Ontario

Integrated Range Assessment for Woodland Caribou and their Habitat

Pagwachuan Range 2011

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: Pagwachuan Range 2011. Species at Risk Branch, Thunder Bay, Ontario, xi + 86pp.

For a copy of the *Integrated Assessment Protocol for Woodland Caribou Ranges in Ontario* (2014) and/or *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 further supported by other Caribou Conservation Plan Implementation team members: Ted Armstrong, Dave Bowman, Peter Davis, Phil Elkie, Larry Ferguson, Michael Gluck, Kevin Green, Glen Hooper, Rodger Leith, and Lindsay McColm. Analytical support was provided by Glen Brown, Kevin Downing, Phil Elkie, Kevin Green, and Lyle Walton. The following district, regional, and Species at Risk Branch staff were involved in the provision and review of data, participation in the aerial survey activities, or coordination and oversight of district activities: Evan Armstrong, Chris Atack, Dave Barbour, Wayne Beckett, Charlotte Bourdignon, Mitch Cloutier, Peter Davis, Darren Elder, Veronique Falardeau, Larry Ferguson, Bonny Fournier, Anne Genier, Bill Greenaway, Patrick Neron, Marcel Pellegrini, Lauren Quist, John Sadowsky, Alison Smith, Ben St. Amour, Sebastien Ukrainetz, Doug Woods, Nicole Woolnough, as well as Richard Crete and Derek Ineese. Thanks to the aerial survey pilots Dan Baron, Pat, Dickie, Bob Ernewien, Andrew Fitch, Ray Freid, and Kevin Grigsby from Aviation, Forest Fire and Emergency Services Branch.

Special thanks to the contributions of Justina Ray from the Wildlife Conservation Society (Canada) who provided recruitment data to support this Integrated Range Assessment.

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* (Range Management Policy). The Range Management Policy provides 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 Pagwachuan Range is located in northeastern Ontario and is approximately 45,000 km^2 in size. The landscape is largely characterized as James Bay Lowlands with extensive wetland complexes in the north and boreal forest in the south with many rivers and few small lakes throughout. There is high occurrence in the northern part of the range where quality refuge habitat is provided by open fens, conifer forests, linear riparian forest stands, and disturbance is low. Collaring data shows a strong movement northward in to the James Bay Range. In contrast, the south is highly impacted by human activity most notably timber harvest and settlement and caribou occurrence is minimal – although there is a group of caribou in the Nagagami Lake area along the southern range boundary.

A two-stage (fixed-wing followed by rotary-wing) aerial winter distribution survey for caribou was conducted during February and March 2011 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 164 caribou, as well as provide an estimate of calf recruitment. Additional aerial surveys were conducted during late winter 2012 and 2013 as well as data from Far North survey work in 2010 was used to further assess calf recruitment to support estimates of population trend. Recruitment rates over the four survey years (11-33 calves per 100 adult females) varied greatly and were lower, particularly for the first two years, than expected values thought to support a stable to increasing population trend (28 calves per 100 adult females). Eighteen (18) adult female caribou were collared as part of the range assessment in 2011. Geometric mean annual survival of these animals was 0.82, and ranged from 0.62-0.92, suggesting survival may be low. The short-term population trend is likely declining with a geometric mean of $\lambda = 0.94$. This estimate suggests a declining trend and is the result of comparatively low calf recruitment and survival estimates and is supported by other long-term trend indicators.

A geospatial analysis estimated 31% of the range can be currently characterized as natural and anthropogenic disturbances. The resulting likelihood of stable or increasing population growth is estimated to be 0.65 and at this level the Pagwachuan Range is capable

of sustaining the caribou population.

Analysis of the amount and arrangement of caribou does not align with that expected in a natural habitat.

The Integrated Range Assessment concludes risk to caribou is intermediate within the Pagwachuan Range and it is uncertain whether range condition is sufficient to sustain caribou.

1.0 Overview

The Ministry of Natural Resources and Forestry (MNRF), then the Ministry of Natural Resources (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 informs 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 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 Pagwachuan Range is located in northeastern Ontario and is approximately 45,000 km^2 in size (Figure 1). The southern boundary is immediately north of Hearst and Kapuskasing, and the town of Longlac is situated along the western boundary. It represents the land area between the Nipigon Range, the Kesagami Range, and is south of the Missisa and James Bay ranges of the Far North. The range includes the eastern edge of the Kenogami Forest, the northern portion of the Big Pic Forest, the northern tip of the Nagagami Forest, and northern portions of the Hearst Forest and Gordon Cosens Forest.

The Pagwachuan Range is situated across the boundary between two ecozones: the Hudson Bay Lowlands and the Ontario Shield. More specifically, the range is comprised of three ecoregions including the James Bay ecoregion (2E), Lake Abitibi (3E), and Lake Nipigon (3W) that have distinct landscape attributes of the boreal forest, lowlands, and the clay-belt (Figure 2). Therefore, ecological attributes of the Pagwachuan Range landscape exist across distinct major gradients in soils, hydrology, and vegetation types as the landscape transitions between ecoregions.

