Ontario.

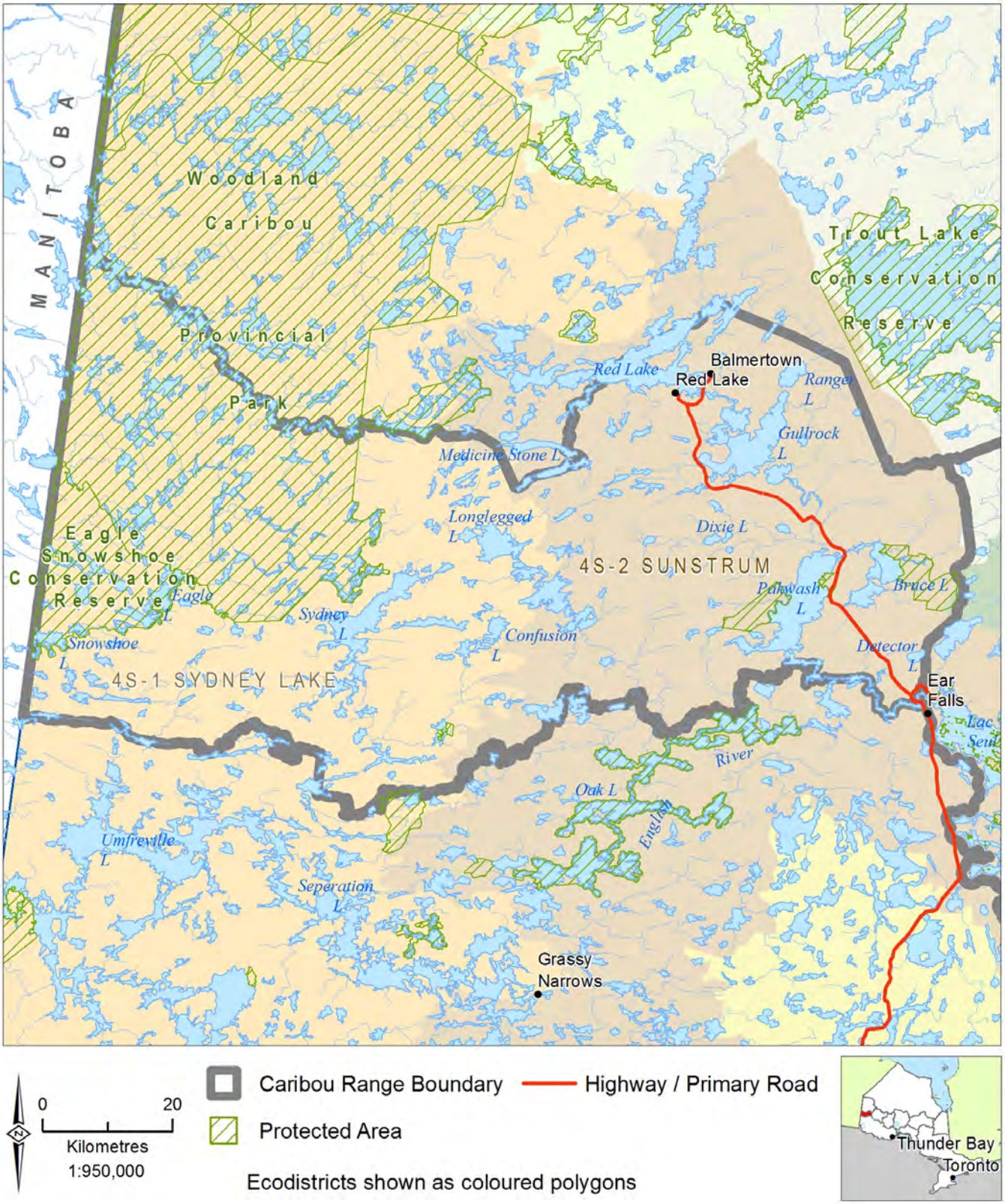


Figure 2. The Sydney Range and associated ecodistricts and protected areas.

3.0 Background Information and Data

3.1 Land management history and management direction

It is likely that caribou numbers and distribution on the Sydney Range have been influenced by a wide variety of natural and anthropogenic factors including large fires, blowdown, mineral exploration and mining activities, and forest management (Figure 3, Table 1), as well as human infrastructure such as roads, town sites, transmission corridors, hydroelectric facilities, and mineral development features (Figure 4, Table 1).

It is imperative to document and interpret the disturbance history within the range in order to better understand current caribou use. Implementation of the Range Management Approach is set against a backdrop of evolving management direction (Table 1). Figure 3, Figure 4, and Table 1 include land management history as well as natural and anthropogenic disturbances up until 2012.

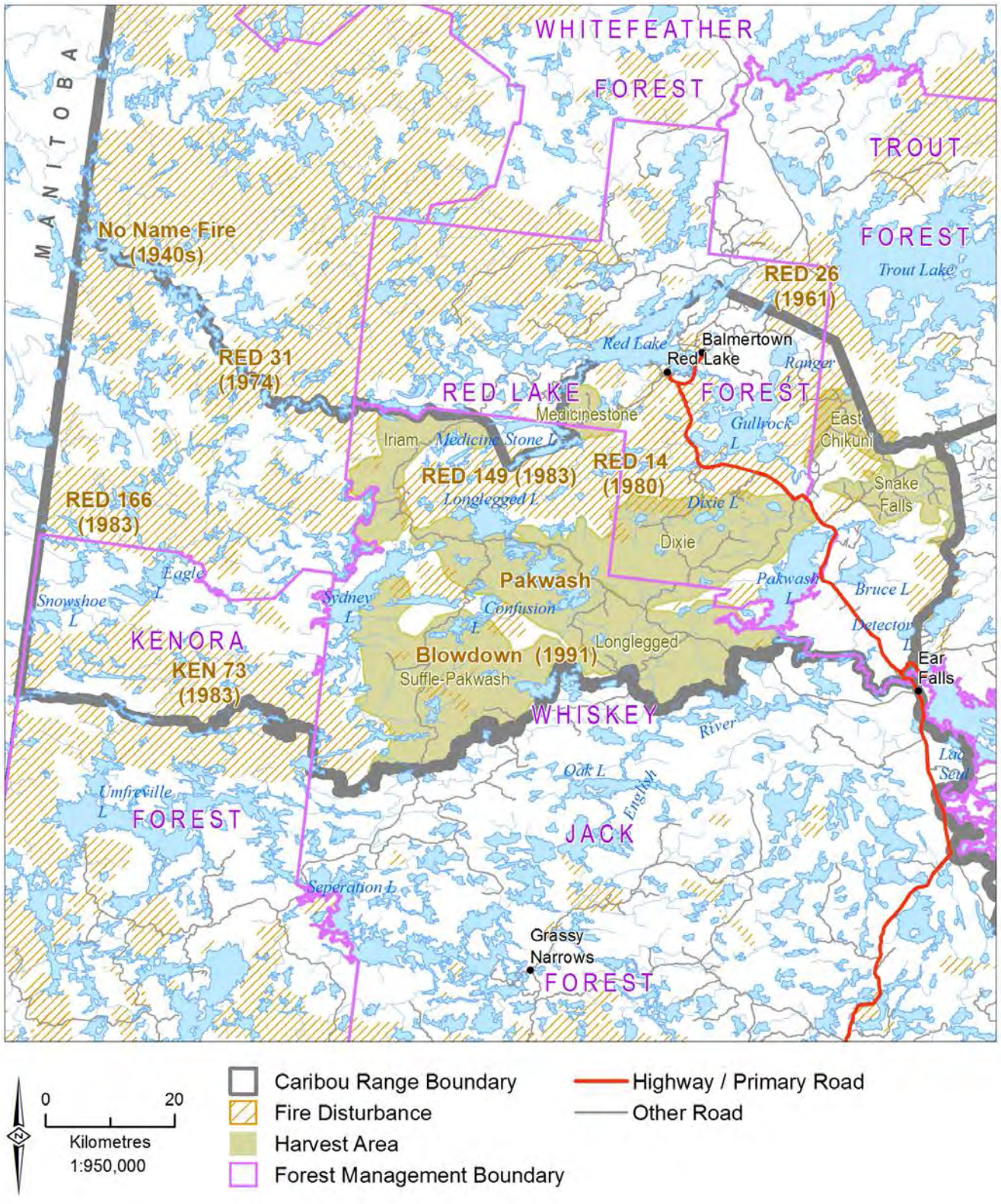


Figure 3. Dates and locations of significant historical natural and anthropogenic disturbances that have occurred within the Sydney Range.

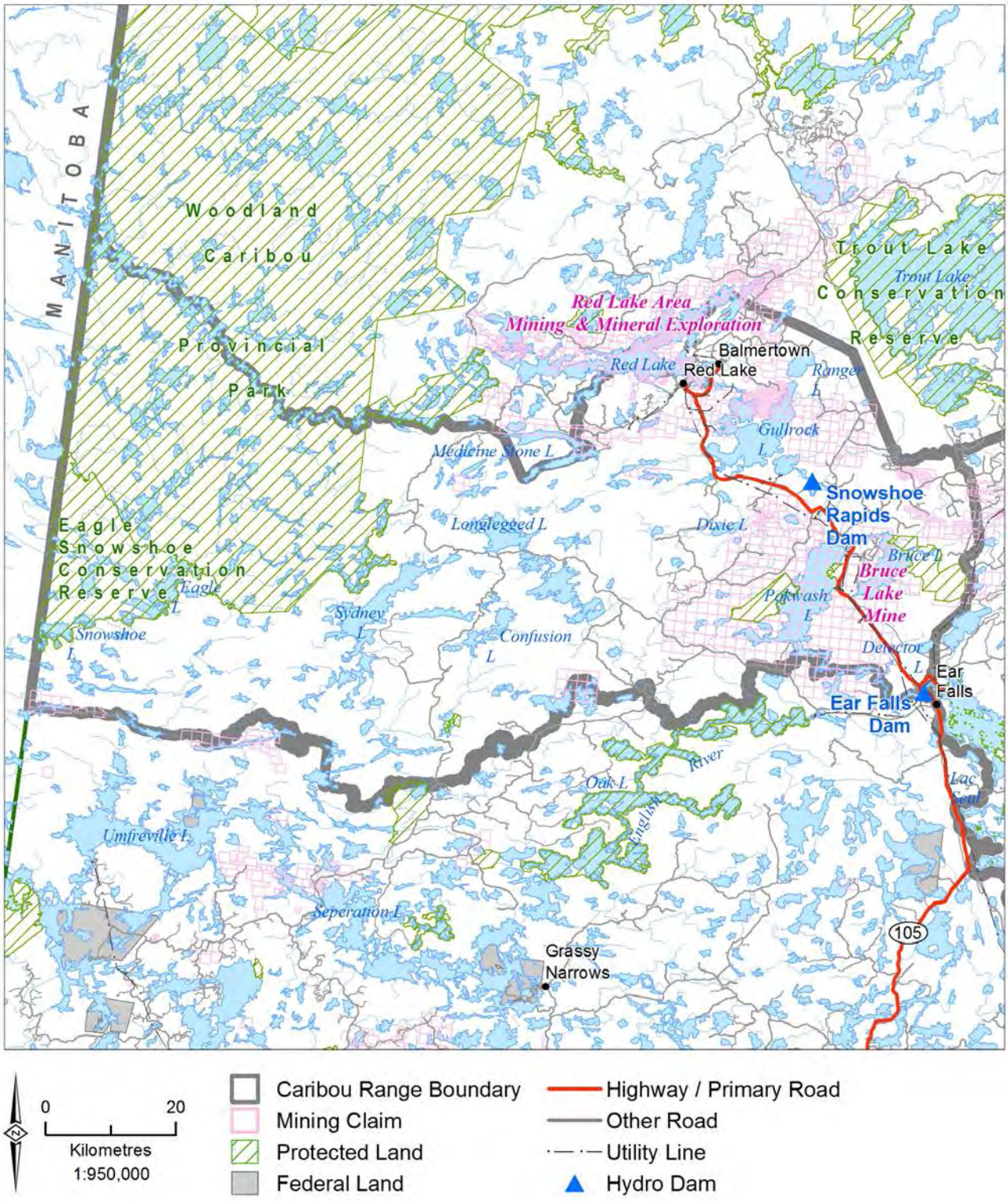


Figure 4. Human infrastructure and historical developments occurring within the Sydney Range.

Table 1. Historical timeline of significant events occurring in or near the Sydney Range.

Significant event, activity or direction			
Natural Disturbance	**Date**	**Description**	**Likely influence on caribou or its habitat**
Historical fires	Pre-1940	Frequent large and small fires.	The relatively young and strongly conifer dominated forests of the Sydney Range were likely always fragmented by large patches of young, regenerating conifer and mixed forests, suggesting the caribou in this range always had a patchy distribution. The aggressive fire regime has likely been the normal habitat renewal mechanism in this range.
No Name	1940-49	Series of fires in and around northern portion of WCPP. Occurred primarily on bedrock and shallow soils.	Large areas of jack pine dominated, open understory forest currently being used by caribou summer and intermittent winter use.
RED 14	1980	51,000 ha fire that burned a previously logged area.	Forms a very large tract of forest, 30 years of age with potential to provide for caribou habitat in the future, and forms the basis for inclusion of the eastern portion of the range.
KEN 73	1983	82,000 ha fire on predominantly shallow to moderately deep soils.	No previous management for caribou. Burn created large expanse of conifer dominated forest with high potential as future winter habitat and likely contributing to current refuge habitat value.
RED 149	1983	27,000 ha fire that expanded the extent of disturbance created by RED 14. Burned area at north end of Longlegged Lake and near Medicine Stone Lake.	Expanded size of even-aged conifer forest. High potential for the provision of future winter habitat on eastern portion of range, in close proximity to other currently used winter and summer habitats.

RED 166	1983	36,000 ha fire with little residual in southern portion of WCPP adjacent to Manitoba boundary.	Burned previously used winter and summer habitat including Irregular Lake area. Formed large tract of conifer dominated forest expected to be used as both winter and summer habitat in the future.
Pakwash Blowdown	1991	173,000 ha blowdown of which approximately 50% was salvaged. Conifer renewal was variable. Interspersed with past forest harvest operations.	High level of uncertainty with regard to future habitat potential in the absence of fire in the south-central portion of the range.
Infrastructure development	**Date**	**Description**	**Likely influence on caribou or its habitat**
Mining and mineral exploration in the Red Lake area	1926 - ongoing	McKenzie Island, Cochenour, McMarmac, Morrisett'es, Rahill, Balmer, Red Lake, Howey, Skookum Bay, St. Paul's Bay, Pipestone Bay, Rowan Lake, Wolf Bay, Slate Bay, Hoyles Bay, East Bay, McFinlay Peninsula, Dorion Island, Whitehourse Island, Snib Lake, Walsh Lake, Para Lake, Madsen Mine, Pineridge.	Historically caribou were around Red Lake and have been observed on Red Lake more recently (e.g. McNeely Bay, Pipestone Bay). Mining developments have likely added stressors to the caribou living in the vicinity of Red Lake through the increased cut lines, roads, human activity, etc.
Mining and mineral exploration east and west of the Hwy 105 corridor and south of Red Lake	1926 - ongoing	Large and small mining developments and mineral exploration on either side of the Hwy 105 corridor south of Red Lake including Baird , Bruce Lake, High Lake, Scott, Bay, and Tigar Lake.	The historical road networks, human activity, and mine site development combined with the effects of Hwy 105 and associated forest harvest activity create a significant challenge for future caribou use in the eastern portion of the range.

Horse logging	1930-50	Early horse logging occurred near all townsites and mine development for local use, and included the shorelines and water systems associated with Red Lake extending from Ear Falls area. A significant amount of this forest harvest occurred near major lakes and on fine textured soils.	Likely reduced the amount of quality caribou habitat adjacent to the major lakes including Red lake because sites largely renewed to balsam fir and popular mixed forests. They also may have influenced the desirability of these lakes as summer habitat.
Highway 105	1940	All-weather road between Ear Falls and Red Lake completed in 40s, paved in 60s.	Supported road-based forest harvest in eastern portion of the range and all forest harvest roads led to Hwy 105. Increased linear features on the landscape.
Suffle and Longlegged blocks	1970s-80s	Large areas of conifer renewal near fire RED 14 (1980) and RED 14, RED 149, KEN 73 (1983).	Extensive areas of conifer renewal with potential to produce future caribou habitat west of Hwy 105 and east of Woodland Caribou Provincial Park.
Snowshoe Rapids Dam	1963	Dam and access road constructed. Prior to 1963, a structure was in place to retain minimum water levels required for navigation throughout the associated five-lake system and for flood protection.	Limited footprint of the dam structure. Access road created permanent linear disturbance as well as tourism operation at the dam site. Initial flooding and continued maintenance of water levels may have impacted nearby wetland complexes.
Fishing and Hunting Lodges	Mid-1900s-present	Lodges and outpost camps occur on the largest calving lakes including Sydney Lake, Chase, Eagle, and Snowshoe.	Encourages activities in remote hunting and fishing sites and increases chances of encountering caribou and potentially creating a sensory disturbance on calving lakes. Tourism activity varies with season with a particularly high level of activity around the calving season. Sensory disturbance may displace caribou.

Land management direction	Dates	Description	Likely influence on caribou or its habitat
Wolf control	1945-72	Wolf bounty in effect	Early depressions of the wolf population that may have helped caribou persist through periods of early road-based forest harvest.
Trap line boundaries regulated	1947	Initiation of Ontario trapline system	Formed the basis for early reporting on wildlife occupancy and relative abundance which provided preliminary insight into historical occupancy.
Wildlife Management Units were implemented for big game management	1975	Under Game and Fish Act, 1983; moose targets then reduced in 2010.	Formed the basis for reporting on moose populations and trends as well as other species (where applicable).
Woodland Caribou Provincial Park (WCPP)	1983	Large protected area (485,000 ha) in western portion of the range. Some parts of the park already had some level of protection established as early as the 1940s when it discovered that caribou used the area.	Anchors caribou habitat on the western portion of the range but is subject to a very aggressive fire regime so habitat is not assured. Where old forest exists, habitat quality is generally high. Supports connectivity of caribou with the surrounding area, including Manitoba.
Draft of Caribou Guidelines	1992	First draft of forest management guidelines for conservation of woodland caribou habitat.	Initial application of the draft caribou conservation concepts from selected Forest Management Plans within the Northwest Region. These guidelines established a mosaic concept in support of planning for a sustainable supply of year-round habitat.
Public consultation	1993	Broad public consultation of caribou habitat management across northwest region.	Increased awareness and regional commitment to caribou conservation.

Northwest Region Interim Caribou Habitat Management Direction	1994	All forest management plans within Northwest Region committed to addressing caribou conservation.	These guidelines established a mosaic concept in support of planning for a sustainable supply of year-round habitat. Trout Lake Forest 1994 ; Red lake Forest 1992-1998, 1996-1998, 1998-2003; Whiskey Jack (1994-1999).
Draft of forest management guidelines for the provision of woodland caribou habitat	1994	Mandated application of caribou conservation concepts from all Forest Management Plans within the Northwest Region.	These guidelines established a mosaic concept in support of planning for a sustainable supply of year-round habitat. (Trout Lake Forest in 1994; Red Lake Forest 1991).
Ontario's Living Legacy	1999	Creation of dedicated protected areas and Enhanced Management Areas with specific conservation considerations for caribou.	OLL additions to WCPP helped secure caribou habitat in the northcentral portion of the Sydney Range. The Eagle-Snowshoe Conservation Reserve provides long-term conservation value to calving and winter habitats south of WCPP and adjacent to the Owl-Flintstone Range in Manitoba.
Forest Management Guidelines for the Provision of Caribou Habitat: A Landscape Approach	1999	Comprehensive and endorsed management direction that implemented a landscape-based approach to habitat conservation including mosaic development and a strategic evaluation of habitat retention or allocation and renewal.	It aimed to maintain continuous supple of year-round caribou habitat distributed across the landscape and through time to ensure permanent range occupancy. Trout Lake Forest 1999, 2004, 2009, and 2019; Red Lake Forest 1998-2003, 2003-2008, 2008-2018; Whiskey Jack Forest 1999-2004, 2004-2009, 2009-2012, 2012-2022; Kenora Forest 1996-2001, 2001-2006, 2006-2011, 2011-2012, 2012-2022.
A Management Framework for Woodland Caribou Conservation in Northwestern Ontario	1999	Regional policy direction regarding caribou conservation and forest management.	Reaffirmation of regional interim direction for the application of caribou guidelines in northwestern Ontario with additional guidance in support of other management actions to conserve caribou.

Deer season	2004, 2009	Opened deer season in WMU 3 (2004) and WMU 2 (’09).	Reduction in alternate prey species for wolves and reduced likelihood of disease transmission.
Provincial Forest Access Road Funding Program	2005	Program was announced in 2005/06 as $28 million to maintain primary access roads and was expanded in 2006/07 to $75 million to include construction and maintenance of primary and secondary access roads.	Maintained or encouraged road building into previously inaccessible areas in support of resource development; increased linear disturbances within caribou habitat; facilitated mosaic planning and implementation.

The progression of anthropogenic disturbances within the Sydney Range (Table 1, Figure 3, and Figure 4) has largely had an east-to-west progression with early activity radiating outwards from Red Lake in the northeast and Ear Falls in the southeast. Highway 105 has added a persistent human presence to the eastern portion of the range and supported forest management operations that moved westward towards Sydney Lake. The cumulative contribution of these historical developments and wildfire has created a landscape heavily weighted towards high levels of disturbance in the east. Overall, fire and forest harvest have been the primary drivers of disturbance within the range.

3.2 Caribou occupancy history and assessment

Caribou observations within the Sydney Range have been identified and recorded within Land Information Ontario (LIO 2014). Observations documented in this report are current to August 2013 (Figure 5, Figure 6, and Figure 7). The summary of previous caribou assessments within the range that estimate or describe population size, health, or occurrence providing historical context and assisting with the interpretation of the current Integrated Range Assessment results (Table 2). These observations may include data results from surveys, collared caribou, research projects, as well as credible casual observations from MNRF staff and the general public (Figure 5, Figure 6, and Figure 7). Historically, these observations reflect our knowledge of caribou occurrence within the range and the possible response to changes in range condition.

Table 2. Previous assessments and reports for caribou relevant to the Sydney Range.

Date	Caribou occupancy assessment	Reference
1948	Estimated 100 caribou in the proposed game preserve in the Sydney Lake area based on aerial surveys in March 1948.	de Vos, A. 1948. Personal communication (letter), March 23. 1948. Dept. of Lands and Forests. Ontario
1948	Estimated one to two dozen caribou in the Sydney Lake area based on fieldwork in the July-August 1948.	de Vos, A. 1948. Report on a Trip to Sydney Lake between July 27, and August 2, 1948. Dept. of Lands and Forests. Ontario
1963	Aerial transect surveys in January 1963 of the Irregular Lake study area (Sydney, Snowshoe, Haggart, Medicine Stone lakes) (old Woodland Caribou Crown Game Preserve) yielded an estimated minimum animal count of 26 caribou with a density of 17.9 square miles per caribou.	Armstrong, A. 1963. Caribou Survey. Dept. of Lands and Forests. Ontario
1964	Aerial transect surveys in January 1964 of the Irregular Lake study area yielded a minimum animal count of 99 (possibly as many as 109) caribou in the area. Calves were estimated to make up 24.5% of the observed caribou classified to age.	Simkin, D. 1964. Aerial Survey for Caribou – Irregular Lake Study Area. Research Branch Report. Ontario
1965	Aerial transect surveys in January 1965 of the Irregular Lake study area yielded a minimum animal count of 91 (possibly as many as 101) caribou. Calves were estimated to make up 28% of the observed caribou classified to age.	Simkin, D. 1965. Aerial Survey for Caribou – Irregular Lake Study Area. Research Branch Report. Ontario
1966	Aerial transect surveys in January 1966 of the Irregular Lake study area yielded a minimum	Simkin, D. 1966. Aerial Survey for Caribou – Irregular Lake Study Area.

	animal population of 80 possibly as many as 90) caribou. Calves were estimated to make up 19% of the observed caribou classified to age.	Research Branch Report. Ontario
1968	Aerial transect surveys in January 1966 of the Irregular Lake study area yielded a minimum animal count of 51. Calves were estimated to make up 22.5% of the observed caribou classified to age. Caribou density was 0.012/km^2 (Wepruk 1985). Survey work was carried out under adverse weather.	Hagan, D. 1968. Aerial Survey for Caribou – Irregular Lake Study Area. Dept. of Lands and Forests. Ontario
1971	Aerial transect surveys in February 1971 of the Irregular Lake study area yielded a minimum animal count of 34, 4 of which were calves. In 1969 the minimum animal count was 183 in the Haggart and Irregular lake area. Caribou density was 0.008/km^2 (Wepruk 1986).	Buss. M. Irregular Lake Study Area - Aerial Survey for Caribou. Dept. of Lands and Forests. Ontario
1971	In February 1971, a survey in the Haggart and Irregular lake area yielded a minimum animal count of 90-100 caribou based on fresh tracks.	Irizawa, K. 1971. Pers Comm (memo)
1973	Aerial transect surveys in March 1973 of the Irregular Lake study area yielded a minimum animal count of 24 with a population estimate of 32 (English 1976), One caribou was identified as a calf. Caribou density 0.006/km^2 was (Wepruk 1986).	Busch, D. Irregular Lake Study Area - Aerial Caribou Survey 1973. Dept. of Lands and Forests. Ontario
1974	Aerial transect surveys in February 1974 of the Irregular Lake study area yielded a minimum animal count of 33 with a population estimate of 41 (English 1976). Caribou density was 0.008/km^2 (Wepruk 1986).	English, G. Aerial Caribou Survey 1974 - Irregular Lake Study Area. Dept. of Lands and Forests. Ontario
1976	Aerial transect surveys in March 1976 of the Irregular Lake study area yielded a minimum animal count of 46 and a population estimate of 58, two caribou were identified as calves. Caribou density was 0.011/km^2 (Wepruk 1986).	English, G. Aerial Caribou Survey - 1976 - Irregular Lake Study Area. Dept. of Lands and Forests. Ontario
1980	A total of 162 caribou were observed from aerial surveys in March 1980 resulting in an estimated 200 caribou inhabiting the Irregular, Know, Peisk lakes area (this area is larger than the survey areas reported above). A similar estimate of 200 caribou was noted in	Drysdale, P. 1980 Caribou Survey and Comments on Past Studies.

	March 1978 for the Peisk Lake area. In addition, 183 caribou were observed in 1969 by P. MacDonald during a special enforcement investigation in the Irregular Lake area.	
1985	Aerial transect survey flown over WCPP in the early winter of 1985. Population density of 0.053 caribou/km^2 was estimated. Wepruk references a West Patricia Winter Area study in 1979 with a density of 0.047/km^2 (Hamilton 1979) and a 1978 study in West Patricia with 11.6% calves (Hamilton 1978).	Wepruk, R. 1986. Woodland Caribou Provincial Park Technical Report #3. MNR, Red Lake District. Hamilton, G.D. 1978. Aerial census of woodland caribou in the West Patricia Planning Area. West Patricia. Wildl. Tech. Report. No. 6. OMN. Kenora. Unpublished. 14p. Hamilton, G.D. 1979. A study of some woodland caribou wintering areas within the West Patricia Planning Area. West Patricia. Wildl. Tech. Report. No. 16. MNR. Kenora. Unpublished. 21 p.

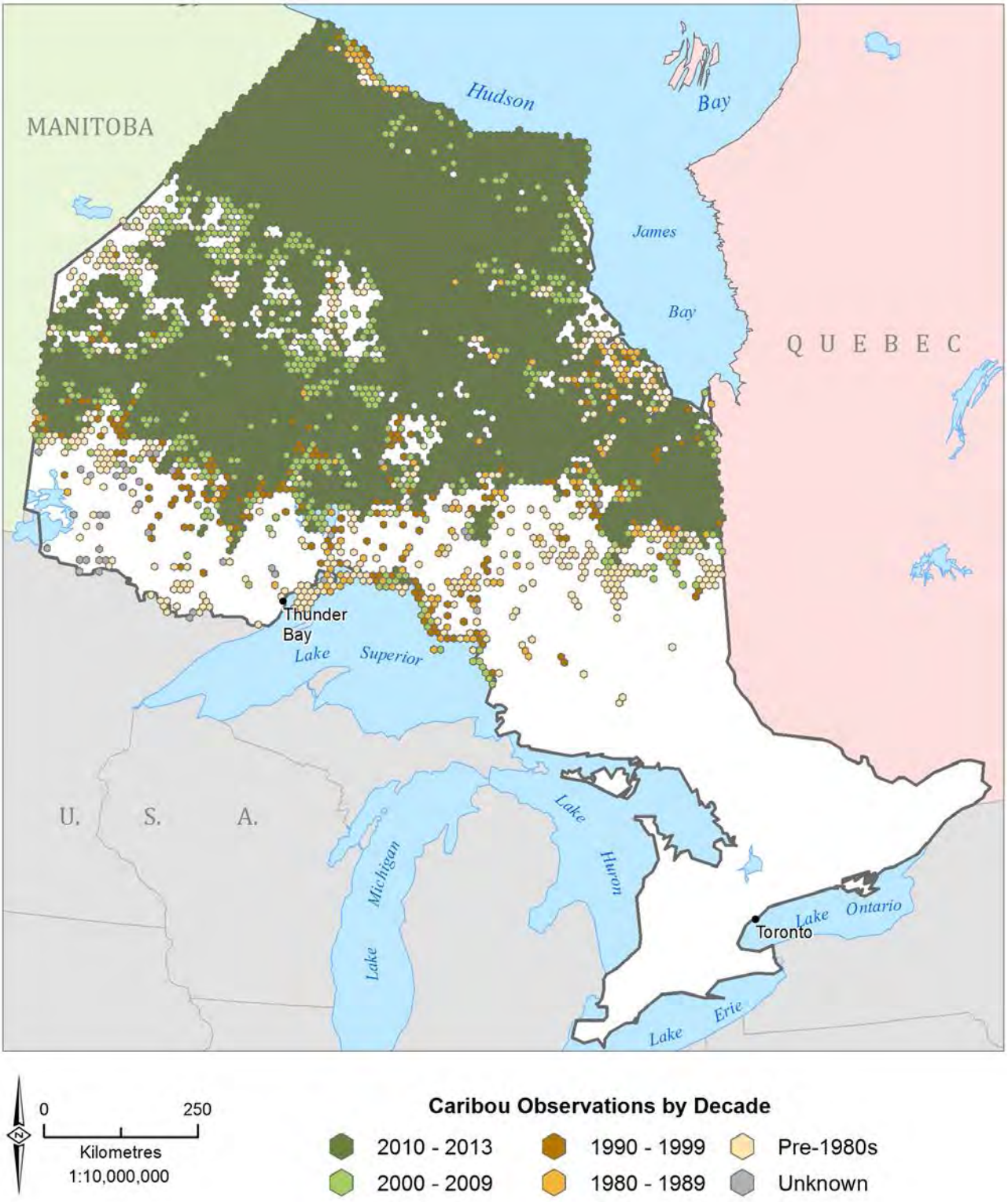


Figure 5. Caribou occurrence across Ontario summarized by date of most recent observation as of June 2013. Absence of observations may reflect low survey effort, lack of reporting, or the absence of caribou.

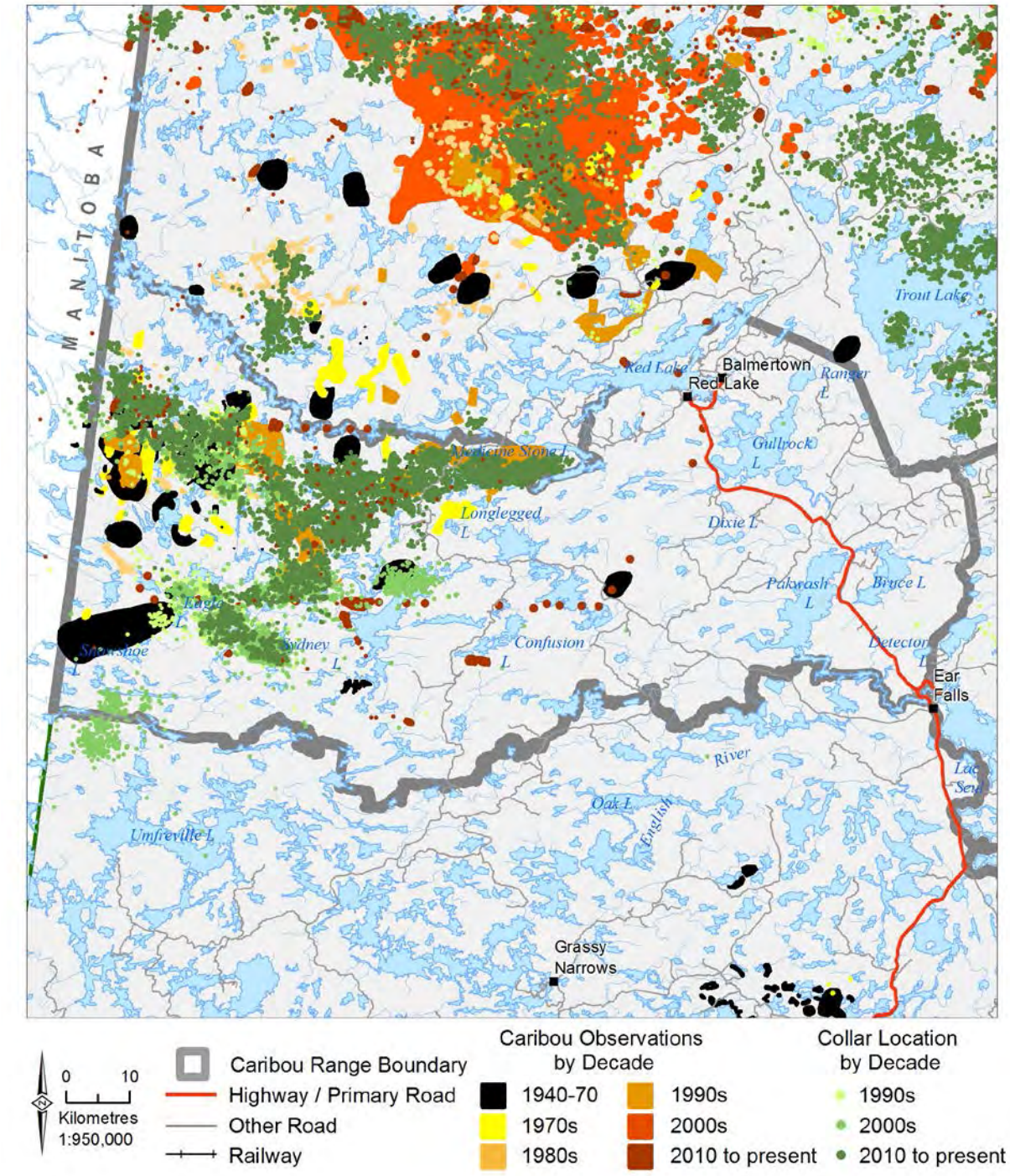


Figure 6. Historical caribou observations[1] within the Sydney Range and surrounding area including observations from aerial surveys, collared caribou locations, research projects, and casual observations.

[1] Home ranges for individual caribou are large, averaging 4,000 km^2 (Brown et al. 2003), and location observations of caribou should not be interpreted as just a single observation point, as it is only one point in time and include group sightings. The actual area used by caribou is much larger as they move throughout the year.

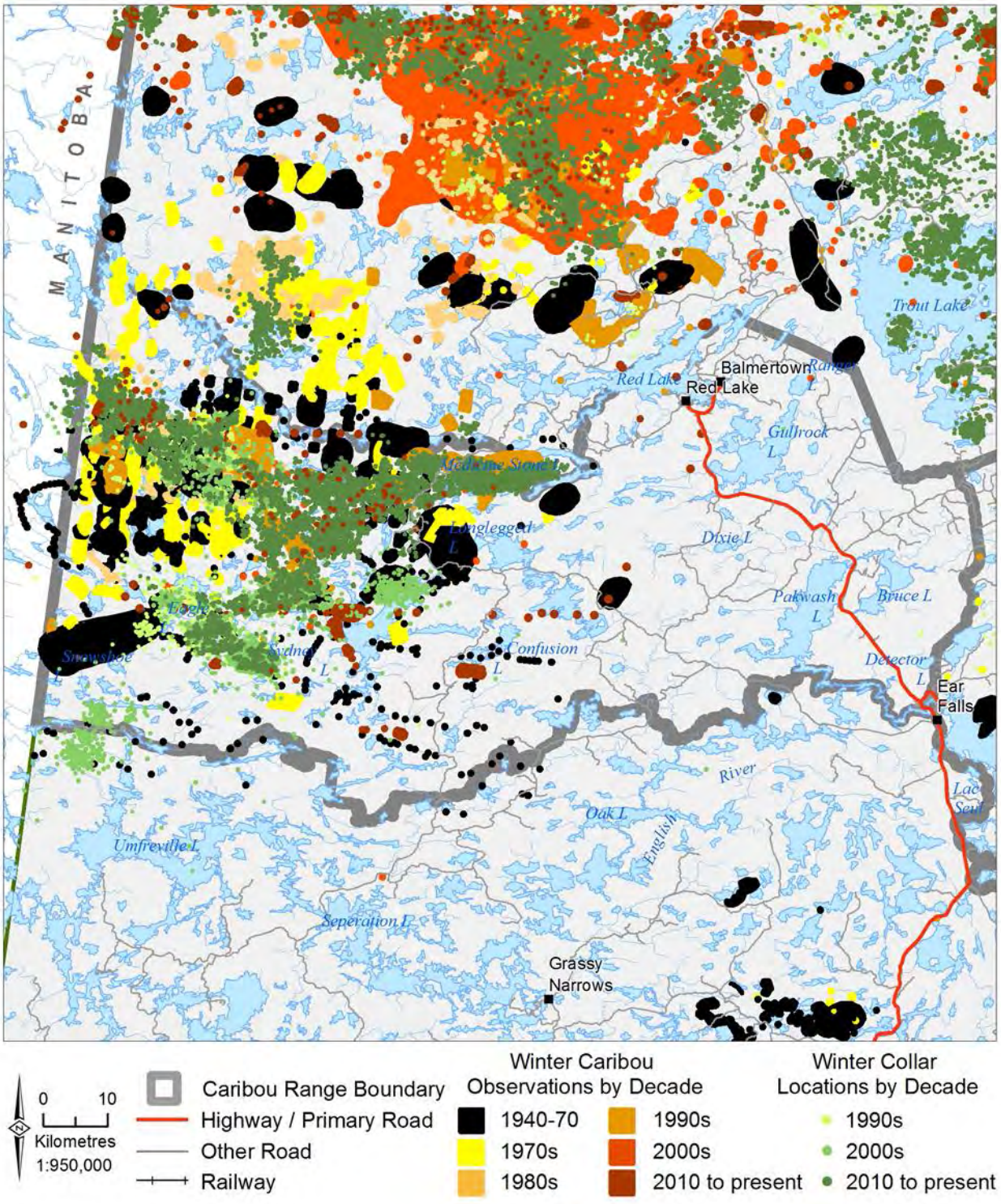


Figure 7. Caribou observations in the Sydney Range during February and March from all observation sources (i.e. aerial surveys, collared caribou locations, and casual observations since 1900) as of August 2013.

3.3 Probability of occupancy survey and analysis

Presence of caribou was identified during an aerial fixed-wing transect survey conducted in February 2012. Details of the fixed-wing survey design and sampling effort standards can be found in the Protocol (MNRF 2014a). The fixed-wing portion of the aerial survey consisted of flying linear transects on a 10 km interval hexagonal sample grid (Figure 8). Each hexagon is approximately 100 km² and 10.6 km across. Between two and four repeat visits were conducted on a portion of hexagons in each range. The occupancy survey was conducted by an experienced crew of MNRF staff using a Turbo Beaver aircraft to fly the linear transects through each sampling hexagon. Spatial patterns in occupancy (i.e. probability of occupancy) within the Sydney Range were estimated using methods described by MacKenzie et al. (2002).

No caribou were physically observed in the Sydney Range (Figure 8). The majority of caribou sign was observed in the western portion of the range.

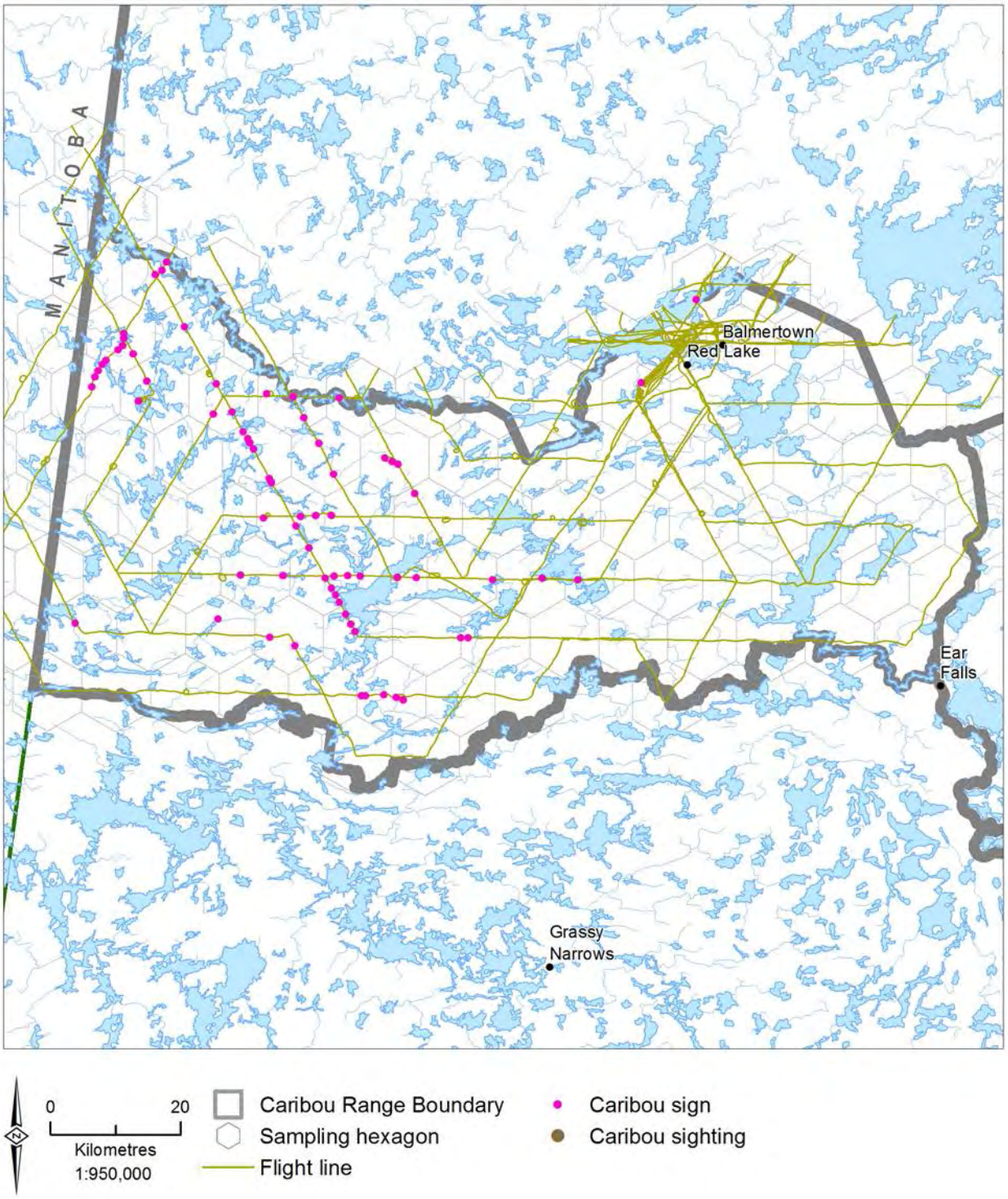


Figure 8. Fixed-wing aerial survey transects on the Sydney Range hexagon sampling grid during the winter of 2012. Observations of caribou and their sign are also shown; any evidence of caribou present within a hexagon contributes to the probability of occupancy calculation.