However, despite the landscape distinctions within the Pagwachuan Range, a commonality throughout the range is that lakes are small and scarce. It is believed that open waterbodies are not significant to their life cycle (particularly calving) for most caribou within the range. Instead, they are believed to rely on the abundance of peatlands and forested upland islands within the peatlands for calving, winter forage, and predator refuge.

Caribou in the southern portion of the range generally have smaller home ranges than those to the north along the transition zone with the James Bay lowlands. This may be attributed to a number of factors such as amount of disturbance, major ecological landscape differences, as well as the presence of forest-tundra dwelling caribou in the northern portion of the range that generally use large areas.

Delineation of the Pagwachuan Range largely reflects ecological and administrative features (MNRF 2014c). The south-eastern portion of the boundary is located immediately north of Highway 11 between Kapuskasing and Hearst. This was delineated using criteria such as habitat capability and the exclusion of permanent human developments and landscape alterations along the highway. The eastern boundary is linked to the waterways and dams on the Kapuskasing and Mattagami rivers. A portion of the southern boundary follows a section of Hwy 631 that connects Hwy 11 (junction 60 km west of Hearst) southbound to the town of Hornepayne. The boundary stops short a couple kilometres north of Hornepayne and heads westward, closely following the CN railway between Hornepayne and Longlac. This section of the boundary is also associated with the formerly proposed Nagagami-Hillsport Enhanced Management Area (EMA) boundary amendment (because caribou habitat was considered in the EMA boundary). The northwestern portion of the boundary closely follows the western shore of Wababimiga Lake, northward to the Little Current River, follows the river northeastward to connect up to the Kenogami River and the Albany River into the James Bay lowlands. The boundary in this area is largely based on approximations of treed density gradients on the lowlands. The boundary then connects to the Rabbit and Missinabi River network, and then joins up with the eastern boundary at the Mattagami River described earlier.