The probability of occupancy index (ψ) varies from 0 to 1, where higher values reflect greater likelihood of observing caribou. Generally, hexagons with caribou likely to be present at the time of the survey have a relatively high probability of occupancy (> 0.5). The general patterns from the probability of occupancy analyses provide insight into the broad-scale distribution and relative abundance of caribou. Figure 9 depicts the estimated probability of occupancy for a model conditional on detection (i.e. occupancy = 1 where caribou sign was detected) and without habitat covariates. Uncertainty exists as to the true winter distribution of caribou inferred from this map, particularly in survey hexagons with low probabilities that are adjacent to hexagons with caribou detection or high probabilities without caribou present. Conditions during the year may have influenced detection, and modified caribou distribution and behaviour.

The occupancy model without habitat covariates suggests the overall probability of caribou occupancy on the Sydney Range was moderate and that the estimate had moderate to low precision (ψ =0.55, S.E. = 0.13, 95% C.I. = 0.31-0.81). These standard errors suggest that existing levels of survey effort may only detect moderate to large changes in caribou occupancy with respect to a single estimate for the entire range. This may be partially due to the relatively low number of sampling hexagons in this range. As a result, a statistically significant change in this occupancy indicator may not be evident until large changes in caribou distribution occur. Precision may be improved in future surveys through increased visits to each hexagon.

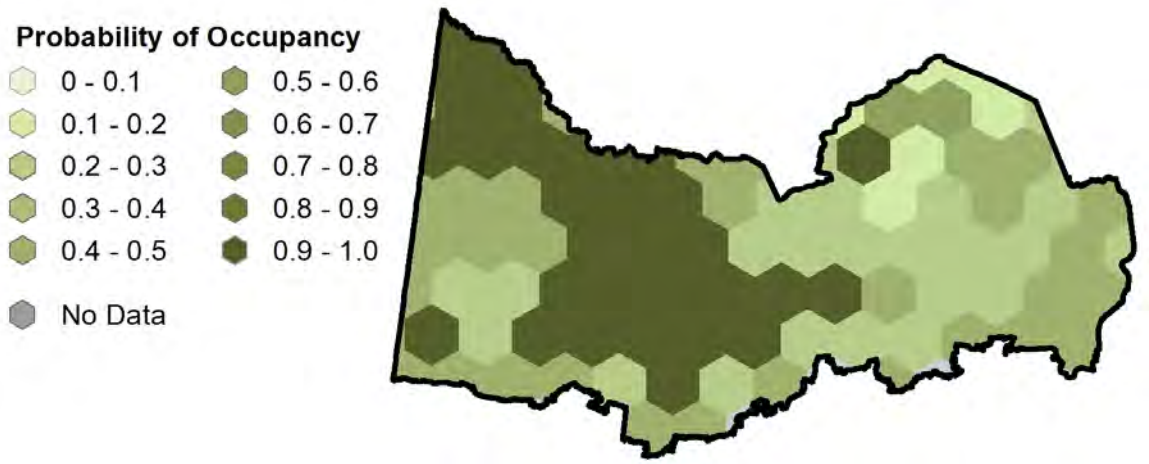


Figure 9. Predicted probability of occupancy of caribou on the Sydney Range based on a model without occupancy covariates and conditional on observation (Probability = 1 for hexagons with detection(s)) from the winter 2012 survey.

The probability of caribou occupancy was significantly correlated with habitat covariates. No single best model containing habitat covariates could be identified and so habitat covariates retained in the four best models supported by the data were used to generate model-averaged estimates of occupancy (Table 3, Figure 10, and Figure 11). The averaged model used to generate mean estimates of caribou occupancy was:

Table 3. Untransformed estimates of coefficients for habitat and detection covariates used in the caribou occupancy model for the Sydney Range. Parameters shown in bold have confidence intervals that do not contain zero. The model detection probability is 0.48. Parameters shown in bold have confidence intervals that do not contain zero.

Covariate	Estimate[1]	S.E.	Lower CI	Upper CI
intercept	0.31	0.93	-1.59	2.21
Sparse forest	2.30	1.70	-1.13	5.74
Settlement	**1.37**	**0.54**	**0.30**	**2.44**
Mixed	-1.41	0.70	-2.84	0.01
Roads	**1.33**	**0.55**	**0.25**	**2.40**

[1]The sign before the covariate estimate indicates the direction of the relationship with species occupancy (positive or negative).

Caribou occupancy on the range is more abundant in areas with limited disturbance (Figure 12).Caribou occupancy occurred primarily in the western half of the Sydney Range where large tracks of suitable habitat exist and human disturbance is low. This area includes the southern end of Woodland Caribou Park (WCPP). The sparse forest class on the landscape is conifer dominated (medium to high density) with a lichen, shrub, and moss component. Conversely, the eastern half of the range has lower occupancy and is dominated by early seral mixed forest and high fragmentation from roads and other human disturbance. Although distance to roads and settlements were retained in the model, they had little influence in predicting occupancy due to the large standard errors relative to coefficient values.

Reliable estimates of occupancy for individual hexagons will be particularly important for tracking changes in caribou distribution within the Sydney Range in response to management activities.

Connectivity between the northeastern side of the Sydney Range with the Berens Range is limited by the relatively high density of roads and human settlement; however, connectivity is evident in the extreme northwestern side of the range in WCPP where contiguous patches of confer forest are present.

There is evidence in other jurisdictions for the negative effects of anthropogenic landscape disturbance on caribou distribution and population persistence (Brown et al. 2007; Wittmer et al. 2007). Also, the positive correlation between caribou occupancy and winter suitable conifer forest is consistent with evidence of the positive effect of these forest types on caribou habitat selection using finer resolution telemetry data (Brown et al. 2007).

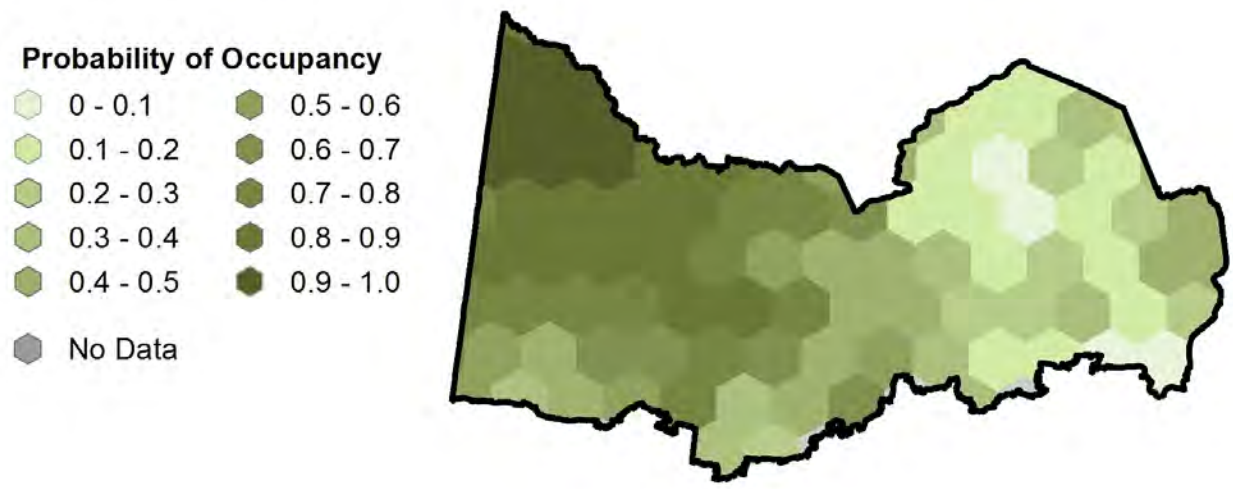


Figure 10. Probability of occupancy determined using habitat covariates across the Sydney Range based on model-averaged estimates using observations for the 2012 winter aerial survey.

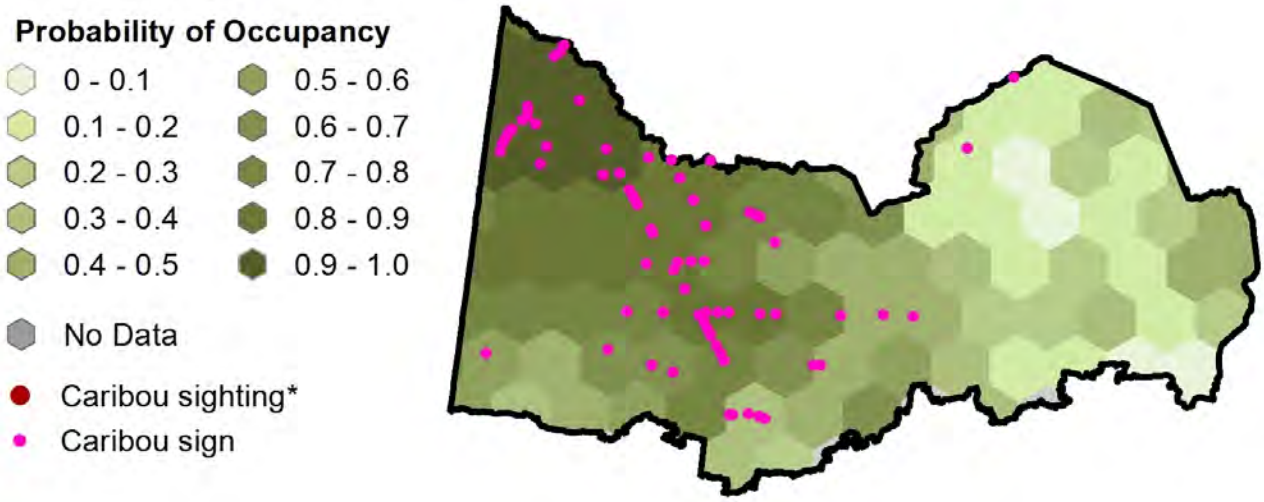


Figure 11. Probability of occupancy determined using habitat covariates across the Sydney Range overlaid with caribou signs and sightings[1] from the 2012 winter aerial survey.
[1]No animals were physically observed during the fixed-wing survey.

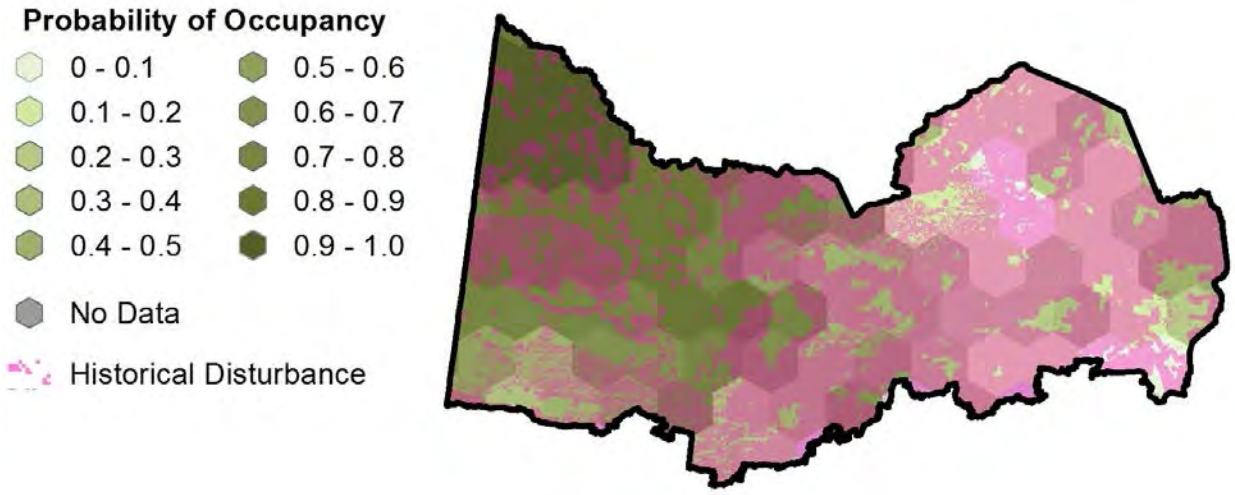


Figure 12. Probability of occupancy determined using habitat covariates across the Sydney Range using observations for the 2012 winter aerial survey overlaid with disturbed areas (i.e. cuts, burns, regenerating depletions).

3.4 Caribou ecology and range narrative

Caribou within the Sydney Range reflect our general understanding of caribou habitat use in the boreal forest as described by the Ontario Woodland Caribou Recovery Team (2007). Caribou occur at low densities over large areas, associating most closely with large tracts of older conifer forest, peatland complexes, and areas exhibiting low densities of moose and deer, and associated predators. These conifer forests are believed to provide caribou with a source of arboreal and terrestrial lichens which are important winter forage for many populations (Schaefer and Pruitt 1991) while primarily reducing the likelihood of predator encounters as a means of reducing adult and calf mortality. Female caribou appear to separate themselves from predators by dispersing into areas where wolves exist at lower density due to fewer sources of prey such as moose, or to isolate themselves from other caribou prior to calving (Bergerud and Page 1987). They exhibit hierarchical habitat selection favouring predator avoidance at a broad scale and forage availability at scales of daily feeding area selection (Rettie and Messier 2000). Caribou exhibit fidelity to calving and post-calving areas (Brown et al. 1986; Schaefer et al. 2000) and the fate of calves may often be determined during the summer months. As a result, the sensitivity of caribou to habitat disturbance may be heightened during the summer, post-calving period (Johnson et al. 2005).

Within Ontario, regional differences in habitat use appears to be associated with variations in climate, disturbance regime, forest types, topographic features, and the distribution and abundance of other wildlife populations. Caribou may exhibit habitat use patterns that take advantage of habitat types available (Moreau et al. 2012) and may use atypical vegetation conditions in more isolated areas such as on islands where refuge value is provided by topographic features instead of vegetation composition and structure (Rudolph 2005).

The Sydney Range is subject to the very aggressive natural fire regime that exists in a sub-humid climatic zone. Fires are frequent and often large contributing to the overall level of

disturbance and the landscape pattern. This aggressive fire regime has likely contributed to the renewal of existing habitats, but adds an element of risk to the maintenance of the relatively small portion of the range currently occupied by suitable habitat.
Conifer forests contributing to caribou habitat within the Sydney Range are dominated by jack pine and black spruce. Due to the shallow soils, abundant bedrock outcrops, and a moderately strong sub-humid prairie influence, these forests are typically open with abundant lichen patches, low densities of herbs and deciduous shrubs, and provide abundant winter forage for caribou. In the mature state, these forests have low browse abundance for moose, and what is available is mostly associated with low areas where soils are deeper and moister. Deep, highly productive fine textured soils associated with the Gammon River system, the shorelines of Red Lake, Sydney Lake, and the southeastern portion of the range north of Ear Falls are remnants of the post-glacial Lake Agassiz and support mixed forest conditions and abundant moose browse. Pockets of fine textured soils occur throughout the range are mostly small and scattered, but represent a consideration for management. Early forest harvest on the fine textured soils north of Ear Falls and in the vicinity of Red Lake has created expanses of shrub-rich multi-species mixed-woods consisting of trembling aspen, balsam fir, white spruce and white birch which is more suited to moose than to caribou.

The Sydney Range features a large number of lakes with islands and irregular shorelines. Many of these that are associated with older forest condition or peatlands are also used by caribou for calving. The majority of calving activity occurs in the western portion of the range where most of the older and undisturbed forest occurs.

Caribou within the Sydney Range are believed to interact and be part of the same population structure as the caribou of the Owl-Flintstone Range in Manitoba. In recent years, several collared caribou have summered in the western part of the Sydney Range after wintering in the Owl-Flintstone Range, one of which entered the Sydney Range from the Atikaki-Berens Range (D. Brannen, Manitoba Conservation, pers. comm. 2013). It is believed that habitat quality and function on either side of the provincial border may have implications to caribou population health on the other side. At present there is limited anthropogenic disturbance within the western portion of the Owl-Flintstone Range; although, forest harvesting previously occurred in Nopiming Provincial Park (Manitoba), recent rules now prevent forest harvesting there.

At present, caribou within the Sydney Range appear to be isolated from the caribou in the Churchill Range by disturbance. The extent of caribou connectivity north into the Berens Range is not fully known, although recent collaring data shows some caribou movement between the Sydney Range and Gammon Lake area in the southwestern corner of the Berens Range. A significant band of fine textured soils and mixedwood forest conditions extends from Red Lake west along the Gammon River and Bloodvein River system towards Lake Winnipeg forming an extensive area of unsuitable caribou habitat. This band of unsuitable habitat may have higher moose and wolf density, presenting a risk to caribou and was part of the rationale for the separation of the Owl-Flintstone and Berens-Atikaki ranges in Manitoba (D. Brannen, Manitoba Conservation, pers. comm. 2013).
Caribou within the Sydney Range and the Owl-Flintstone Range exhibit short but distinct migratory behaviour between winter and summer/calving habitats. Caribou appear to follow lake and river systems from wintering areas in the southern portion of Woodland Caribou

Provincial Park (WCPP) to a number of likely calving lakes including Chase, Midway, and Eagle lakes which are associated with a major peatland complex and Underbrush and Detour lakes which are adjacent to areas with high levels of disturbance.

The southwestern portion of the range has the Werner Lake Road providing human access from southeastern Manitoba. This road crosses a large 1983 fire associated with abundant shallow soils. The young jack pine dominated forests on these shallow soils have high potential to provide quality winter and refuge habitat into the future.

The east side of the Sydney Range has high levels of disturbance and is predominantly young forest, a portion of which resulted from an extensive 1980 forest fire and the other areas resulting from forest harvest activities within the Whiskey Jack Forest. This area has high potential for caribou occupancy in the future. The habitat recovery potential on the east side of the range is important to the provision of long-term connectivity to the Trout Lake Forest and potentially the Churchill Range. Moose densities are very low in this area, despite the young forest condition, suggesting that these regenerating forests may already be providing some refuge value even though not currently exhibiting caribou occupancy. This is corroborated with occupancy modelling that suggests moderate habitat value associated with the large fires on the east side of the range. The observed occupancy patterns are consistent with evidence in other jurisdictions for the negative effects of anthropogenic landscape disturbance on caribou distribution and population persistence (Brown et al. 2007; Wittmer et al. 2007). Notable areas of occupancy include the Irregular, Haggart, Sydney, Paull, Wrist, Bulging, and Aegean Lake areas in the southern portion of WCPP, despite the widespread fire disturbance in the area. These areas have a long and documented history of occupancy (Simkin 1964, 1965, 1966). The large fires that occurred in the southern portion of WCPP in 1983 altered the winter habitat suitability in the vicinity of Irregular Lake but the lake still has summer occupancy on the islands and shorelines. At present, the southern portion of WCPP is a significant winter habitat, but is under constant threat of new and large fire events due to the shallow soils, sub-humid climate, and conifer dominated forests.

The Eagle-Snowshoe Lake chain and the associated bog complex provides calving and summer habitat and is the most significant calving and nursery area within the range. From a broader perspective these calving lakes may be considered regionally significant due to its proximity to the southern extent of Continuous Distribution in Ontario and its proximity to the Owl-Flintstone Range in Manitoba. This area is now contained within the Eagle-Snowshoe Conservation Reserve.

Sydney Lake, in the central portion of the range and within WCPP is adjacent to portions of the range that have been harvested and are now undergoing forest renewal. Caribou calving and nursery-use is known on Sydney Lake which is also used by humans for remote tourism. Caribou also occupy areas north and west of Sydney Lake in the winter. The general area around Sydney Lake represents a significant opportunity to maintain caribou in the central portion of the range until forest renewal on the Whisky Jack Forest increases the amount of suitable winter and refuge habitat to the east.

The Medicine Stone Lake area northeast of Sydney Lake, but within the Berens Range exhibits occupancy by woodland caribou in the winter and the summer. This situation exists despite the fact that the Medicine Stone Lake area is surrounded by harvested forest in the past 30 years and is adjacent to a very large burned area to the east. This area received a large "no-cut" reserve in the approved FMP (1990s) to attempt to conserve caribou calving potential and has been deemed successful with caribou sightings by Underbrush Lake.

This range narrative does not represent a detailed synopsis of all important caribou use areas within the Sydney Range.

3.5 Influence of current management direction

Recent and current management direction, up to the time of this Integrated Range Assessment, has had many positive influences on the current state of caribou within the Sydney Range. Direction from the Crown Forest Sustainability Act (1994) to "emulate natural disturbances" was significant to support the landscape and stand-level approaches necessary to sustain caribou habitat and provide an integrated and receptive policy environment for other caribou habitat conservation direction.

Implementation of *Northwest Region Interim Caribou Habitat Management Direction* (MNR 1994) and the early implementation drafts of the *Forest Management Guidelines for the Conservation of Caribou Habitat: a Landscape Approach* (Racey et al. 1999), and the subsequent *A Management Framework for Woodland Caribou Conservation in Northwestern Ontario* (MNR 1999a) were instrumental in initiating and integrating caribou conservation efforts into forest management planning. Although imperfect, implementation of caribou habitat tract mapping, mosaic planning, and priority retention of larger areas of high value habitat components contributed to continued range occupancy and ecologically sustainable forest management.

Caribou habitat within the Sydney Range has been acknowledged and, at least partially addressed in Forest Management Plans (FMPs) for more than two decades. Caribou habitat was considered in the Red Lake Forest 1991 FMP and the Trout Lake Forest 1994 FMP through implementation of a caribou habitat mosaic. Timber harvest scheduling in the Kenora Forest, and in the vicinity of the Werner Lake Road, considered caribou habitat values. The Whiskey Jack FMP has identified that no harvest operations will occur in C and D blocks within the Sydney Range for more than twenty years. This provides a significant and positive opportunity for large tracks of conifer dominated forest within the eastern portion of the Sydney Range to mature to the point where it should begin to provide for both winter and refuge habitat. Monitoring efforts will determine if habitat renewal objectives has been achieved.

Also significant was the decision to set aside a large tract of currently used caribou habitat in the westerly portion of the range including the area associated with the Eagle-Snowshoe Conservation Reserve that was created by *Ontario's Living Legacy* (OLL). OLL justified an expansion to WCPP to include the Sydney Lake area and created the Eagle-Snowshoe Conservation Reserve. Both of these contributed to caribou habitat protection in the southern portion of WCPP and in the central portion of the Sydney Range.

There are few aspects of current and recent management direction that may have been detrimental to caribou conservation within the Sydney Range. Racey et al. (1999) provided direction for habitat renewal and the rehabilitation of roads after forest harvesting, but implementation of these two key habitat management strategies has not yet met expectations or achieved the desired effect. This may be especially true in the large areas of blowdown salvage. The lack of forest management activities for the next 20 years, including the cessation of tending efforts may further entrench some of the mixed forest conditions that were established post-harvest.

3.6 Major data and analysis uncertainties

The Sydney Range and the landscape adjacent to the Manitoba border has been subject to a number of large and many small blowdown events in the last 15 years since the last full Forest Resources Inventory was completed. Typically, only large blowdown events result in forest inventory updates. It is unknown how much undocumented blowdown has occurred within the range, but we suspect there is more young forest than is reflected in the forest inventory or disturbed forest than is reflected in the disturbance analysis.

Habitat assessment within WCPP was conducted using Provincial Land Cover 2000 (PLC 2000) data, and the remainder of the forest was assessed using Forest Resources Inventory (FRI) data. The greater the proportion of the range that relied upon PLC 2000 data, the more uncertainty there is about the habitat assessment results. Approximately 23% of the range was assessed using data other than the FRI.

National meta-analysis of the relationship between caribou recruitment and the total amount of anthropogenic and natural disturbance relied on data from the Global Forest Watch database (EC 2008) which was updated by Environment Canada in 2011 (EC 2011). This relationship was intended to be refined as improved data was provided by various jurisdictions across Canada. There may be substantial differences between forest cover, forest disturbance, and linear features represented in this analysis compared to the Environment Canada data. In general, the current range analysis included more complete data related to road and mineral development activities, documented fires, and non-fire forest disturbances. The calculated habitat disturbance on the Sydney Range using Ontario data is estimated to be approximately 5.1% greater than that generated using the Environment Canada data. There is some uncertainty as to how to interpret the results of analysis using these different datasets in light of the desire to use the best data available.

This range assessment has been completed with only two years of recruitment data, one from the winter distribution survey and one from the 2013 collared caribou recruitment survey. Recruitment rates for the Sydney Range were low in both survey years. In 2012, recruitment rates were also very low in the Berens, Churchill, and for ranges in Manitoba. It was thought that 2011-12 recruitment year must have been very poor in general. However, in 2013 recruitment rates in both the Berens and Churchill ranges were substantially higher than in 2012. This pattern was not observed in the Sydney Range with the 2013 rates being even lower suggesting that the factors affecting the low recruitment are persistent on the range.

As there was no documented mortality among the 10 collared adult females, the survival rate was 100%. This number is not reflective of the overall adult mortality rate. However, using this single survival estimate of 1.0 would result in a theoretical stable population, even if recruitment rates were zero. This result is likely due to the low sample size. Therefore the Sydney and Berens Range mortality data was pooled in order to provide a relevant estimate of survival and population trend (λ). The resulting trend estimates were based on only one year of survival from the pooled data and two years of recruitment. Caution should be used in the interpretation of these results and continued monitoring in future years will be important to refine and build confidence in these results.

There is considerable uncertainty in the appropriate treatment of water during the disturbance analysis. The sensitivity of the "total disturbance" parameter to removal of water bodies of different sizes was identified to inform interpretation of the likelihood of stable or increasing population growth and evaluation of range status. In the Sydney Range, waterbodies account for a significant (17.1%) portion of the range extent. It is unknown whether the inclusion of these water bodies in the range extent for the purpose of the disturbance analysis introduces a positive or negative bias.

3.7 Special considerations within the range

Special circumstances exist within the Sydney Range that should be considered when interpreting the Integrated Range Assessment. These include significant physical and biological factors influencing the status of caribou, trends, or habitat use that are unaccounted in population and habitat modeling. Such factors should give context to results of the Integrated Range Assessment Framework.

There are two highly important special considerations within the range: the soils and landforms within this range and the associated climate are highly conducive to the renewal of conifer dominated forest and conifer-lichen woodland conditions. The abundance of lakes, and shrub-poor conifer dominated forests suggests a high refuge value to the landscape for those portions of the landscape that consist of older forest and have not burned within the last 40 years. Although the pockets of fine textured soils and the young forest can be exceptionally good moose habitat, there is good potential for the creation of quality caribou refuge and winter habitat.

The aggressive fire regime adds a high level of uncertainty to the outcome of all planned habitat management efforts. The creation of a conservation reserve or the deferral of a large tract of high value habitat may have short-lived, or transient benefit if it is later lost to a large wildfire. The large burns at the southwestern portion of the range all appear to be regenerating to the high conifer content and relatively even aged conditions that would be expected to produce high quality winter and refuge habitat for caribou. The current low probability of occupancy in those areas should not be taken as an indication of low value or be considered inconsistent with the recovery goals identified within the Caribou Conservation Plan. Aboriginal harvest of caribou is permitted but harvest levels are unknown.

3.7.1 Special considerations related to the Owl-Flintstone Range

Currently, it is uncertain as to the full degree of interaction between the Sydney Range and the Owl-Flintstone Range, consideration of the number of caribou, population health and movement patterns of the Owl-Flintstone caribou should be a major consideration when interpreting the results of the Sydney Integrated Range Assessment. The climate, soils, geological history and broad vegetation patterns are relatively similar. The province of Manitoba has generously provided key information about the Owl-Flintstone Range to assist with the Integrated Range Assessment for the Sydney Range.

In Manitoba's Owl-Flintstone Range, the MAC was determined to be 55 when the survey was carried out in 2012. It is believed that the Owl-Flintstone Range MAC underestimates the size the population. In November 2008, Manitoba determined a MAC of 62 animals from survey observations (D Brannen Manitoba Conservation, pers. comm. 2013).

In total, 21 collared females have moved into Ontario from Manitoba between 1998-2013 during the calving season and summer (D Brannen Manitoba Conservation, pers. comm. 2013); of these, six collared females moved into the Sydney Range between 1998 and 2013. Furthermore, one female collared in the Atikaki-Berens Range traveled east into Ontario's Berens Range and then proceeded to move south into the Sydney Range. This was a pre-calving movement (the animal wintered in Manitoba prior to the movement). This animal stayed the winter in the Sydney Range as well as the subsequent calving and summer period before returning to Manitoba in the fall. This movement data support assumptions of connectivity with Manitoba made in the delineation of the Sydney Range and proposed collaboration on caribou conservation efforts.

3.8 Other wildlife

The boundaries of the Sydney Range include all or parts of Wildlife Management Units (WMU) 2 and 3 (Figure 13), within cervid ecological zones A and B (MNR 2009b).

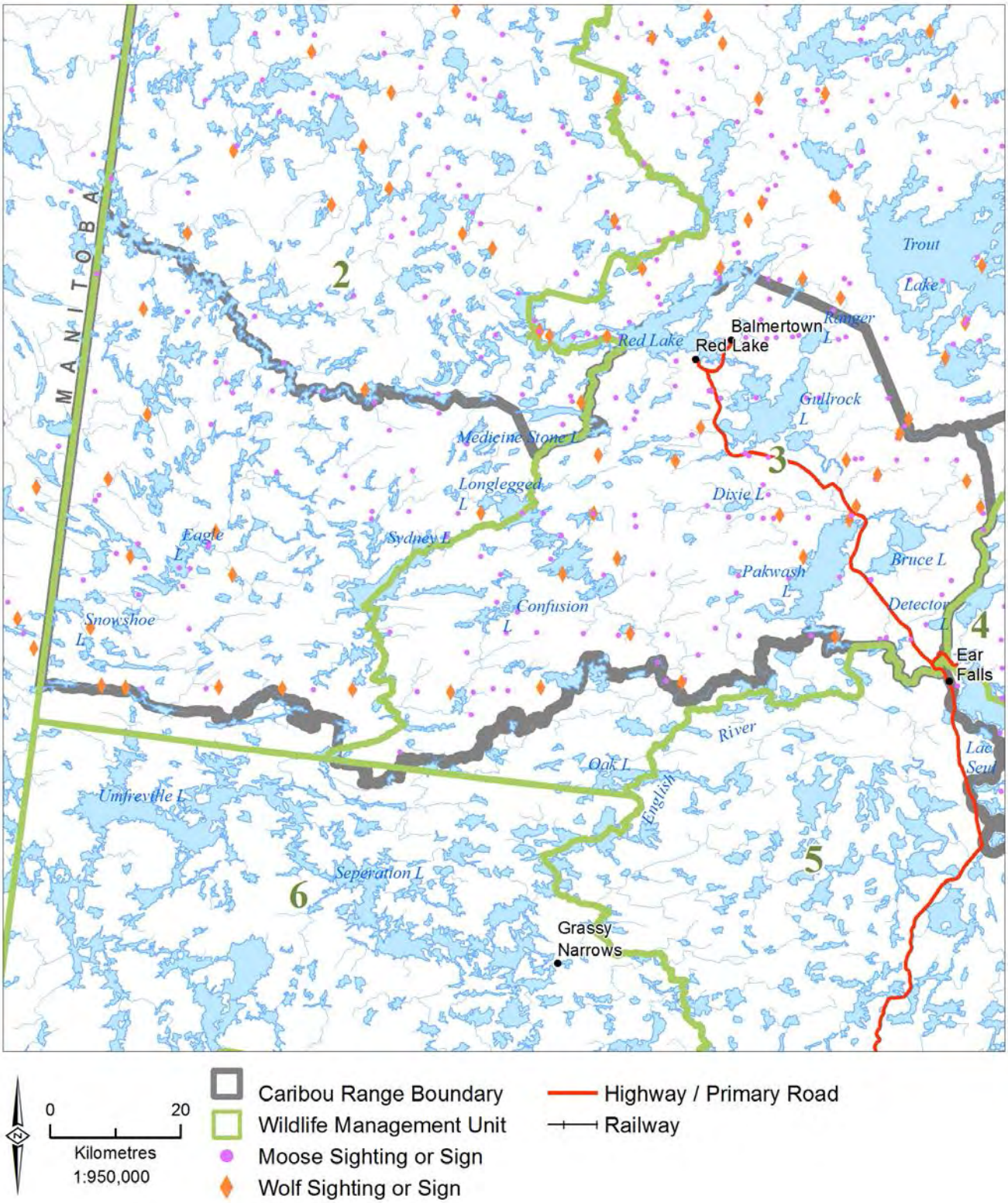


Figure 13. Wildlife Management Units overlapping the Sydney Range with moose and wolf signs or sightings observed during the winter 2012 aerial surveys.

Moose densities have historically been moderately low across much of the Sydney Range and at the WMU level are currently estimated at densities from 13.8 to 20.0 moose per 100 km^2 (Table 4). Moose population trends are considered to be declining in WMU 2 and stable in WMU 3.

Table 4. Recent moose population estimates for Wildlife Management Unit (WMU) within Sydney Range.

WMU	Cervid Ecological Zone	MAI strata area (km^2) [1]	Moose population estimates no. of moose (survey year)	Current density (moose / 100 km^2)
2	A	8,500 (includes water)	1,169 (2013)	13.8[2]
3	B	12,650	2,574 (2009)	20.0

[1]Area is for the WMU
[2]Should be higher based on current objectives

Densities of white-tailed deer have increased over the last 20 years in the Sydney Range, but it is unknown if it is still increasing. Deer may function as both alternate prey for wolves and as a vector for disease, specifically brainworm (*Paralaphostrongylus tenuis)*, and may be expected to increase with northward expansion.

Black bear density estimates derived through the implementation of barbed-wire hair trap (BWHT) protocol indicates that black bear densities may be relatively low (11-13 bears/100 km^2) (Table 55) (M. Obbard, MNR unpublished data), compared to average densities from other WMUs within Ontario's northwest region and black bear ecological zone D.

Table 5. Recent black bear density estimates for Wildlife Management Units (WMU) within the Sydney Range derived from barbed-wire hair trap protocol.

WMU	BBEZ[1]	Year	Density (# bear/100 km^2) ± SE	Density relative to BBEZ mean	Density relative to regional mean
2	D	2006	13.2 ± 3.9	Below	Below
3	D	2007	11.4 ± 3.9	Below	Below

[1]Black bear ecological zone

Over the past 10 years, anecdotal evidence has suggested relatively high numbers of wolves. However recent anecdotal evidence suggests numbers may be declining (based on recent caribou and moose aerial inventories). Results of the Moose Hunter Post Card Survey (PCS) wolf sighting index indicate high numbers that may be stable (Figure 14). This information is to provide context with other wildlife population trends, and is not used in determining range condition.

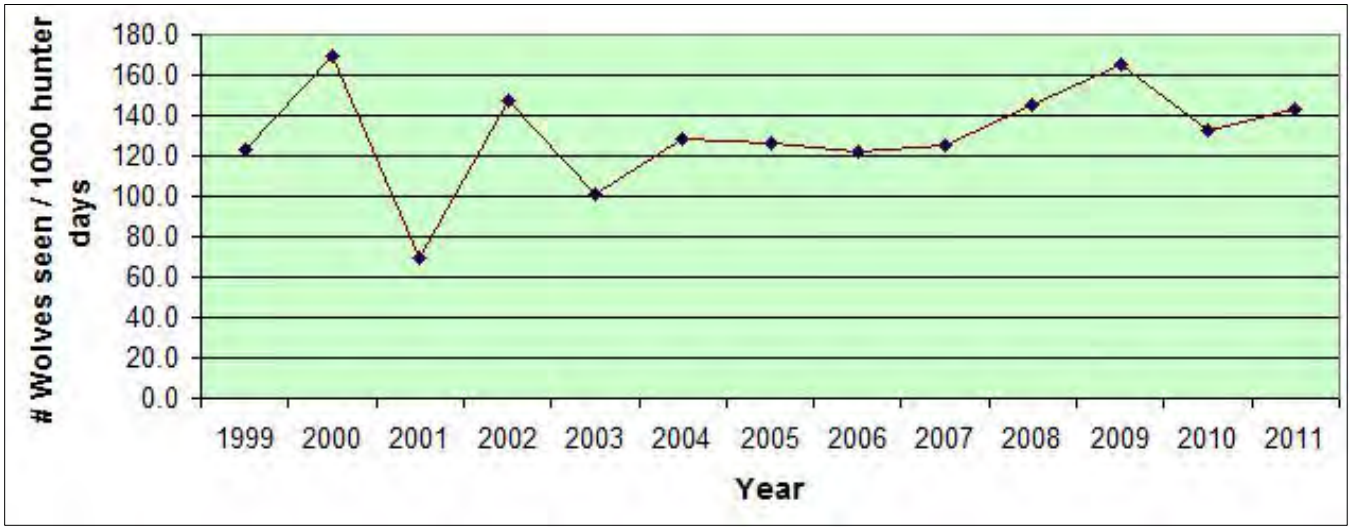


Figure 14. Trend in number of wolves sighted by moose hunters, 1999-2011; pooled data for WMU 2 and 3 (MNR, Science and Research Branch, moose hunter post card survey database).

3.9 Results of past range assessments

No previous range assessments have been completed for the Sydney Range. However, range level summaries of data and models pertaining to the Sydney Range are described in Elkie et al (2012).

4.0 Integrated Range Assessment Framework

The Protocol (MNRF 2014a) identified the process to conduct an Integrated Range Assessment (Figure 15) involving: 1) collection of data to inform four quantitative lines of evidence and their interpretation; 2) an Integrated Risk Assessment; and 3) determination of range condition. The Integrated Risk Assessment considers the influence of habitat disturbance and population trend on the likelihood of stable or positive population growth, and the influence of population size on the probability of persistence. This assessment is supported by scientific findings adapted from Environment Canada (2011).

The process of determining range condition (Section 7.5) will be based on the best available information that supports the lines of evidence. Range condition is reflected in the IRAR as a statement pertaining to the ability of the range to sustain caribou. Range condition is declared with full acknowledgement and understanding of the current risk to caribou but with the additional insight provided by the habitat assessment which describes the amount and arrangement of habitat. If the fourth line of evidence representing the amount and arrangement of habitat is not available for the range, results of the integrated risk assessment will be used to determine range condition as follows: if risk to caribou is low, then range condition is sufficient to sustain caribou; if risk to caribou is intermediate, it is uncertain whether range condition is sufficient to sustain caribou; if risk to caribou is high, then range condition is insufficient to sustain caribou.

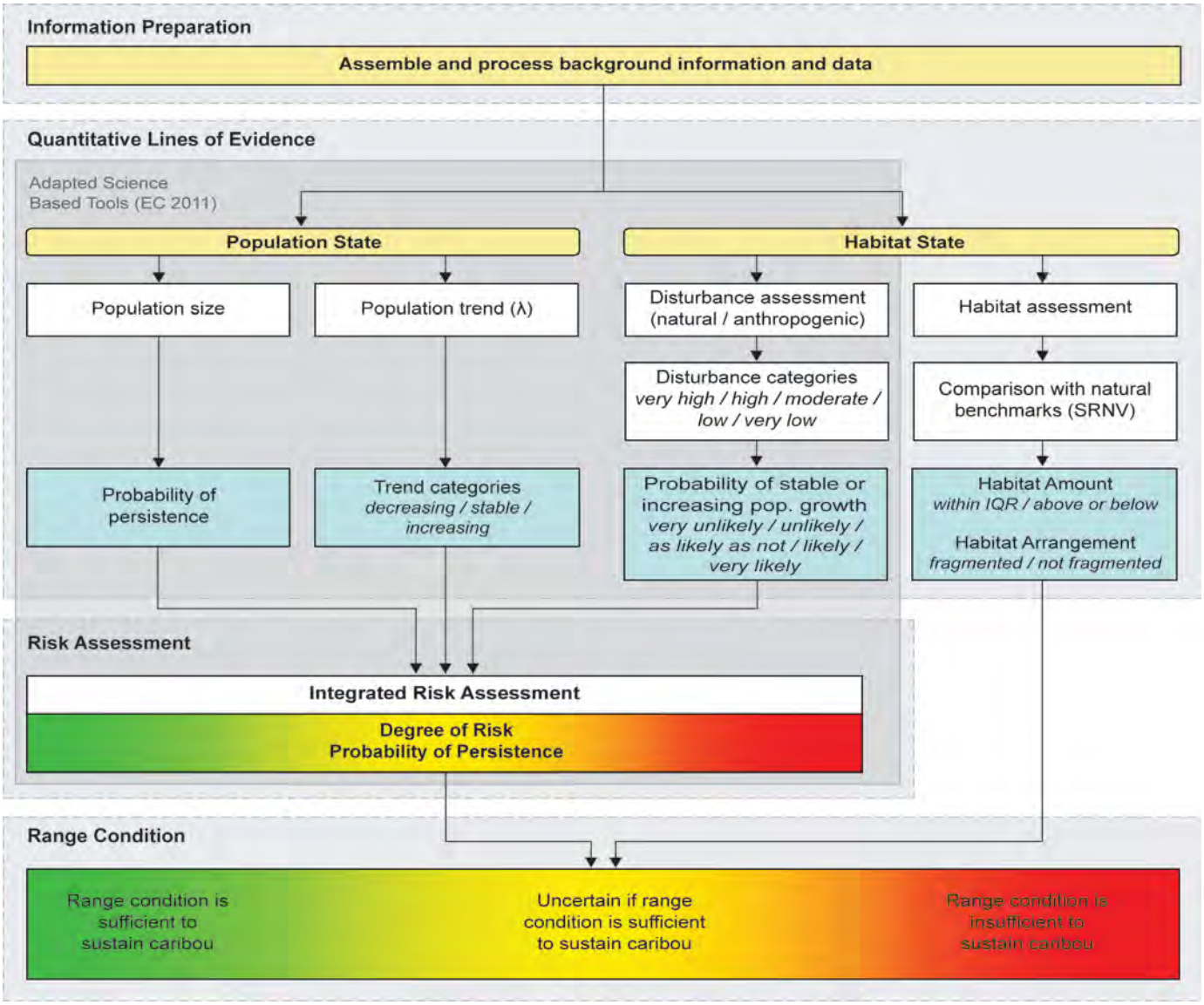


Figure 15. The integrated assessment framework with four quantitative lines of evidence. Three lines of evidence related to population size, trend and habitat disturbance assessment contribute to an integrated risk assessment. The results of the integrated risk assessment are combined with habitat assessment (fourth line of evidence), to inform the determination of range condition (MNRF 2014a).

5.0 Quantitative Lines of Evidence Methods and Results

5.1 Population state: size and trend

Caribou population health is conventionally measured in terms of population size (i.e. the number of caribou) and trend. It is preferably described by average intrinsic rate of growth, lambda (λ). The best available data is used to estimate the number of caribou and the

demographic trend within the range. These are used in the integrated assessment framework (Figure 15).