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

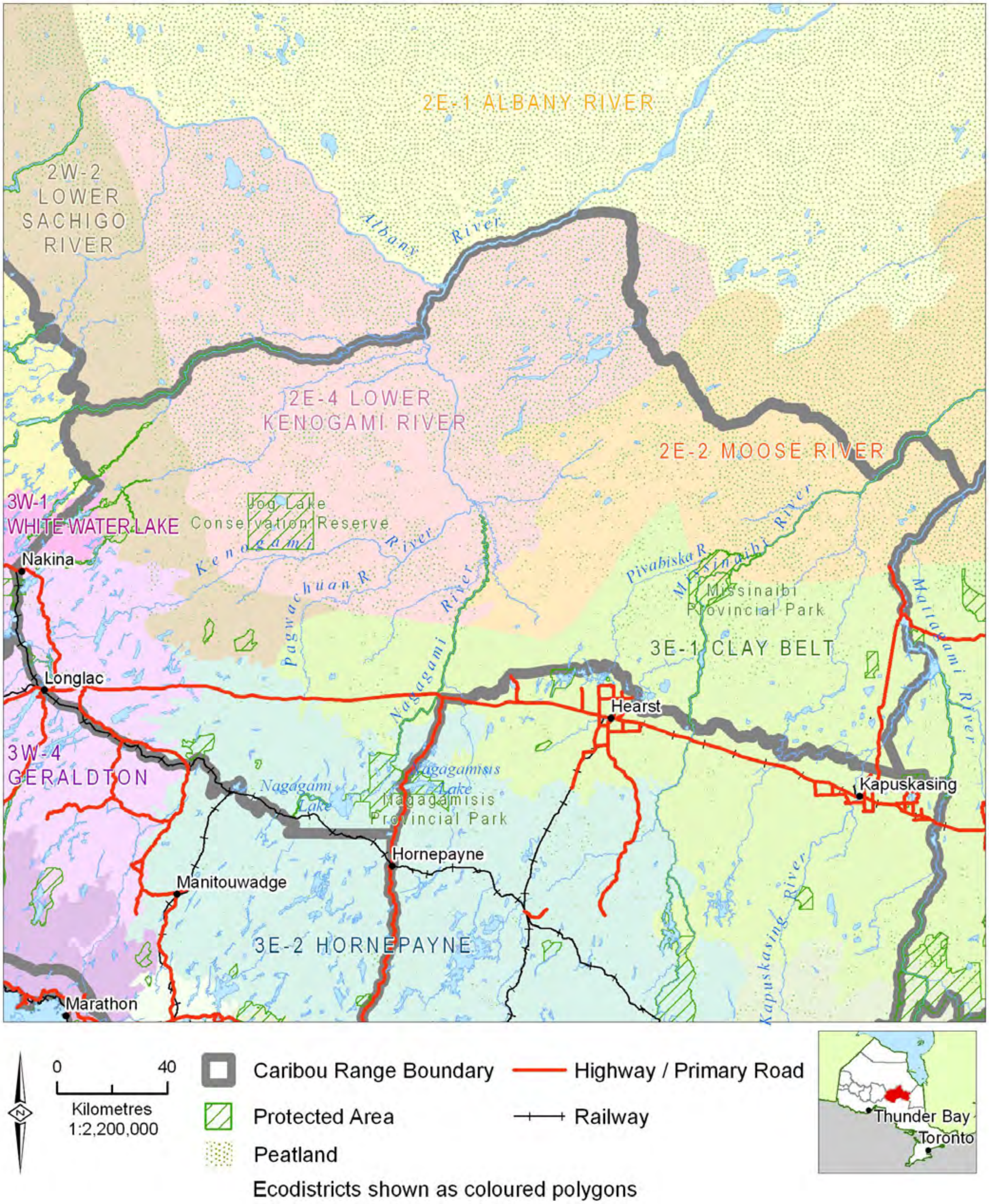


Figure 2. The Pagwachuan Range and associated ecodistricts and protected areas.

3.0 Background Information and Data

3.1 Land management history and current management direction

It is likely that caribou numbers and distribution on the Pagwachuan Range have been influenced by a wide variety of natural and anthropogenic factors including fire, 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 (Figure 4, Table 1). Past land use planning decisions, infrastructure development, and land management direction on the Pagwachuan Range all have potential implications for the current distribution, abundance, and survival of caribou in the range. Therefore, it is imperative to document and interpret the disturbance history within the range in order to better understand current caribou use. Implementation of Ontario's CCP is set against a backdrop of these evolving developments.

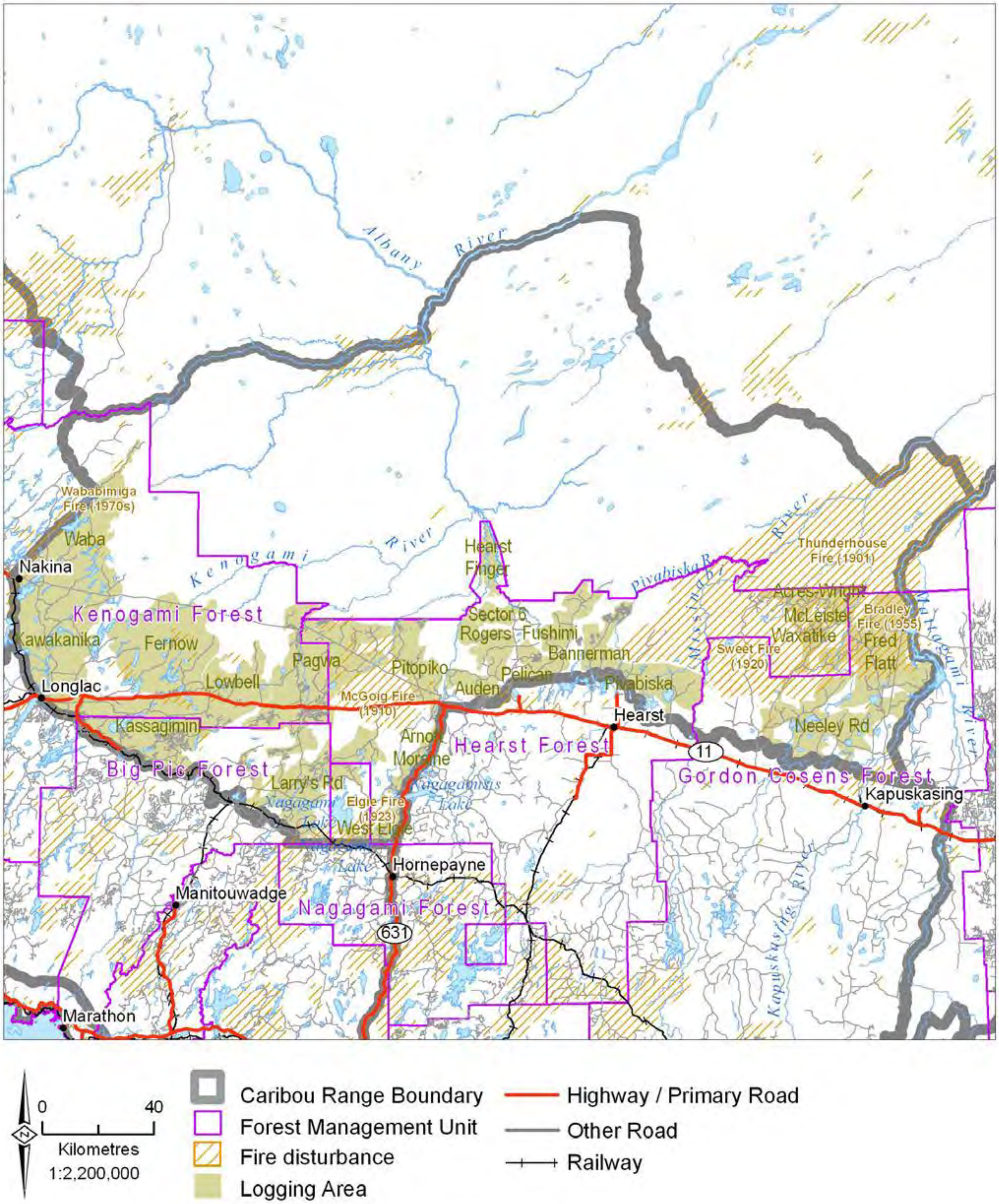


Figure 3. Dates and locations of significant historical natural and anthropogenic disturbances that have occurred within the Pagwachuan Range.