The ability to establish population trend improves with the addition of more indicator estimates. In this assessment the short-term population trend is approximated by: 1) estimates of recruitment expressed as percent calves in the population or number of calves per 100 adult females as an index of population condition (EC 2008), 2) an estimate of lambda (MNRF 2014a) and 3) a minimum estimate of the population size based on a minimum animal count (MAC). The long-term population trend is approximated by using historical data compared to recent data.

Currently, estimates of survival/mortality are not available but estimates of short-term trend can be refined with the addition of survival data attained by monitoring caribou fitted with GPS collars in late winter 2012.

5.1.1 Population state methods

5.1.1.1 Telemetry

Historically, there were local studies involving the deployment of telemetry collars on caribou within the Sydney Range. Three female caribou were collared in July 1998, in the Eagle/Midway/Chase lake chain; one of these collars was retrieved the following February from what appeared to be a wolf kill. Two collars were fitted to adult females in February, 2000, in the vicinity of Haggart and Welkin lakes. All the collars were retrieved in January 2001 near Haggart, Welkin, and Sydney lakes. These studies were used to get a preliminary estimate of movement patterns and habitat configuration in the southern portion of WCPP (Ranta 2001).

In February 2012, 10 GPS collars were fitted on adult females within the Sydney Range. Data generated from collared caribou will be used in this and future reports to determine annual survival, recruitment, and refine trend estimates.

5.1.1.2 Winter aerial surveys

Between February 4th and 19th, 2012, a fixed-wing hexagon-based aerial survey was conducted for the Sydney Range (Figure 8). All caribou and signs of their presence were recorded. Where possible, observed caribou were counted and classified as adults or calves. Also recorded was evidence of wolves, moose and wolverine. Survey efforts were strictly controlled to support occupancy analysis (Section 3.3). Additional searching for caribou off the transect lines was discouraged once sign was confirmed.

The second stage of the survey was conducted by helicopter in February 6th and19th, 2012, and included areas where caribou were sighted and/or where there was significant evidence of caribou presence. Caribou group size and age/sex composition were determined at this time. Caribou were counted and classified as: unknown adults, adult males, adult females, calves, or unknown age and sex. Sex of adults was determined through observation of the presence or absence of a vulva patch, animal behaviour, and/or body morphology.

5.1.1.3 Recruitment

Recruitment estimates follow the Protocol (MNRF 2014a). The observed sex ratio of known adults obtained from aerial surveys was used to estimate the number of adult females present in the groups containing unknown adults. The adjusted number of adult females (AF_{adj}) was used to estimate recruitment.

5.1.1.4 Trend

Generally, in forest-dwelling caribou, a stable population requires a late-winter estimate of at least 12 to15% calves in a non-hunted population with a density of 0.06 caribou per square kilometre (Bergerud 1992; 1996). Recruitment rates exceeding 28.9 calves per 100 AF_{adj} would suggest the population is increasing. Recruitment rates below this value would suggest the population is decreasing based on assumed average adult mortality rates (EC 2008). The relationship between annual estimates of recruitment and adult female survival was used to provide an estimate of trend (λ) (Hatter and Bergerud 1991).

Trend Estimation

Annual population growth (λ), was estimated based on the following female –only survival and recruitment equation (Hatter and Bergerud 1991):

$$\lambda = (1 - M) / (1 - R) \qquad \text{Equation 1}$$

Where M is adult female mortality (or 1 - S, the survival rate) and R is the recruitment rate of female calves: 100 adult females (assuming a 50:50 sex ratio) at 12 months of age.

Baseline estimates of annual survival (S) were calculated using three equations described in the Protocol (MNRF 2014a).

$$\textit{Daily survival rate} = 1 - (\#\ \textit{of mortalities} / \#\ \textit{of animal days}) \qquad \text{Equation 2}$$

$$\textit{Annual survival rate} = (\textit{Daily Survival Rate})^{365} \qquad \text{Equation 3}$$

$$\textit{Annual mortality rate} = 1 - \textit{Annual Survival Rate} \qquad \text{Equation 4}$$

As some caribou moved between ranges, data from all adult female collared caribou that had the majority of their telemetry locations (>50%) within the Sydney Range was utilized.

5.1.1.5 Size

The aerial survey methods used to conduct a probability-based occupancy survey (Section 3.3) supplemented with a follow-up helicopter survey to obtain improved age and sex information (MNRF 2014a) was used to generate a minimum animal count (MAC). This is interpreted as an absolute minimum number of caribou occupying the range in February 2012. The MAC was calculated based on all caribou observations that were not deemed to be duplicate observations (MNRF 2014a).

5.1.2 Population state results

Fifty-five (55) caribou observations were recorded in the Sydney Range during the 2012 aerial survey; all were observed during the rotary-wing survey. None were considered to be recounts so the total minimum animal count (MAC) was 55 caribou during the February 2012 winter distribution survey; four were calves (Table 6 and Table 7). Eight groups in total were observed; the largest group contained 29 caribou but most groups consisted of three to six animals. Detection of caribou from aerial surveys is known to be incomplete and the detection rate is unknown. As a result the MAC only represents a proportion of the actual number of caribou present within the Sydney Range.

Table 6. Minimum animal count observed during a fixed-wing and rotary wing aerial survey conducted on the Sydney Range, February 4-19, 2012.

	Caribou age and sex identification[1]						
Survey method	**UA**	**AM**	**AF**	**Calves**	**UN**	**Total adults**	**Total caribou**
Fixed-wing (FW)[2]	-	-	-	-	-	-	-
Rotary-wing (RW)	26	14	11	4	0	51	55
Total	**26**	**14**	**11**	**4**	**0**	**51**	**55**

[1]UA=Adult of unknown sex, AM= Adult male, AF=Adult female, UN=Caribou of unknown age or sex
[2]No caribou were observed during the fixed-wing survey

Only caribou groups for which 50% or more of the group was successfully identified to age and sex were included in the estimation of adult sex ratio and recruitment (Table 7). During the 2012 aerial survey, the sex ratio of known adult females to known adult males observed during the rotary-wing survey was 0.433. Using this sex ratio to determine the number of AF_{adj} resulted in a total recruitment estimate of 18 calves per 100 AF_{adj} (Table 7; Figure 16).
The 2013 recruitment survey targeted collared adult female caribou and observed 74 caribou, 6 of which were calves. The sex ratio was 0.778, resulting in a recruitment estimate of 13.6 calves per 100 $AF_{adj.}$ These levels of recruitment are low and comparable to studies in which populations were known to be in decline (Rettie and Messier 1998; McLoughlin et al. 2003; EC 2008).

Table 7. Counts of caribou and estimates of recruitment from both the fixed-wing and rotary-wing aerial surveys conducted in the Sydney Range during February 2012 and 2013.

		Caribou age and sex identification[1]										
Year	**Survey**	**UA**	**AM**	**AF**	**Calf**	**UN**	**Total adults**	**Total caribou**	**Sex ratio**	AF_{adj}[1]	**Calf: 100** AF_{adj}[2]	**% Calves**[3]
2012	Winter distribution (FW/RW)	26	14	11	4	0	51	55	0.433	22.3	18.0	7.3
2013	Recruitment survey	4	14	41	6	9	59	74	0.778	44.1	13.6	n/a[4]

[1]UA=adult of unknown sex, AM= adult male, AF=adult female, UN=caribou of unknown age or sex, AF_{adj} = adjusted adult females
[2]Recruitment estimate using the ratio of calf: 100 adjusted adult female
[3]Percentage of calves observed, only reported for the winter distribution survey, as this survey was not targeting collared adult females and therefore represents a less biased survey for calculating percentage of calves in the population
[4] Due to bias created by targeting collared adult female caribou during recruitment surveys, % calves is not applicable from recruitment survey data

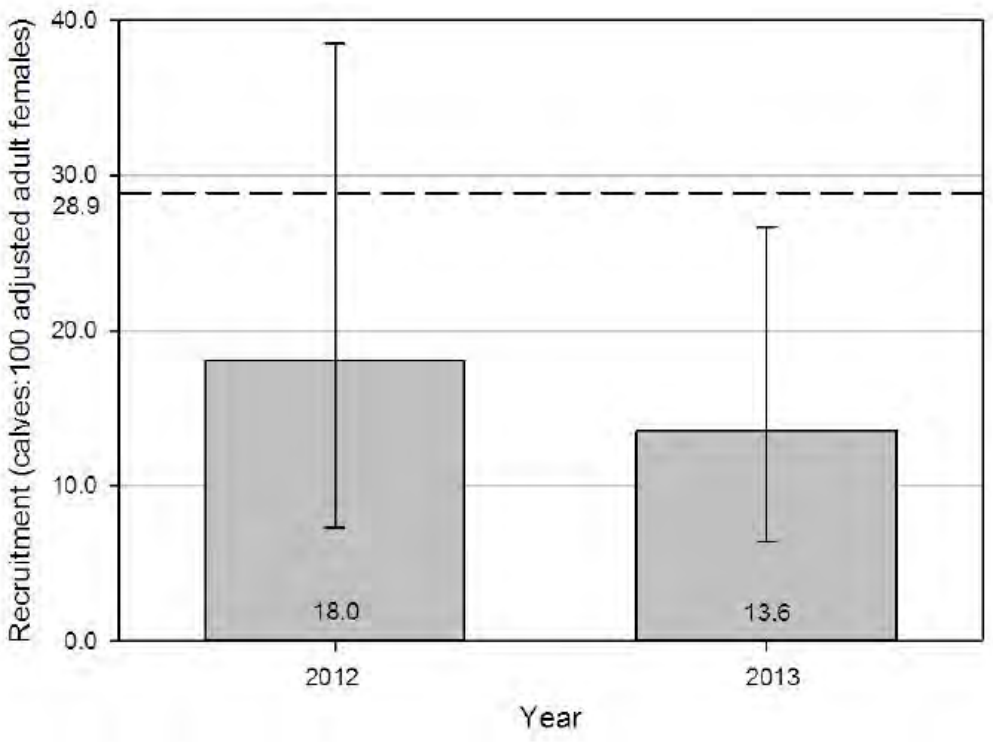


Figure 16. Recruitment estimates (calves/100 AF_{adj}) with associated 95% confidence intervals from 2012 and 2013 in the Sydney Range. Dashed line indicates recruitment levels expected for a stable to increasing population (EC 2008).

Annual survival was estimated for all collared adult females that spent the majority of their time within the Sydney Range during the biological year (April 1st to March 31st). No mortalities occurred among the 10 collared caribou during the 2012 biological year. This would have resulted in a survival rate of 1.0. Because the Berens Range is in close proximity, pooled survival data from both ranges was used to provide a representative estimate of annual survival. The pooled annual survival rate was 0.91 (95% CI 0.82-1.00; Table 8 and Figure 17), and resulted in an estimated mean population trend (λ) of 0.98 (ranging between 0.97-0.99), suggesting that the short-term population trend is likely stable to declining.

Table 8. Annual survival rates (*S*) and population trend (λ) of collared female caribou (*n*) and number of mortalities (*d*) during the 2012 biological year (April 1st, 2012 to March 31st, 2013). Data from the Sydney Range were pooled with the adjacent Berens range.

Biological year	n	d	Exposure days	Daily survival rate	Survival (S)[1]	Upper 95% CI	Lower 95% CI	Lambda (λ)[2]
2011					0.91			0.99
2012	33	3	11650	0.9997	0.91	1.00	0.82	0.97
						Geometric λ Mean		**0.98**

[1]The survival rate from 2012 was used to estimate population trend (λ) for the 2011 biological year
[2] λ calculated from recruitment (Table 7) from the end of the biological year (i.e. biological year 2012 and recruitment from 2013)

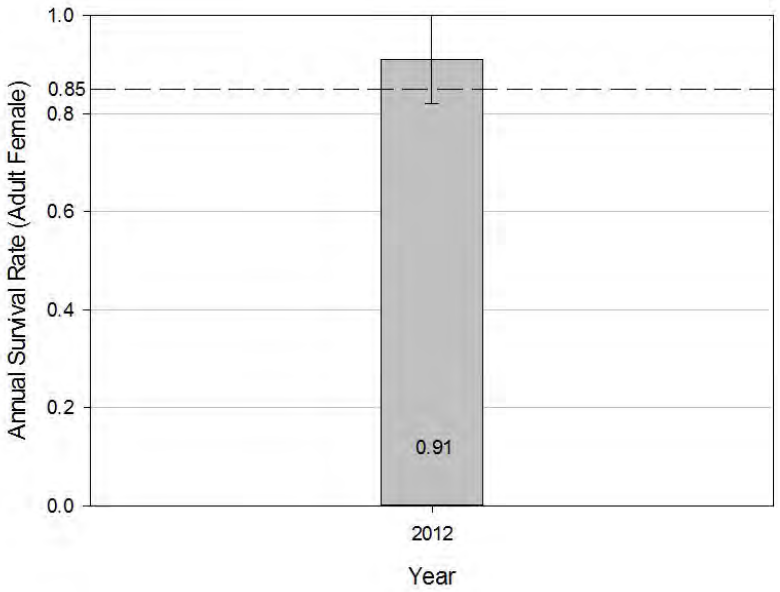


Figure 17. Annual survival rate and 95% confidence intervals of collared adult female caribou which spent the majority of the biological year (April 1st to March 31st) within the Sydney Range (pooled with Berens data). Dashed line represents the 85% survival rate (EC 2008).

5.2 Habitat state: disturbance and habitat

5.2.1 Disturbance assessment

The disturbance analysis is intended to reflect the loss or conservation of functional habitat and be an independent and indirect predictor of recruitment and likelihood of stable or increasing population growth (MNRF 2014a).

For the purpose of this analysis and in areas for which FRI coverage was available, young forest was defined as being less than 36 years of age (MNRF 2014a). In areas without FRI coverage (e.g. Provincial Parks), the 2012 Provincial Satellite Derived Disturbance Mapping data, PLC 2000, and various Lands Information Ontario (LIO) layers were used (Figure 18).

Anthropogenic disturbance data included features associated with infrastructure, industrial and resource extraction, and recreation such as:

i. Infrastructure
   - airports sites
   - railroads
   - transmission lines (e.g. electric, pipeline, fibre-optics)
   - highways/primary/secondary/tertiary roads
   - roads, trails, and landings
   - water power stations / dams

ii. Industrial and resource extraction
   - pits and quarries; mining-related sites
   - forest harvest,
   - forest processing facilities
   - agricultural land
   - wind farms

iii. Recreational
   - recreational camps and cottages
   - commercial campgrounds, outposts, and camps

Anthropogenic disturbances were buffered by 500 metres (MNRF 2014a). When buffers overlapped water polygons, the buffer area over water was counted as anthropogenic in the disturbance statistics.

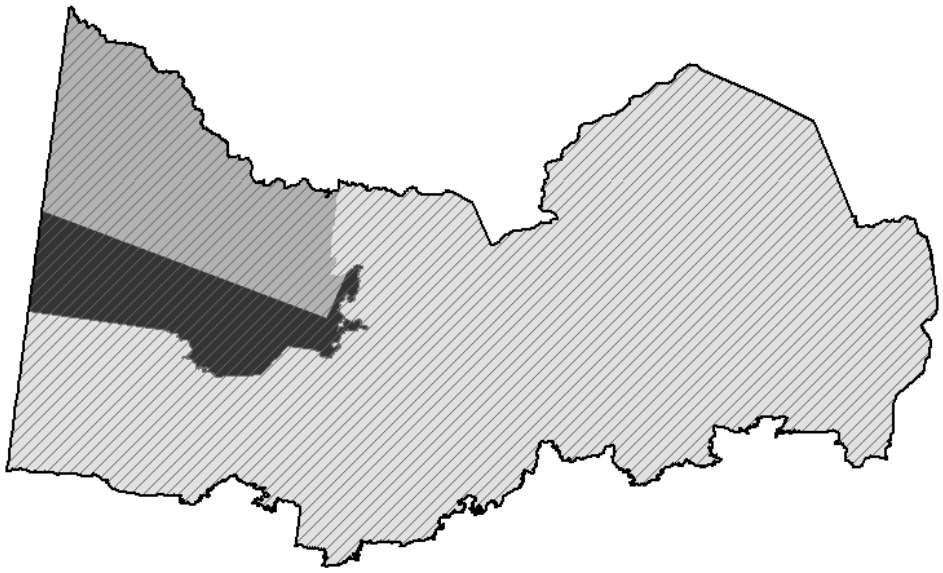


Figure 18. The Sydney Range including the extent of the FRI data ( ), the extent of 2012 Provincial Satellite Derived Disturbance Mapping data ( ), the extent of PLC 2000 data ( ), and the extent of relevant data from LIO ( ).

5.2.2 Disturbance analysis results

The physical disturbance from various sources within the Sydney Range (Figure 19 to Figure 24) contributes to the cumulative disturbance footprint (Figure 25). Sections 5.2.2.1 to 5.2.2.6 describe the disturbance contributions of forest harvest, other industry, linear features, mineral development, tourism, and natural disturbances relevant in 2012.

5.2.2.1 Forest harvest

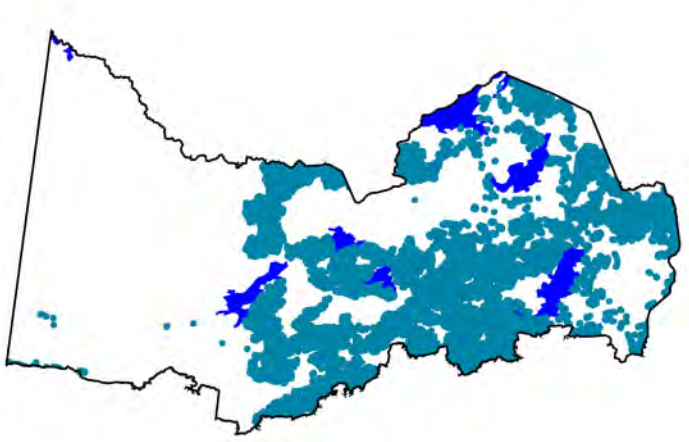


Figure 19. Forest harvest disturbances ( ) including 500 metre buffers in the Sydney Range.

Table 9. Forest harvest statistics in the Sydney Range.

Harvest features	Count (n)	Area (ha)	Buffer area (ha)
Harvest stands (FRI)	11,081	85,266	146,394
Harvest areas (2012 Provincial Satellite Derived Disturbance Mapping)	0	0	0
Harvest areas (PLC 2000)	n/a[1]	518	15,804

[1]derived from land cover (raster) and count of number features not available

5.2.2.2 Other industry disturbance

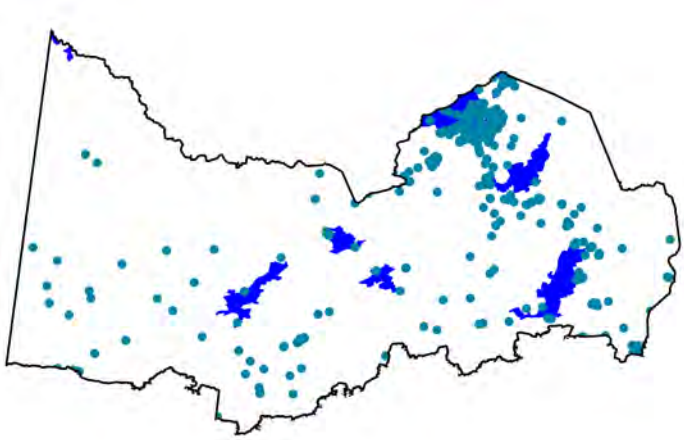


Figure 20. Other industry features ( ) including 500 metre buffers in the Sydney Range.

Table 10. Other industry disturbance statistics in the Sydney Range.

Other industry features	Count (n)	Area (ha)	Buffer area (ha)
Agriculture	0	0	0
Airports	14	64	1,276
Buildings	3,333	n/a[1]	15,212
Dams	2	n/a[1]	130
Forest processing facilities	2	n/a[1]	157
Infrastructure	1	140	441
Towers	24	n/a[1]	1,767
Trap cabin	33	n/a[1]	2,622
Utility Sites	2	n/a[1]	157
Waste disposal sites	14	6	1,203
Water power generating stations	1	n/a[1]	60
Work camps	1	n/a[1]	79

[1]features are represented by point data types; area not available

5.2.2.3 Linear features disturbance

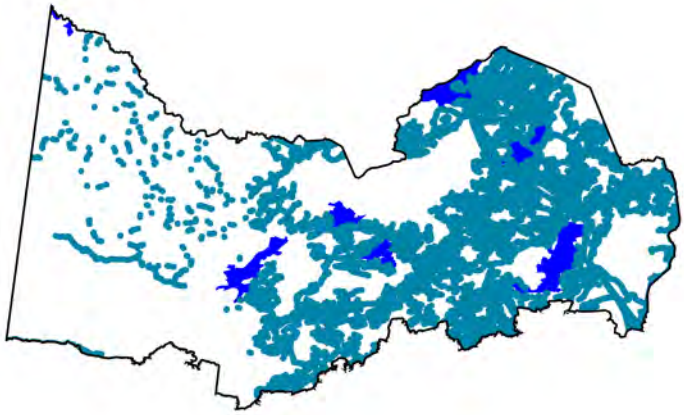


Figure 21. Linear features ( ) including 500 metre buffers in the Sydney Range.

Table 11. Linear features disturbance statistics in the Sydney Range.

Linear feature	Count (n)	Area (ha)	Buffer area (ha)
Roads	n/a[1]	n/a[2]	218,448
Trails	n/a[1]	n/a[2]	61,153
Railways	0	0	0
Utility lines	n/a[1]	n/a[2]	14,592

[1] single line features crossing entire range boundaries or multi-part features
[2]features used in analysis represented by centre-line, not right-of-way; area not available

5.2.2.4 Mineral development disturbance

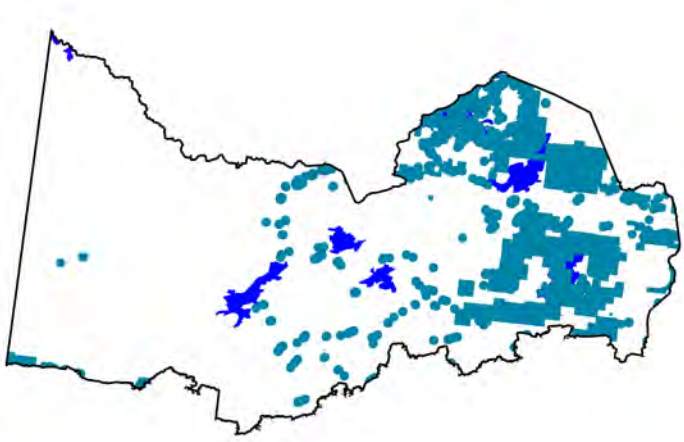


Figure 22. Mining and mineral exploration features ( ) including 500 metre buffers in the Sydney Range.

Table 12. Mining disturbance statistics in the Sydney Range.

Mining feature	Count (n)	Area (ha)	Buffer area (ha)
Active mining claims	618	85,471	n/a[2]
Aggregate sites – authorized	0	0	0
Aggregate sites – un-rehabilitated	6	n/a[1]	417
Drill holes	1,367	n/a[1]	16,980
Mining locations	0	0	0
Mine (shafts, open pit)	38	966	4,209
Pits and quarries	192	943	16,346

[1] Drill holes are “point features”. Disturbance extent is represented by the buffer area.
[2]Active mining claims are not buffered. As no specific disturbance records representing the amount or extent of clearings, drill pads, trails, cut lines etc. are digitally available for these analyses, the entire claim area is considered disturbed.

5.2.2.5 Tourism infrastructure disturbance

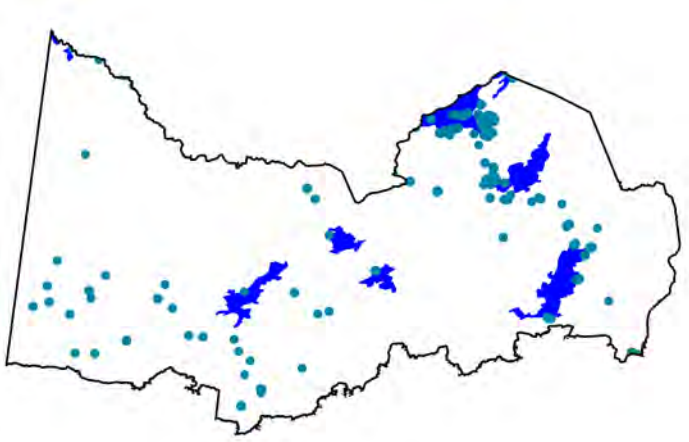


Figure 23. Tourism infrastructure features ( ) including 500 metre buffers in the Sydney Range.

Table 13. Tourism infrastructure disturbance statistics in the Sydney Range.

Tourism feature	Count (n)	Area (ha)	Buffer area (ha)
Cottage areas	22	161	2,561
Cottage and residential sites	53	15	2,847
Commercial campgrounds/parking lots/outpost camps/main base lodges	68	125	5,936

5.2.2.6 Natural disturbance

Similar to the anthropogenic disturbance analysis, there were several cases where the same landscape disturbance existed in two or more of these datasets. In these cases, the most up-to-date source and the source that contained the finest resolution was used.

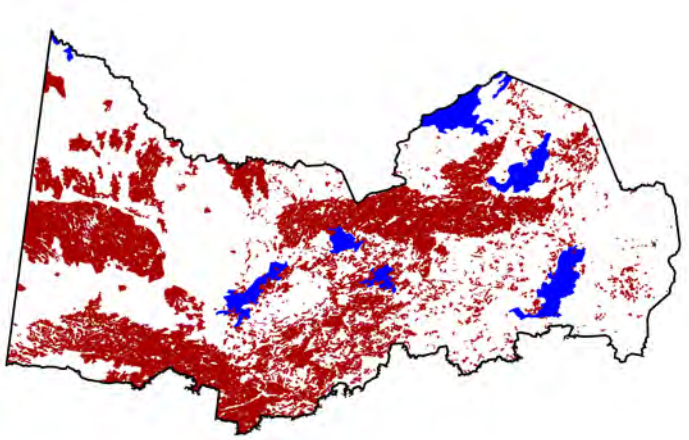


Figure 24. Natural disturbances from fire, blowdown, snow, and insect damage (■) in the Sydney Range.

Table 14. Natural disturbance statistics in the Sydney Range.

Natural feature	Count (n)	Area (ha)	Buffer area (ha)
Fire (FRI)	n/a	122,686	n/a[2]
Fire (2012 Provincial Satellite Derived Disturbance Mapping)	n/a[1]	14,164	n/a[2]
Weather (2012 Provincial Satellite Derived Disturbance Mapping)	n/a[1]	0	n/a[2]
Unknown causes (2012 Provincial Satellite Derived Disturbance Mapping)	n/a[1]	45	n/a[2]
Fire (PLC 2000)	n/a[1]	7	n/a[2]
Fire (LIO)	n/a	33,567	n/a[2]

[1]Derived from raster imagery; number of features not available
[2]No zone of influence (buffer) associated with natural disturbance

5.2.3 Disturbance analysis summary

Water accounts for 17.1% of the area within the Sydney Range (Table 15). Approximately 23% of the land area of the range is represented by data sources other than the FRI. Table 15 includes range statistics which assist with the interpretation of disturbance statistics and map (Figure 25). The amount of area, inferred as functional habitat loss identified from the disturbance analysis amounts to 468,901 ha, or 62.7% of the Sydney Range. Natural disturbance accounts for 16.2% of the range and anthropogenic disturbance accounts for 46.6% of the range. The overlap of natural and anthropogenic disturbances accounts for 6.5% of the range area and 10.3% of the total disturbance, this value is counted as part of anthropogenic disturbance.

Table 15. Sydney Range landscape statistics.

Range component	Area (ha)	%
Total range area	747,541	100.0
Water	128,152	17.1
Non-water	619,389	82.9
FRI extent[1]	575,851	77.0
Non-FRI extent[1]	171,690	23.0
Total disturbance within range	468,901	62.7
Natural[2]	120,893	16.2
Anthropogenic[2]	348,008	46.6
- Overlap of natural and anthropogenic disturbance[3]	48,469	6.5
Not disturbed within range	278,640	37.3

[1]FRI and non-FRI extents include water
[2]Anthropogenic disturbances include a 500 m buffer. When an anthropogenic disturbance overlaps with a natural disturbance it is counted as an anthropogenic disturbance.
[3]Overlap is included in the total amount of anthropogenic disturbance

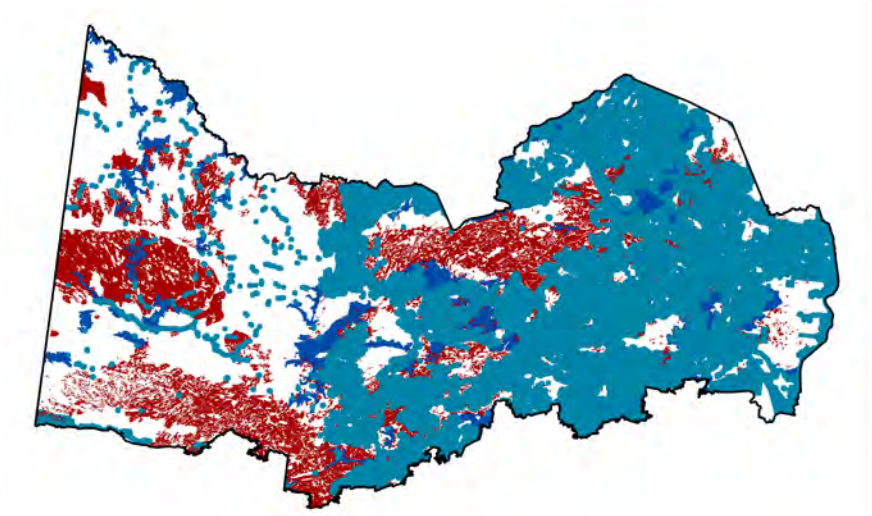


Figure 25. Anthropogenic[1] ( ) and natural ( ) disturbances (i.e. forest <36 years) in the Sydney Range.
[1]Anthropogenic disturbances include a 500 m buffer. When anthropogenic disturbances overlap with natural disturbances it is counted as anthropogenic.

The pattern of disturbance across the Sydney Range reflected in 100 km^2 hexagons (Figure 26). A high concentration of disturbance, primarily a result of anthropogenic causes, is distributed in the central and eastern half of the range. Disturbances to the east are considered permanent on the landscape as they are the results of infrastructure associated with towns of Red Lake, Balmertown, and Ear Falls.

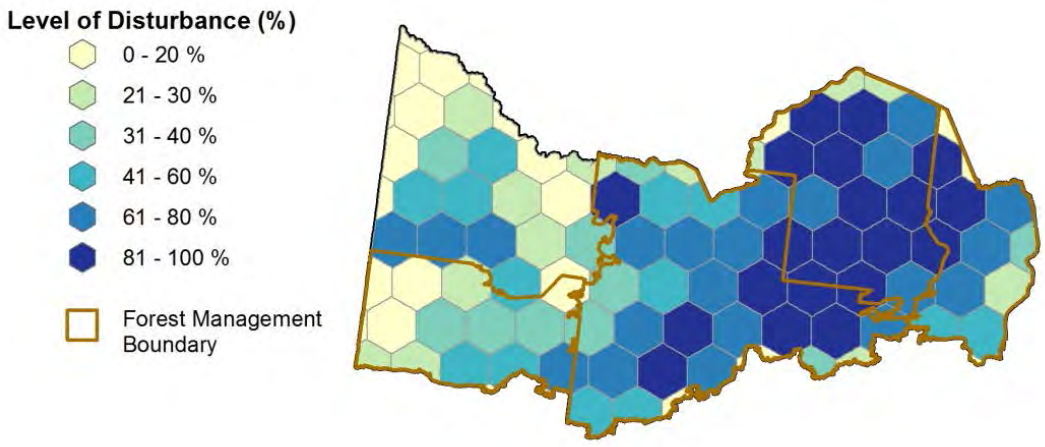


Figure 26. The concentration of natural and anthropogenic disturbances on the Sydney Range within 100 km^2 hexagon grid cells (used for the probability of occupancy survey, Section 3.3).

In addition to the physical landscape disturbance representing functional habitat loss as described using these methods, sensory disturbance (not addressed in this analysis) may also

contribute to range quality to some degree. Sensory disturbance includes the displacement of caribou due to human recreational or industrial activities.

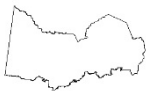
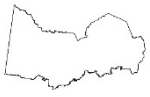
5.2.4 Disturbance considerations related to water

Water accounts for a substantial portion of the Sydney Range (17.1%) and contributes to the ability of caribou to isolate themselves from predators and the provision of calving habitat. However, the footprint of natural and anthropogenic disturbances (such as wildfires and harvest blocks) does not directly apply to waterbodies within the range. Therefore, the intensity and extent of disturbances and the associated functional habitat loss is likely underestimated when represented as a proportion of the total range area.

A sensitivity analysis was conducted in which waterbodies of different size classes were removed (Table 16) and the proportion of disturbance on the landscape was adjusted accordingly. This was completed to assist with interpretation of the disturbance analysis results and to inform the interpretation of the integrated probability of persistence calculated using the results of the disturbance analysis.

As the sensitivity analysis shows, water accounts for a combined area of 1,281 km^2 of the range and disturbance ranges from 62.7-75.7%, depending on the inclusion of water.

Table 16. Disturbance sensitivity analysis. The percent disturbance is estimated by removing waterbodies of different sizes from the denominator (i.e. lakes > 10,000 ha, lakes > 5,000 ha, lakes > 1,000 ha, lakes > 500 ha, lakes > 250 ha, and all water).

Sydney Range	Waterbody	Water ha (%)	Disturbance (%)		
			Natural	Anthropogenic	All
	Range extent	0 (0.0)	16.2	46.6	62.7
	> 10,000 ha removed	0 (0.0)	16.2	46.6	62.7
	> 5,000 ha removed	26730 (4.3)	16.8	48.3	65.1
	> 1,000 ha removed	50,022 (6.7)	17.3	49.9	67.2

	> 500 ha removed	60,805 (8.1)	17.6	50.7	68.3
	> 250 ha removed	77,270 (10.3)	18.0	51.9	70.0
	All Water removed	128,152 (17.1)	19.5	56.2	75.7

5.2.5 Habitat state: habitat assessment

Habitat assessment compares the current amount and arrangement of habitat against that projected by the Simulated Range of Natural Variation, or SRNV (MNRF 2014a). For the Sydney Range, both the amount and arrangement SRNV are compared against 2012 amounts and 2010 arrangement as inferred from the FRI (Figure 27). The relative difference is a measure of how close or how far away the range condition is to the natural levels of habitat. The SRNV values may be compared to the land, water, and inventory coverage for the Sydney Range (Table 15).

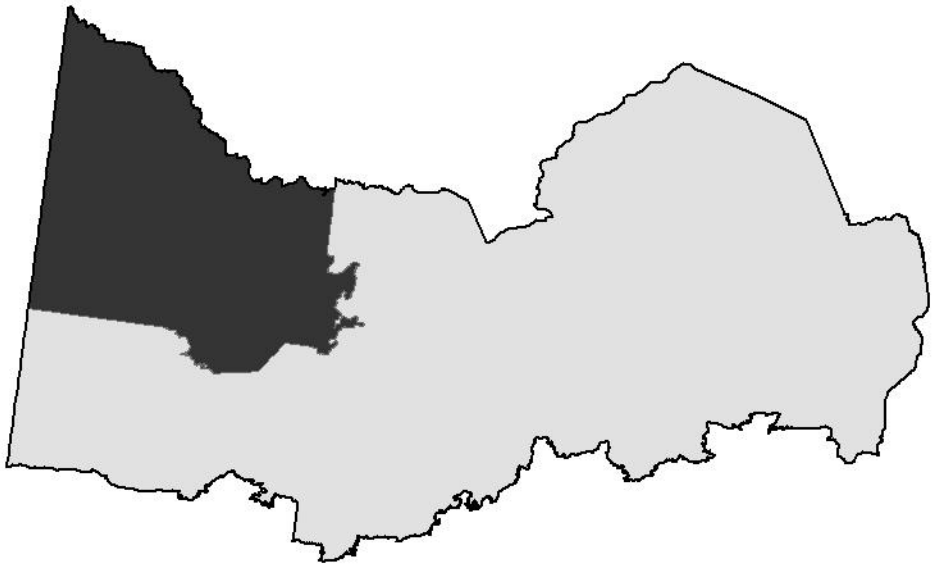
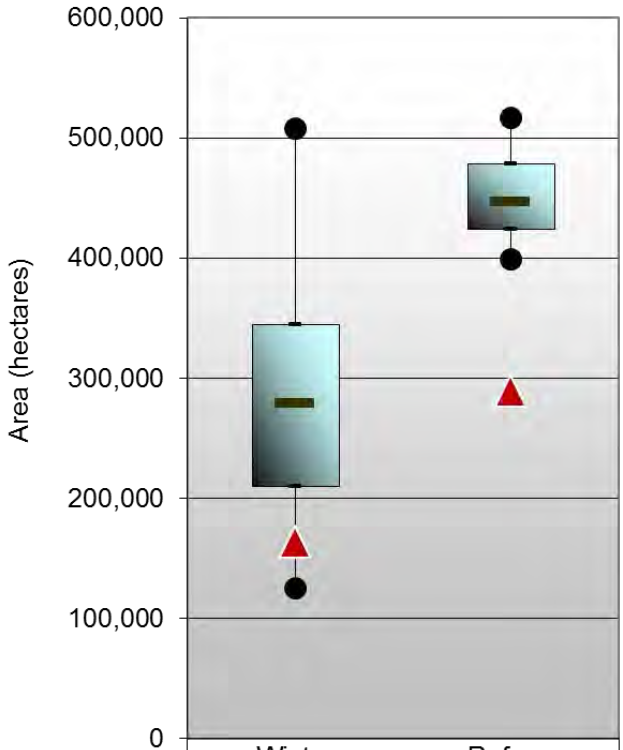


Figure 27. The Sydney Range including the extent of the FRI data ( ) and the extent of PLC 2000 data (■).

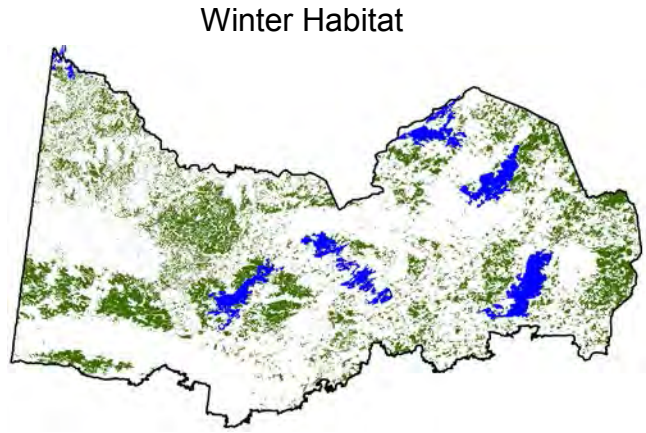
5.2.6 Habitat assessment results

5.2.6.1 Caribou habitat SRNV amount

Relative to the SRNV estimate (MNRF 2014a), the amount of winter habitat is above the lower range and the amount of refuge habitat is below the lower range of what is expected in a natural system projected by the SRNV (Figure 28). The values shown for each FMU inlude all land regardless of ownership. Consequently, the Integrated Range Assessment estimates are higher than those used in forest management planning which would include managed crown land only.



	Winter	Refuge
– Lower Quartile	209,612	424,324
● Lower Range	125,113	399,333
– Median	278,872	446,740
● Upper Range	507,590	516,741
– Upper Quartile	344,657	478,858
▲ 2012	163,195	289,249



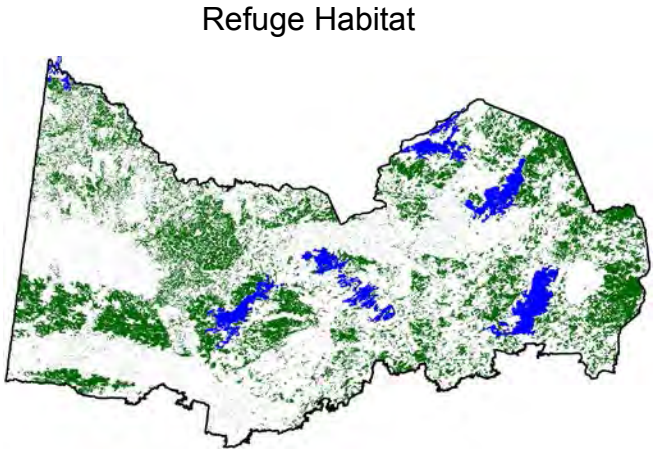
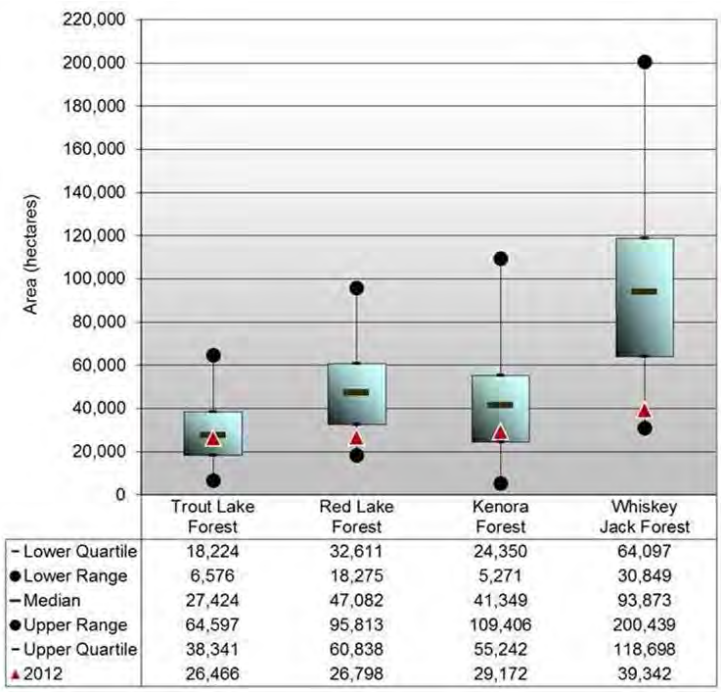


Figure 28. Box and whisker plot of caribou winter and refuge habitat amounts in the Sydney Range as compared to the SRNV.

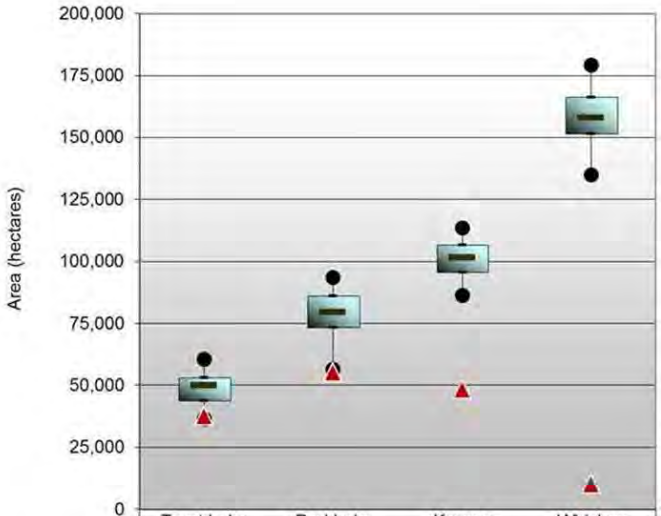
Current winter habitat amounts across the Sydney Range were examined according to Forest Management Unit (FMU) (Figure 29). Most current amounts were below the median of the SRNV. The current amount of winter habitat within the Trout Lake FMU is near the median and in the Kenora FMU it is above the lower quartile range. Amounts in the Red Lake and Whiskey Jack FMUs are below the lower quartile but above the lower range of the SRNV.