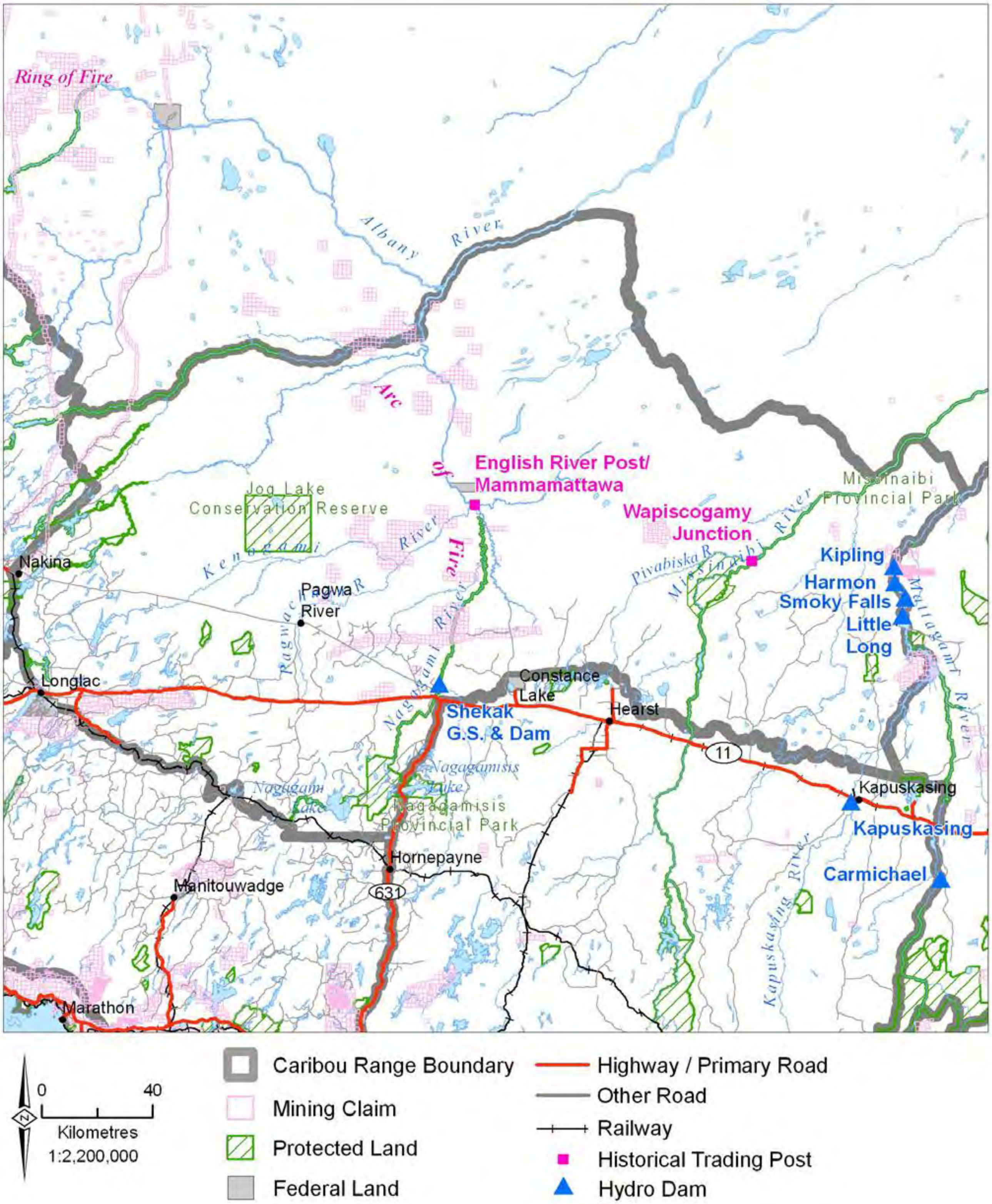


Figure 4. Human infrastructure and historical developments occurring within the Pagwachuan Range.