Current refuge habitat amounts in the FMUs are at or below the lower range of the SRNV within the Sydney Range (Figure 30).



	Trout Lake Forest	Red Lake Forest	Kenora Forest	Whiskey Jack Forest
Lower Quartile	18,224	32,611	24,350	64,097
Lower Range	6,576	18,275	5,271	30,849
Median	27,424	47,082	41,349	93,873
Upper Range	64,597	95,813	109,406	200,439
Upper Quartile	38,341	60,838	55,242	118,698
2012	26,466	26,798	29,172	39,342

Figure 29. Box and whisker plots of winter habitat amount for each of the Forest Management Units within the Sydney Range as compared to the SRNV.



	Trout Lake Forest	Red Lake Forest	Kenora Forest	Whiskey Jack Forest
Lower Quartile	43,715	73,266	95,540	151,474
Lower Range	36,401	56,425	86,210	134,796
Median	49,749	79,493	101,326	157,895
Upper Range	60,498	93,477	113,467	179,136
Upper Quartile	53,034	86,012	106,578	166,326
2012	37,808	55,216	48,385	10,042

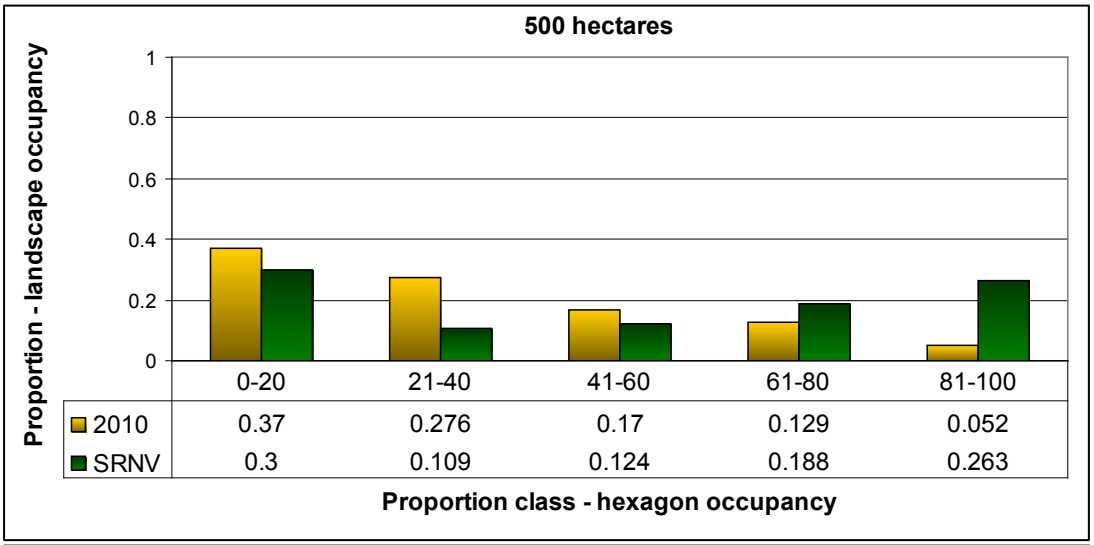
Figure 30. Box and whisker plots of refuge habitat amount for each of the Forest Management Units within the Sydney Range as compared to the SRNV.

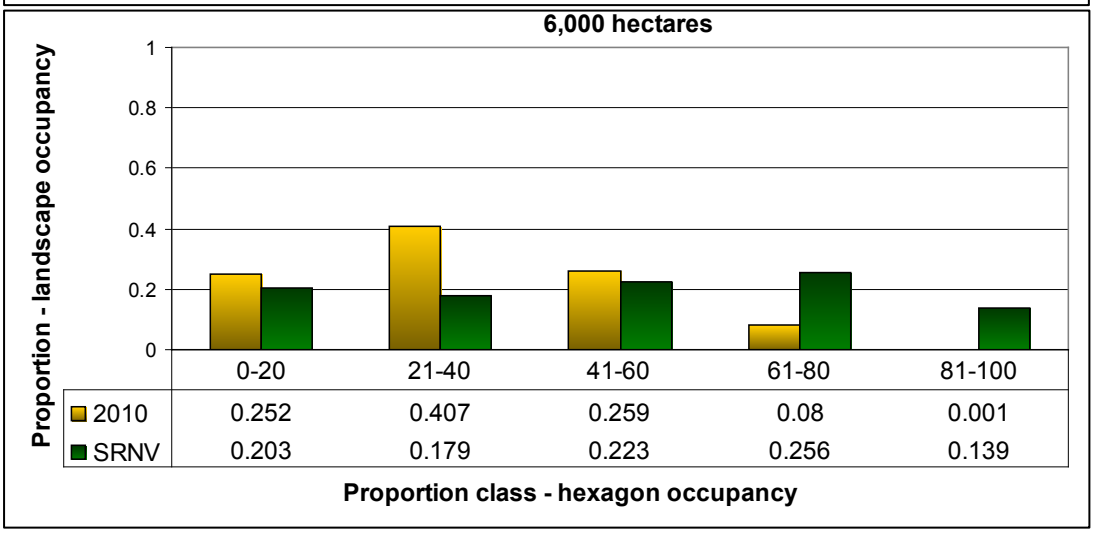
5.2.6.2 Winter habitat arrangement

At the 6,000 hectare level, 8.1% (0.08 + 0.001 = 0.081) of the hexagons have 61% or more winter caribou habitat (Figure 31). The mean from the SRNV is substantially greater with 39.5% (0.256 + 0.139 = 0.395) of the hexagons having 61% or more winter caribou habitat. Most of this difference occurs in the 81-100% proportion class. This represents a present arrangement value 31.4% below the SRNV.

At the 30,000 hectare level, 1.9 % (0.019 + 0.0 = 0.019) of the hexagons have 61% or more winter caribou habitat. The mean from the SRNV is substantially greater with 32.8% (0.261 + 0.067 = 0.328) of the hexagons having 61% or more winter caribou habitat. This represents a present arrangement value 30.9% below the SRNV.

Currently caribou winter habitat measured at the 6,000 and 30,000 ha levels is fragmented relative to our estimates of the natural landscape.





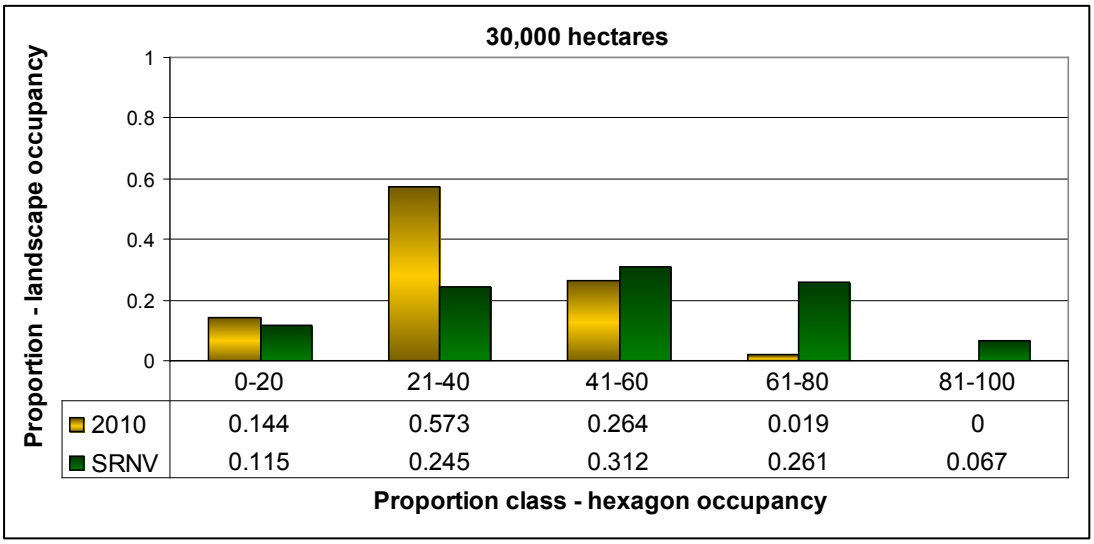


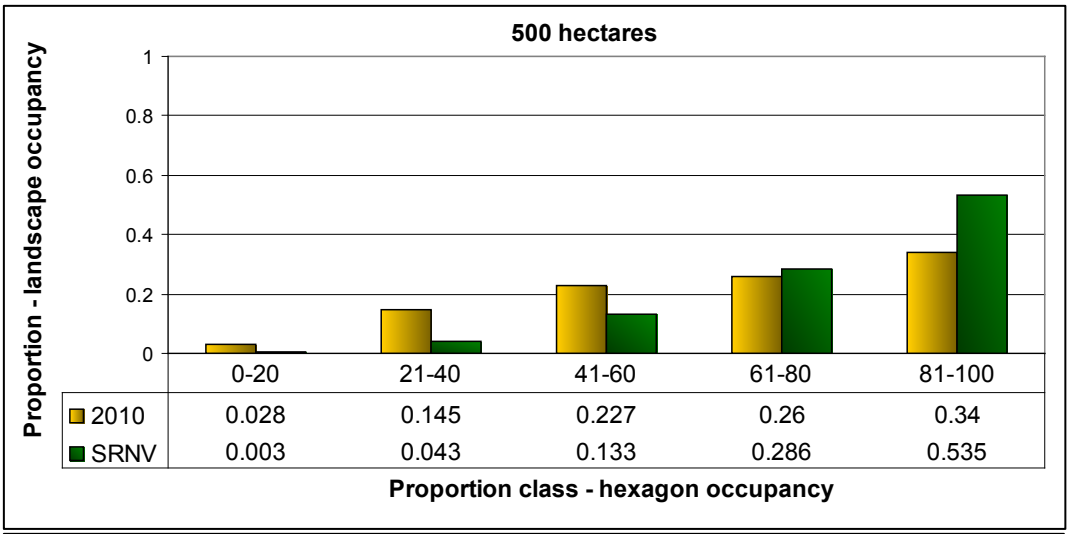
Figure 31. Caribou winter habitat texture histogram compared to means from the SRNV at the 500, 6,000, and 30,000 hectare levels for the Sydney Range.

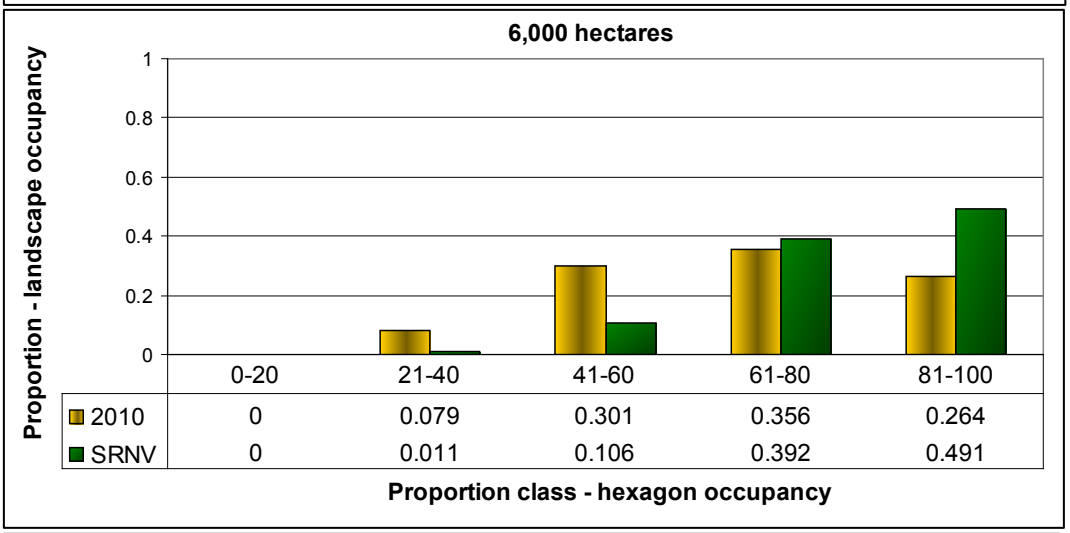
5.2.6.3 Refuge habitat arrangement

At the 6,000 hectare level, 62% (0.356 + 0.264 = 0.62) of the hexagons have 61% or more refuge habitat (Figure 32). The mean from the SRNV is greater with 88.3% (0.392 + 0.491 = 0.883) of the hexagons having 61% or more refuge habitat. Most of this difference occurs in the 81-100% proportion class. This represents a present arrangement value 26.3% below the SRNV.

At the 30,000 hectare level, 60% (0.43 + 0.17 = 0.6) of the hexagons have 61% or more refuge habitat. The mean from the SRNV is greater with 92.8% (0.49 + 0.438 = 0.928) of the hexagons having 61% or more refuge habitat. Most of this difference occurs in the 81-100% proportion class. This represents a present arrangement value 32.8% below the SRNV.

Caribou refuge habitat measured at the 6,000 and 30,000 ha levels is fragmented relative to our estimates of the natural landscape.





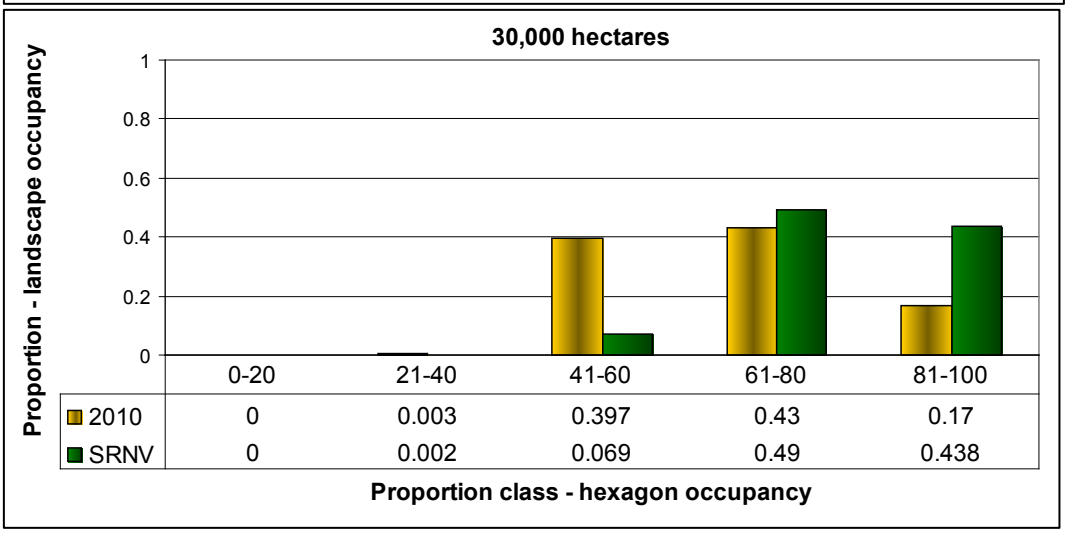


Figure 32. Caribou refuge habitat texture histogram compared to means from the SRNV at the 500, 6,000, and 30,000 hectare levels for the Sydney Range.

5.2.6.4 Young forest SRNV area results

The current amount of young forest is approximately at the median estimated by the SRNV (Figure 33). This indicates that the current amount is about what would be expected in a natural system. Young forest includes all young forests regardless of origin and includes forest areas created by fire, forest harvest, or blowdown. Further increases in the amount of young forest above the median will result in expected deterioration in range habitat quality for caribou.

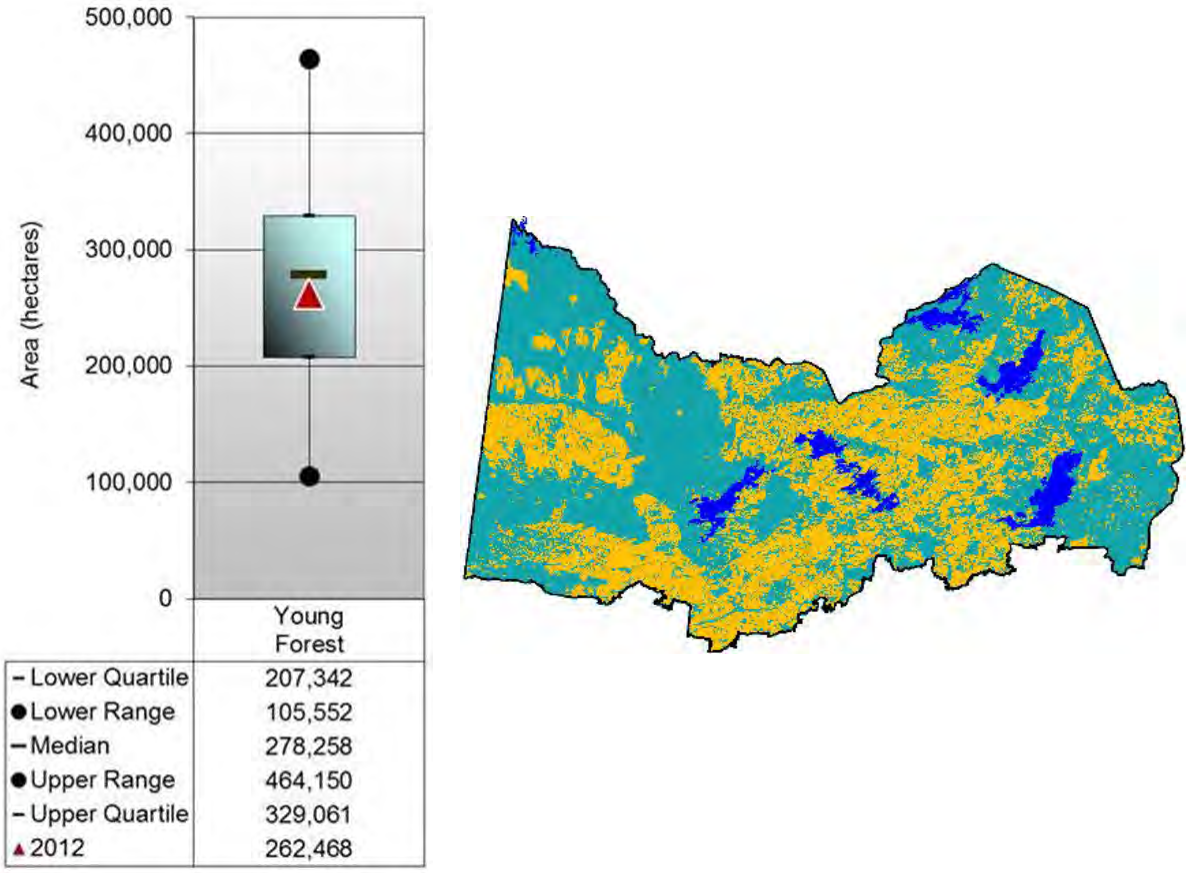


Figure 33. Box and whisker plot of young forest (i.e. <36 years) and permanent disturbance in the Sydney Range as compared to the SRNV.

6.0 Interpretation of Lines of Evidence

6.1 Interpretation of the population state

The minimum animal count (MAC) for caribou occupying the Sydney Range was determined to be 55 caribou. Although it is known that the population is larger than 55 caribou, we do not expect there to be a lot more.

Recruitment rates in 2012 and 2013 (18.0 and 13.6 calves per 100 AF_{adj}, respectively) were well below the threshold for maintaining a stable population (28.9 calves per 100 adult females, assuming an adult female survival rate of 85%, EC 2008, EC 2011) and indicate low

recovery potential within the Sydney Range. Low recruitment in 2012 was also observed in Manitoba as well as the adjoining Churchill and Berens Ranges. It is likely that other factors, such as weather patterns during the previous year, may have contributed to low calf survival within this larger region.

The survival estimate (1.0) cannot be considered reliable as there were only 10 adult female caribou collared in the Sydney Range during the 2012 biological year and no mortalities. This estimate is likely a result of having such as small sample size and it is assumed that 100% adult female survival is not biologically reasonable. The pooled (Berens-Sydney) estimate of adult female survival is good at 91%, compared to the national average of 85% (EC 2008). However, with such low recruitment rates, the estimated mean population trend (λ) of 0.98 (range 0.97-0.99), suggests that the short-term population trend is likely stable-to-declining. Estimates of recruitment and survival rates from collared caribou in future years will allow for additional estimates of population trend, leading to improved interpretation of trend estimates.

The probability of occupancy estimates were higher in the northwest portion of the range and lower in the east, south, and central portions of the range. There is an apparent inverse relationship between occupancy estimates and the amount of disturbance. The average range-wide probability of caribou occupancy without habitat covariates is moderate (0.55; ±0.25) and is best used as a quantitative benchmark against which to compare future assessment results. Modelled indices are sensitive to the data employed and care will need to be taken to ensure consistency in the survey design standards, data and analytical methods to ensure appropriate comparisons of change through time.

The degree of immigration and emigration across the range boundary is unknown although there is collaring evidence to suggest caribou traverse the western (Owl-Flintstone Range) and the northern (Berens Range) range boundaries. Movement between the Sydney and Churchill Ranges is less likely due to high levels of disturbance in the eastern portion of the Sydney Range. Immigration and emigration rates, if known, may be relevant to the interpretation of probability of persistence. However, the extent to which immigration and emigration may contribute to population state cannot be estimated at this time.