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

Significant event, activity or direction			
Natural Disturbance	**Date**	**Description**	**Likely influence on caribou or its habitat**
Thunderhouse fire	1901 (1904)	Fire in eastern part of the range; possibly a million ha. Extent is deduced from tree ages (aged as 1904), and a railway surveyor's journal from 1901.	No previous access or development. In the Hearst Forest and Gordon Cosens Forest, the fire produced even-aged spruce pine poplar stands with spruce lowlands. Area subsequently not accessed until forest matured. Caribou would have been present, especially at the northern edge of fire, but recent observations suggests caribou have low levels of occupancy in the central and southern edge of this fire disturbance.
McCoig fire	1911	70,000 ha fire around bog complex	Produced a large natural disturbance of even-aged spruce around a large bog complex resulting in good spring calving and summer rearing habitats. Calving is known to occur here.
Sweet fire	1920 (provincial fire database shows 1945)	35,000 ha along north edge of Gordon Cosens Forest	Produced large mixedwood forest conditions that were not likely used by caribou to a large degree.
Elgie fire	1923	Northeast tail (of a large fire in Hornepayne area; a bad fire year.	Resulted in spruce on upland and lowland sites, jack pine dominating ridges. Good wintering area for caribou confirmed through collar data.
Bradley fire	1955	18,000 ha fire along north edge of Gordon Cosens	Resulted in spruce and pine dominated high ground and ridges, with some areas consisting of mixedwood stands.

	Forest	Some caribou usage would be expected, especially to north, but this area likely would have received moderate use by caribou. Dam development and road construction along the eastern boundary likely negatively influenced use by caribou.

Significant event, activity or direction

Forest Management	**Dates**	**Description**	**Likely influence on caribou or its habitat**
Mulvey-Ritchie Block	1930-65	Small high-graded saw log operations during horse logging era. Primarily winter roads.	Some capable lowland forest; horse-logging activity combined with 1904 burn to the north.
Neely Block	1940s-present	Sandy pine & spruce sites. Continuous harvest since 1940s with complete all-weather road access and planting.	Decades-old caribou sightings, but shift to moose. Heavily hunted, which would discourage caribou occupation.
	Early 1980s	Neely Rd established	
Fernow Block	1950s -2010	Large harvest area on productive soils near edge of James Bay lowlands.	Adjacency to James Bay Lowlands, the large size and the level of investment in conifer renewal suggests it should provide for future caribou habitat. Possibly exhibiting greater levels of hardwood than previously present. Currently incorporated as a renewal block in the Dynamic Caribou Habitat Schedule (DCHS).
Rogers Block	1950s-present	Entire area accessed via Rogers Road has been continually harvested. Area interspersed with high and low	Productive mixedwood uplands with low capability as caribou habitat. Therefore, not likely to have a big influence on caribou. High use by hunters would have also discouraged caribou presence.

		ground with no muskeg occurring.	
Bannerman Block	1970s-present	Primary Bannerman Road accesses equal high and low ground.	No reported caribou sightings; nearest sighting ~10km northward. Therefore, likely minor impacts to caribou. Upland sites regenerating with a fairly even mix of conifer and mixedwood. May provide for future habitat.
Fushimi Block	1970s-95+ some recent	Primary Fushimi Road accesses high and low ground.	No reported caribou sightings; nearest sighting ~10km northward. Therefore, likely minor impacts to caribou. Regenerating to more upland mixedwood than conifer lowlands.
Wababimiga Lake Block	1970s	Prescribed burn around Wababimiga Lake	Very thick Jack pine regeneration but once it has naturally thinned it should complement caribou habitat.
	1990s	Large forest harvest area with good forest renewal.	Should provide for future caribou habitat value.
Arnott Moraine Block	1974-1997 and 2007	Rich morainal uplands with sandy outwash plain. Forest harvest access roads enable very high recreational fishing use, an EMA for recreation and timber production, silviculture has produced high conifer with lichen renewal on sandy areas.	No previously known caribou use but adjacent to occupied caribou habitat. May support adjacent occupied habitat in future.
Kassagimini Block	1978 - present	Harvest area south of Highway 11 with abundant shallow and moderately deep soils and conifer renewal.	Southwestern portion of range but has the potential to provide future connectivity between the Kenogami Forest and the Big Pic Forest. The combined contributions of the Lowbell and Kassagimini harvest blocks has created a large disturbed area north and south of Highway 11 which may mature as a large area of suitable habitat providing north- south connectivity.

Auden Block	1982-1996	Mostly spruce lowland but not muskeg, regenerated to conifer	Adjoins probably Nagagami River corridor but not likely used as no rock and little muskeg, permanent access and intense hunting use especially by Constance Lake First Nation.
Pagwa Bock	1985 to 2005 (HFI side only)	Harvest in Hearst Forest and Kenogami Forest. Higher ground with complete all-weather road access and mostly regenerated by planting.	CN railway bisected this block in 1915 but otherwise remained intact until 1985. First Nation comments included sightings along the Pagwachuan River, but no sightings on the rail line. Original forest was primarily conifer and regeneration is believed to be conifer dominated. Although uncertain, may provide contributions to refuge habitat in the future.
Pitopiko Block	Late 1980s - present	Primary road access.	Mostly natural regeneration with a heavy cedar component. Anecdotal information suggests that caribou were seen in the vicinity of Highway 11 west of the Pitopiko Block. There is significant north-south connected forest of suitable age in the McCoig Burn but collaring and survey data have not provided evidence of occupation north of Highway 11.
Lowbell Block	1990 - present	Progressive harvest north of Highway 11, contributing a high level of disturbance in predominantly spruce dominated forests on the edge of the James Bay Lowlands.	The combined contributions of the Lowbell and Kassagimini harvest blocks has created a large disturbed area north and south of Highway 11 which may mature as a large area of suitable habitat providing north-south connectivity.
Waxatike Block	1997- present	Mostly high ground with mixedwoods and complete all-weather road access.	Medium-to-low habitat capability so likely minor impact to caribou. Collared caribou came within 10km.