6.2 Interpretation of habitat state

Nearly two thirds of the Sydney Range is disturbed. These landscape disturbances are heavily concentrated in the eastern half of the range and are primarily human-caused. The western side of the range is less affected by human-caused disturbance mainly due to the protection of Eagle-Snowshoe Conservation Reserve and Woodland Caribou Provincial Park.

The level of disturbance on the Sydney Range is 62.7% (all waterbodies included). As a result, it is unlikely that the population growth on the Sydney Range is stable or increasing, with an estimated probability of 0.2 (EC 2008). The influence of waterbodies in the disturbance analysis should be considered when evaluating the level of disturbance within the range. The water sensitivity analysis (section 5.2.4) demonstrated that the disturbance estimate for the Sydney Range may be as great as 75.7%. At such a level it is even less likely that the range could sustain caribou. However, it is possible that landscapes containing large waterbodies

with islands may help compensate for moderate levels of landscape disturbance by providing valuable caribou habitat because the surrounding body of water may provide additional refuge.

Collectively, there are a number of anthropogenic disturbance types not addressed in the above analyses including outfitter activities, access points, camps sites, and shore lunch activities – all of which are suspected to influence caribou, contribute to habitat alteration, as well as sensory disturbance. The extent and intensity of these disturbances are not quantified but the impacts are expected to be considerable at a local scale.

In the Sydney Range, the amount of winter habitat is below the median, but above the lower range, whereas the refuge habitat is below the lower range of the SRNV. Increasing or maintaining the amount of winter habitat and increasing the refuge habitat throughout the Sydney Range and on individual FMUs to within the interquartile range would create conditions that would more commonly have occurred in landscapes to which caribou have adapted.

Both winter and refuge habitats are fragmented at the 6,000 and 30,000 ha scales as compared to the SRNV. Similar to habitat amount, creating and retaining strategically placed large contiguous patches of winter and refuge habitat would create conditions that would have more commonly occurred in landscapes to which caribou have adapted.

Retaining the amount of young forest at or below the estimated natural landscape of the SRNV is desirable to improve prospects for caribou conservation and recovery. At present, the amount of young forest (including permanent disturbances) within the Sydney Range is close to the median of the SRNV. Improvements could occur through the creation and retention of strategically placed large contiguous patches of winter and refuge habitat.

Islands on large lakes are considered valuable caribou habitat, but the conventional assignment of winter and refuge habitat value is not always appropriate. In this circumstance, the refuge value of islands is typically high, regardless of the underlying vegetation condition, although conifer forest conditions are generally more desirable than mixed forest conditions.

7.0 Integrated Risk Assessment

7.1 Population size

The minimum number of caribou on the Sydney Range, based on the MAC from the winter 2012 survey, is 55 (Figure 34) but the overall population is known to be larger. Seventy four (74) caribou were observed the following year during the 2013 recruitment survey. The Sydney Range is part of Continuous Distribution in Ontario, some immigration and emigration likely occurs. By using the minimum animal count of 55, estimates of probability of persistence are likely conservative. The probabilities of persistence for 20 and 50 years are approximately 0.50-0.85 and 0.35-0.65 respectively (Figure 34) (MNRF 2014a; EC 2011).

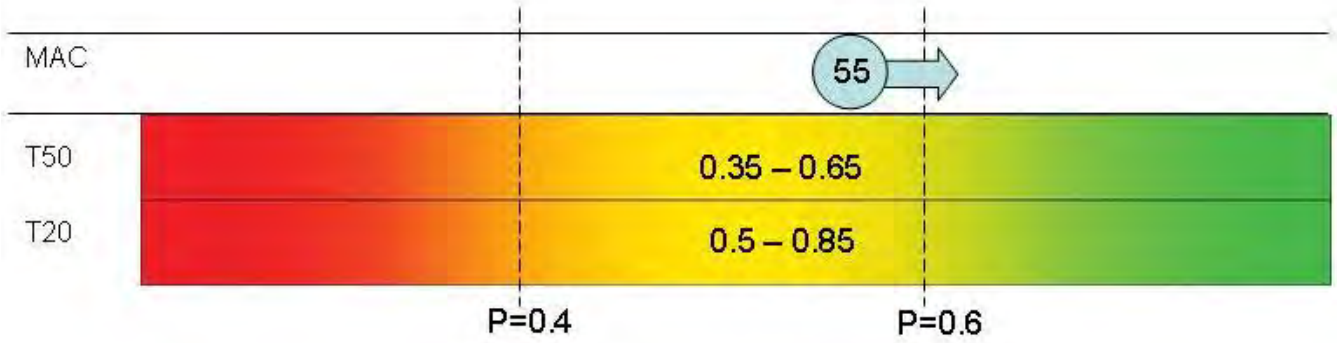


Figure 34. Minimum animal count (MAC) in the Sydney Range estimated from the 2012 winter aerial survey as compared to probability of persistence in 20 years (T20) and 50 years (T50).

If the Sydney Range and the Owl-Flintstone Range are considered together and caribou are assumed to move freely across the provincial boundary, then the total number of caribou would exceed 110 (i.e. 55 (Sydney) and 55 (Owl-Flintstone)) resulting in expected probabilities of persistence for 20 and 50 years of 0.9-0.95 and 0.75-0.78 respectively.

7.2 Population trend

The current estimate of trend, based on the 2011 and 2012 biological years, using a one-year pooled survival estimate from the Berens and Sydney ranges, suggests the short-term population trend is likely stable to declining ($\lambda = 0.98$) (Figure 35). Uncertainty exists regarding this estimate as it based on only one year of pooled survival data, and both annual estimates of recruitment were low. Future recruitment and survival estimates from collared adult females will continue to inform and support the population trend information.

Furthermore, there are many areas within the Sydney Range where caribou existed during the 1960s but were not found during the recent survey efforts (Table 2). Therefore, the Sydney Range has been identified as having a long-term declining trend.

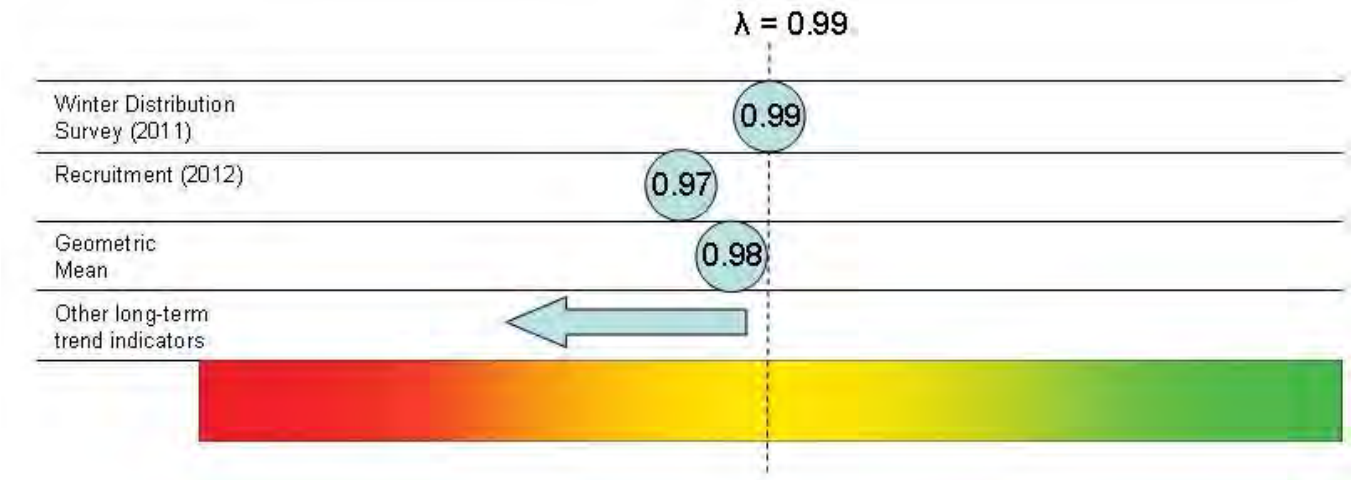


Figure 35. Estimated population trend (λ) for the Sydney Range according to the source of the data (i.e. survey) and the corresponding biological year (not the survey year), as well as the short-term trend (geometric mean) and long-term trend as determined from other trend indicators.

7.3 Disturbance analysis

The Sydney Range is 62.7% disturbed (Figure 36). Calculated values of disturbance range from 62.7-75.7%, depending on the treatment of water. When considering the accuracy of fine-scale data used in the disturbance analysis, we believe the calculated value of 62.7% provides a realistic depiction of the amount of disturbance in the Sydney Range. This level of disturbance would suggest that the likelihood of stable or increasing population growth is approximately 0.2 and is considered unlikely or declining.

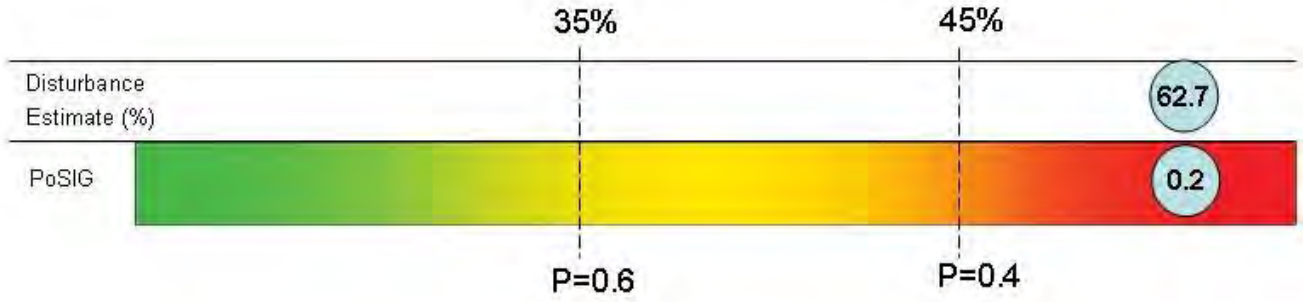


Figure 36. Disturbance estimate as a percentage of area within the Sydney Range as it relates to the probability of stable or increasing population growth (PoSIPG).

7.4 Integrated risk assessment process

The six steps of the risk assessment process as identified in the Protocol (Figure 16 in MNRF 2014a) lead to a conclusion of the degree of risk.

Step 1: Lambda is less than 0.99 and the likelihood of stable to increasing pop growth is less than 0.4; MAC is less than 80 caribou.

Based on this analysis, risk to caribou in the Sydney Range is high.

If the Sydney Range and the Owl-Flintstone Range (Manitoba) are considered together and were assumed to have free movement of caribou across the provincial boundary, then the risk assessment for the combined areas may differ from the risk assessment above.

7.5 Range condition

Risk is estimated to be high in the Sydney Range. The amount of winter habitat is below the median, but above the lower range and the amount of refuge habitat is below the interquartile range. Winter and refuge habitat arrangement is fragmented relative to the SRNV implying a strongly diminished range condition compared to that suggested by the risk analysis alone. Therefore, the Assessment Team determined that range condition is insufficient to sustain caribou.

8.0 Involvement of First Nation Communities

Red Lake staff discussed the Integrated Range Assessment with the communities of Pikangikum, Deer Lake, Poplar Hill, Grassy Narrows, Wabaseemoong, and Manitoba First Nation communities Pauingassi and Little Grand Rapids. Community members involved in the 2012 winter aerial survey work includes George Land (Wabaseemoong), Darrell Keeper (Pikangikum), Freddie Meeseewapetung and Isiah Pahpasay (Grassy Narrows), and Seymour Owen (Poplar Hill). In September 2011, notification letters were sent to each of the above communities describing the planned Integrated Range Assessment work. Follow up was undertaken through phone calls and visits to the communities in the ensuing weeks. The following is a summary of face-to-face meetings held with communities.

- While in the community during the winter of 2011, MNRF representatives met with Deer Lake First Nation Chief and Council to describe the survey in greater detail.
- While meeting with representatives of Pauingassi and Little Grand Rapids First Nations in Manitoba during the winter of 2011, further details regarding the Integrated Range Assessment work were shared and discussed.
- Correspondence between Pikangikum First Nation, the Whitefeather Forest Management Corporation (WFMC) and MNRF led to a number of informal meetings and discussions throughout the winter of 2011/2012 with the WFMC Elders Steering Group. MNRF shared details of the Integrated Range Assessment work and discussed and addressed comments and concerns from the WFMC Elders Steering Group. MNR and the WFMC Elders Steering Group also discussed community participation on survey crews.
- Poplar Hill First Nation invited MNRF representatives to the community during the winter of 2011 for a half-day session to share further details on the Integrated Range Assessment work and discuss community participation on survey crews.

- Two visits to Grassy Narrows First Nation were organized; one in the winter of 2011 and one in winter 2012. During the first meeting, the Integrated Range Assessment work was discussed in greater detail and questions and concerns regarding the survey work were discussed. Follow-up from the head of the Grassy Narrow's Trapper's Council after the first meeting indicated a willingness by community members to participate in the survey work. During the second meeting, a trip to a seventh grade class was organized by the head of the Grassy Narrows Trapper's Council so that youth could learn more about the work. During the second visit community participation in the work was further discussed.
- One visit to Wabaseemoong was organized in the winter of 2011.

While understanding of and support for the Integrated Range Assessment work was generally favourable amongst the majority of the communities, there were some key concerns raised by some community members that became the subject of further discussion including:

- Concerns regarding the extent to which aircraft would disturb or cause the animals to run, leading to stress on the animals that could affect their health.
- Concerns regarding the affixing of collars to animals; the amount of wear on an animal's neck, the stress caused the animal during collaring and increased vulnerability of animals that have been collared.
- Concerns regarding how the information would be used and how the conduct of the survey may either interfere with hunting or information used to make decisions that could affect the harvesting/livelihood activities of community members.

9.0 Comparison with the Federal Generalized Approach

Environment Canada published a *Scientific Assessment to Inform the Identification of Critical Habitat for Woodland Caribou (Rangifer tarandus caribou), Boreal Population, in Canada* (EC 2011). Based on available information and specific methodologies used by EC (2011), it was determined that caribou occupying the Sydney Range are unlikely to be self-sustaining. EC concluded that the Sydney Range was 58% disturbed; no population estimate or probability of persistence was given based on insufficient available data at that time. These results were based on best available data at the time provided to EC from the MNRF. Data presented in this IRAR will be used by EC to update their analysis in the future.

Differences between the Integrated Range Assessment documented in this report and the results of the EC assessment can be attributed to the following:

1. Ontario estimated a minimum animal count of 55, and suggests the population is larger than 55 caribou.
2. The amount of disturbance identified on the range includes additional disturbance associated with mining claims, linear features, and blowdown events which were not addressed by EC. MNRF used a finer grained depiction of fire disturbance than the broad polygonal fire disturbance used by EC. MNRF determined varied estimates of disturbance associated with stated assumptions relating to the treatment of water in the disturbance calculations.

3. Current recruitment and adult survival estimates derived from the winter 2012 distribution survey and collared caribou, resulted in lambda calculations that suggest a stable to declining trend over the short-term. Other long-term trend indicators suggest a declining trend.
4. MNRF considered amount and arrangement of caribou habitat in the determination of overall range condition which was not considered by EC.

10.0 Literature Cited

Bergerud, A.T. 1992. Rareness as an antipredator strategy to reduce predation risk for moose and caribou. Pages 1008-1021 *in* Mccullough, D.R., Barrett, R.H. editors. Wildlife 2001: Populations. Elsevier Scientific Publications Ltd., London. 163 pp.

Bergerud, A.T. 1996. Evolving perspectives on caribou population dynamics, have we got it right yet? *Rangifer. Special Issue* 9: 95-115.

Bergerud, A.T. and R.E. Page. 1987. Displacement and dispersion of parturient caribou at calving as antipredator tactics. *Canadian Journal of Zoology*. 65:1597-1606.

Brown, G.S., W.J. Rettie, R.J. Brookes, and FF. Mallory. 2007. Predicting the impacts of forest management on woodland caribou habitat suitability in black spruce boreal forest. *Forest Ecology and Management*, 245: 137-147.

Brown, W.K., J. Huot, P. Lamonthe, S. Luttich, M. Pare, G. St. Martin, and J.B. Theberge, 1986. The distribution and movement patterns of four woodland caribou herds in Quebec and Labrador. *Rangifer*, Special Issue 1: 43-49.

Elkie P., K. Green, G. Racey, M. Gluck, J. Elliott, G. Hooper, R. Kushneriuk and R. Rempel, 2012. Science and Information in support of Policies that address the Conservation of Woodland Caribou in Ontario: Occupancy, Habitat and Disturbance Models, Estimates of Natural Variation and Range Level Summaries. Electronic Document. Ontario Ministry of Natural Resources, Forests Branch. Species at Risk Branch

Environment Canada [EC]. 2008. Scientific Review for the Identification of Critical Habitat for Woodland Caribou (*Rangifer tarandus caribou*), Boreal Population, in Canada. Ottawa, Ontario, Canada. 238 pp.

EC. 2011. Scientific Assessment to Inform the Identifiacaiton of Critical Habitat for Woodland Caribou (*Rangifer tarandus caribou*), Boreal Population, in Canada: 2011 update. Ottawa, Ontario, Canada, 102 pp + Appendices.

Hatter, I.W. and W.A. Bergerud. 1991. Moose recruitment, adult mortality and rate of change. *Alces*. 27: 65-73.

Johnson, C.J., M.S. Boyce, R.L. Case, H.D. Cluff, R.J. Gau, A. Gunn, and R. Mulders. 2005. Cumulative effects of human developments on Arctic wildlife. *Wildlife Monograph*, 160: 1-36.

Land Information Ontario (LIO). 2012. Lands Information Ontario Warehouse. Peterborough, Ontario: Ontario Ministry of Natural Resources. Digital database.

MacKenzie, D.I., J.D. Nichols, G.B. Lachman, S. Droege, J.A. Royle, and C.A. Langtimm. 2002. Estimating site occupancy rates when detection probabilities are less than one. *Ecology*, 83: 2248-2255.

McLoughlin, P.D., E. Dzus, B. Wynes, and S. Boutin. 2003. Declines in populations of woodland caribou. *Journal of Wildlife Management*, 67:755-761.

Ministry of Natural Resources [MNR]. 1994. Northwest region interim caribou habitat management direction.

MNR. 1999a. Ontario's Living Legacy Land Use Strategy. MNR, Queen's Printer for Ontario, Toronto, Ontario. 40pp + Appendix.

MNR. 1999b. A management framework for woodland caribou conservation in northwestern Ontario. MS Report, MNR, Thunder Bay, Ontario.

MNR. 2009a. Ontario's woodland caribou conservation plan. MNR, Queen's Printer for Ontario. Toronto, Ontario, Canada. 24 pp.

MNR. 2009b. Cervid ecological framework. MNR, Queen's Printer for Ontario, Toronto, 18 pp.

Ministry of Natural Resources and Forestry [MNRF]. 2014a. Integrated Assessment Protocol for Woodland Caribou Ranges in Ontario. Species at Risk Branch, Thunder Bay Ontario.

MNRF. 2014b. Range Management Policy in Support of Woodland Caribou Conservation and Recovery. Species at Risk Branch, Thunder Bay, Ontario.

MNRF. 2014c. Delineation of Woodland Caribou Ranges in Ontario. MNR, Species at Risk Branch, Thunder Bay, Ontario.

Moreau, G., D. Fortin, S. Couturier, and T. Duchesne. 2012. Multi-level functional responses for wildlife conservation: the case of threatened caribou in managed boreal forests. *Journal of Applied Ecology*, 49:611-620.

Ontario Woodland Caribou Recovery Team. 2007. Recovery strategy for woodland caribou (*Rangifer tarandus caribou*) (Forest-dwelling, boreal population) in Ontario. MNR, Peterborough, Ontario. 93 pp.

Racey, G., A. Harris, L. Gerrish, E. Armstrong, J. McNicol, and J. Baker. 1999. Forest management guidelines for the conservation of woodland caribou: A landscape approach. MNR, Thunder Bay, Ontario. 69 pp + Appendix.

Ranta, B. 2001. Report on Woodland Caribou and their Use of Habitats in the Kenora Management Unit and Southern Portions of Woodland Caribou Provincial Park. MNR. Kenora, Ontario. 18 pp.

Rettie, W.J., and F. Messier. 1998. Dynamics of woodland caribou populations at the southern limit of their range in Saskatchewan. *Canadian Journal of Zoology*. 76: 251-259.

Rettie, W.J. and F. Messier. 2000. Hierarchical habitat selection by woodland caribou: its relationship to limiting factors. *Ecography*. 23: 466-478.

Rudolph, T.D. 2005. Trout Lake Conservation Reserve Vegetation Management Strategy. Ontario Ministry of Natural Resources, Red Lake, Ontario. 74pp + Appendices.

Schaefer, J.A., C.M. Bergman, and S.N. Luttich. 2000. Site fidelity of female caribou at multiple spatial scales*. Landscape Ecology*, 15: 731-739.

Schaefer, J.A. and W.O. Pruitt Jr. 1991. Fire and woodland caribou in south-eastern Manitoba. *Wildlife Monograph.* No. 116: 3-39.

Simkin, D. 1964. Aerial Survey for Caribou – Irregular Lake Study Area. Research Branch Report. Ontario.

Simkin, D. 1965. Aerial Survey for Caribou – Irregular Lake Study Area. Research Branch Report. Ontario.

Simkin, D. 1966. Aerial Survey for Caribou – Irregular Lake Study Area. Research Branch Report. Ontario.

Statutes of Ontario. Crown Forest Sustainability Act, 1994. S.O. 1994, Chapter 25. Last amendment: 2011, c. 10, s.28.

Wittmer, H.U., B.N. McLellan, R. Serrouya, and C.D. Apps. 2007. Changes in landscape composition influence the decline of a threatened woodland caribou population. *Journal of Animal Ecology*. 76: 568-579.