Significant event, activity or direction			
Infrastructure development	**Dates**	**Description**	**Likely influence on caribou or its habitat**
Community development associated with CN Railway	1880s-early 1900	Hillsport/Caramat	Hunting pressure and other human activities.
Railways	1912-15	Sections of Trans Continental/Grand Trunk Railway and Algoma Central Railway built	Railway fires, access for humans, collision mortality, establishment of villages and enabled establishment of a timber products industry.
Town of Kapuskasing planned; Spruce Falls Power & Paper Co. built & begins operations	1920s	Municipal infrastructure begins to develop.	Human activity likely influenced caribou distribution and habitat in the area. Caribou likely hunted.
Smokey Falls railway and hydro dam – Kapuskasing River (and later, Fred Flatt Rd). First Nations community at Mile 22	1920s-1960s, present	Constructed to service dam(s) along the Mattagami River.	Human activity begins with railroad construction, followed by dam construction and creation of the Mattagami River headpond. Some First Nation harvests would have occurred. Human disturbance likely began influencing caribou.

Pagwa	1915-60s	Community becomes a rail/air/ river transport hub.	Increased human population, likely disturbed caribou; likely incidental hunting of caribou; close to area of current caribou occupation; less influence now.
Neeshin Line	1940s-50s	Railway spur line that is currently maintained and used as a trail.	Linear corridor for predators, increased human access.
Fred Flatt	1940s - present	Access to service hydro dams, now supporting ongoing harvest. Road on an esker complex.	Historical and recent sightings in the Guilfoyle Lake area; sightings by First Nation living at Mileage 22, ~10km from current collar locations. Some First Nation caribou harvest likely occurred. Development and harvest has favoured moose.
Trans-Canada Highway 11	1940-44	Built west of Hearst.	Large and heavily-used linear disturbances with associated human activity contributed to early fragmentation of caribou habitat and likely habitat use patterns. Highway workers saw caribou travel north-south along the Nagagami River. Highway may have discouraged caribou movement. (No other land clearing or forest harvest until 1980).
Highway 631	1950s	Highway from Hornpayne north to Hwy 11, west of Hearst.	Likely contributed to discouraged caribou connectivity east of Nagagami Lake.
Calstock	1950s	First Nation moved from Pagwa & Mammamattawa to Calstock; Lecours Lumber moved to Calstock, Rogers Road constructed by government North from Calstock for development and access to Kabi River	Shift in focus of forest harvesting, hunting, and other human activity.

PhosCan Development	1965 1967-1981 1985 1997	Claims aerial survey completed Claims staked Claims converted to licence of operation, then to mining lease MCK Mining Corp. (now PhosCan) bought mining lease and began winter sampling	No disturbance to caribou or habitat during survey. Human activity may have begun to impact caribou. Winter drilling for mineral samples would have negatively impacted caribou habitat features in the vicinity. Located in vicinity of significant winter and summer habitat Development of trails within claim increased linear features and may have provided caribou predators with increased accessibility.
Larry's Road	1996-2005	Long government funded access road through spruce lowland to reach high ground pine.	Observation of caribou by local forest mangers led to collaring study. Access and harvest possibly impacted caribou use but extent is unknown.
Arc of Fire	2000-present	Large arc-shaped zone of mining claim development above the Area of the Undertaking (AOU), on the James Bay Lowlands.	Potential for significant linear feature and human activity on the southern portion of the James Bay Lowlands which currently represents a large area of occupied habitat in the northern portion of the Pagwachuan range.

Significant event, activity or direction			
Land management direction	**Dates**	**Description**	**Likely influence on caribou or its habitat**
Colonization strategy under Free Grants and Homestead Act	1908-16	Land from Cochrane to Hearst was subdivided in lots. Intense promotion of homesteading led to influx of settlers.	Land clearing removed habitat and likely favoured predator species. Settler fires and agricultural disturbances would have impacted caribou.

and Agricultural Development Act. Resettlement program for returning WWI vets.			
Declining economic trend	1925-30s	Government incentives (Gordon Plan 1921-35, Vautrin Plan 1935-37, Rogers-Augur Plan 1937-47) for urban unemployed to move north during a time that homesteading and land clearing slowed and did not extend as far as initially envisioned	Slowed incursion of humans and clearing of habitat. Caribou habitat may have been compromised by this time.
Initiation of large scale commercial timber harvest	1920s-30s	Timber concessions granted to Spruce Falls Power & Paper Co., and other American companies. Large-scale timber harvest begins south of Kapuskasing (to river-drive north) and along Algoma Central Railway	Significant alteration of forest condition along waterways and in southern portion of the range.
Development of chips; introduction of hydro power to sawmills	1960s	Better log utilization, ban on log exports, and windstorm salvage lead to significant increase in sawmill licences. It also tended to increase area access with gravel roads and	Rapid increase in linear feature development associated with road construction likely increased movement and distribution of predators.

		area harvest through 1972.	
Forest Management Agreements	Hearst Forest 1987, Spruce Falls 1980	Full planning and harvest scheduling of licensed areas some of which occurred under accelerated harvest strategy and policies intended to promote moose habitat and forest diversity.	Rapid reduction in older forest, increase in linear features and changes in forest composition likely also increased predation pressure on caribou.
Provincial Parks	1970s	Nagagamisis and Missinabi Provincial Parks	Nagagamisis Lake area known to be used by caribou. Park designation prevents hydro development of Missinabi River.
Wolf control	1972	Provincial wolf bounty rescinded.	Early depressions of the wolf population that may have helped caribou persist through periods of early road-based logging.
Timber Management Plan – Gordon Cosens Forest	1995-2015	TMP includes first biodiversity strategy entitled: A Biological Diversity Strategy for the Gordon Cosens Forest 1995-2015 Timber Management Plan.	This TMP was the first GCF plan to formally recognise the importance of landscape ecology and ecosystem management. As a result of this biodiversity strategy, a large block located in the Beardmore Township area was deferred from harvest for biodiversity reasons. This deferral would have favoured caribou in the area by maintaining forest cover and keeping human activities low while surrounding harvested areas began to regenerate to a condition suitable for caribou.
Hearst Forest Management Plan	1997-2017	Objective for long-term forest health is delivered through a strategy to manage the forest by emulating natural disturbances.	This FMP was the first in the Northeast Region (Ontario?) to design and implement strategies that emulate natural disturbances. Lessons learned from studying 13 wildfires and the pre-fire suppression landscape were applied to defragment forest cover, retain physical structure and manage for a pre-settlement landscape condition. The strategy halted caribou-unfriendly moose habitat direction

			on the Hearst Forest.
Ontario's Living Legacy	1999	Expansion of Nagagamisis Park with specific conservation considerations for caribou in mind.	Caribou use the Nagagamisis Park expansion area, but there is concern the degree of protection provided may not be able to hold caribou while forest management occurs in the vicinity. Expansion was negotiated with the Sustainable Forest Licence holder recognizing the significance to caribou in the area. Potential support for linkage to the Discontinuous Distribution.
Woodland Caribou Management in Northeastern Ontario – Interim Habitat Management Direction	1999	Provided interim direction on forest management activities to protect caribou values within the Continuous Distribution. Direction was based on information gained from a research study (1998-2001).	Resulted in a focused landscape approach to consolidate disturbed areas and seek current and future large retention patches for the conservation of caribou.
Hearst FMP	2002-2022	FMP included an objective and forest management strategies for the Nagagami area caribou.	The adoption of measures to conserve the Nagagami caribou was initiated by the SFL holder because MNR did not recognize the population known by local managers and public. In habitat of the Nagagami caribou actions were taken to minimize forestry operations and to reverse landscape fragmentation caused by promoting moose habitat during the previous 15 years.
Nagagami FFMP	2006	Long-term no-harvest deferrals developed within the FMP. Three adjacent planning teams (Hearst, Big Pic and Nagagami) worked to develop a broader landscape approach	Long-term no-harvest deferrals were created within the northern portion of the Nagagami Forest surrounding Nagagami Lake and near Nagagamisis Provincial Park. Suitable habitat was maintained for caribou utilizing this area.

		for managing the habitat of the Nagagami herd.	
Big Pic FMP	2007	Developed a broader landscape approach for managing habitat of Nagagami herd.	Long-term no-harvest deferrals were created within the northern portion of the Big Pic Forest adjacent to Nagagami Lake as well as other areas containing suitable habitat. Suitable habitat was maintained for caribou providing opportunities for caribou to occupy these areas.
Hearst FMP	2007	Develop a broader landscape approach for managing the habitat of the Nagagami herd.	Long-term no-harvest deferrals were created within the southwest portion of the Hearst Forest associated with the habitat used by the Nagagami herd. Suitable habitat was maintained for caribou utilizing this area.
Caribou Conservation Plan	2009	Vision is to have self-sustaining caribou populations in a healthy boreal forest.	To maintain self-sustaining genetically-connected local populations of caribou where they currently exist, improving security and connections and facilitating the return of caribou to key areas.
Cervid Ecological Framework	2009	Strategic ecological landscape level policy on how to manage caribou, moose, deer, and elk in relation to each other.	Within caribou landscapes, maintain and manage densities of other cervids that reflect natural ecological conditions with caribou having a higher consideration.
Deer season regulation changes and additions streamlined by cervid ecological zone (CEZ) across Northeast Region	2009	Long deer seasons implemented within CEZ A & B, as well as providing liberal additional antlerless deer seal quotas.	Reduction in alternative prey species for wolves and reduced likelihood of disease transmission.

Gordon Cosens FMP	2010 to present	First DCHS incorporated covering a 120-year planning cycle. Schedule allows for forestry operations to be conducted in selected blocks while maintaining large tracts of currently suitable caribou habitat across the landscape.	The implementation of these habitat schedules are intended to reduce the fragmentation across the landscape and provide for a better arrangement and increased amount of mature conifer and winter suitable habitats than currently exists. Longer-term deferrals of currently used critical habitat will promote caribou persistence on the forest. Regeneration of adjacent areas to suitable caribou habitat will provide opportunities for re-colonization of previously harvested areas. Careful forest harvest practices used in eligible sites to retain as much of the habitat characteristics and function of the ecosystems as possible to ensure a more rapid return to suitable conditions.
Nagagami FMP	2011 to present	Planning team developed First Dynamic Caribou Habitat Schedule. Access and silviculture strategies also incorporated in FMP. Three adjacent planning teams (Hearst, Big Pic and Nagagami) again worked together to develop a broader landscape approach for managing the habitat of the Nagagami herd.	Much of the area within the Continuous Distribution in the Nagagami Forest has been planned as long-term no-harvest deferrals (40-60+ years). This will maintain suitable habitat characteristics within this currently southern-most occupied area within the range. Deferral areas have been developed to provide long-term strategic linkage for caribou to adjacent forests and to the Discontinuous Distribution. Access and silviculture strategies will limit the development and persistence of linear and forest harvest disturbances within the forest.
Big Pic FMP Phase 2	2012 to present	Planning team developed first DCHS. Access and silviculture strategies also incorporated in	Primary focus of the plan is to defragment to create large contiguous suitable habitat blocks. Regeneration of areas to suitable caribou habitat will provide opportunities for re-colonization of previously harvested areas. Longer-term

		FMP. Develop a landscape approach for managing habitat of Nagagami herd.	no-harvest deferrals have been developed adjacent to the Hearst and Nagagami FMUs where caribou are currently known to reside. Access and silviculture strategies will limit the development and persistence of linear and forest harvest disturbances within the forest.
Hearst FMP Phase 2	2012 to present	Planning team developed first DCHS. Develop a landscape approach for managing habitat of Nagagami herd.	The caribou science and information package in support of the Boreal Landscape Guide showed a large area in the central portion of the Forest that had low current suitability and low probability for caribou habitat. Productive mixedwood uplands occur in this part of the range and the FMP does not apply Silviculture objectives for caribou habitat in this area.

The progression of anthropogenic disturbances within the Pagwachuan Range (Table 1, Figure 3 and Figure 4) has largely had a northward progression and forest harvest has been the primary driver of disturbance. The Trans-Canada Highway, natural gas, and hydro transmission corridors in the southern portion of the range coincide with historical mineral exploration, mining, and community establishment that has created a significant area of disturbance. The cumulative contribution of these historical developments as well as wildfire has created a forest and infrastructure landscape heavily weighted towards high levels of disturbance in the south, with low levels of disturbance in the north above the AOU.

3.2 Caribou occupancy history and assessment

Caribou observations within the Pagwachuan Range have been identified and recorded within the Land Information Ontario (LIO 2014). Observations documented in this report are current to August 2013 (Figure 5, Figure 6, and Figure 7). Table 2 briefly summarizes previous caribou assessments within the range that estimate or describe population size, health, or occurrence providing historical context and assist with the interpretation of the current Integrated Range Assessment results. 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. Historically, these observations reflect our knowledge of caribou occurrence within the range and the possible response to changes in range condition.

Table 2. Past assessments and reports for caribou relevant to the Pagwachuan Range.

Date	Caribou occupancy assessment	Reference
1965	Caribou density of 0.008/km^2 in Wildlife Management Unit (WMU) 25[1].	Simkin, D.W. 1965. A preliminary report of the woodland caribou study in Ontario. Ont. Dept. Lands and Forests Sect. Ret. No. 59.
1978	Aerial transect moose survey in WMU 25[1] in which a caribou density estimate of 0.004_± 0.005/km^2 with a calculated total population of 161 ± 189. This was based on 19 caribou observed during the transect survey as well as an additional 28 caribou observed off transect.	Gautier, M. and I.D. Thompson. 1978. 1978 Aerial Moose Survey of Wildlife Management Unit 25 (including caribou observations). Cochrane District.
1989	Aerial transect moose survey in WMU 25[1] in which a caribou density estimate of 0.039_± 0.011/km^2 with a calculated total population of 1,544 ± 440. This was based on a projected total of 151caribou from 82 caribou observed during the transect survey, three caribou observed off transect, and caribou estimated from tracks alone.	Wiechers, B. 1989. 1989 Aerial Survey of Moose in Wildlife Management Unit 25. Cochrane District.
1995	Aerial transect moose survey in WMU 25[1] in which a caribou density estimate of 0.013_± 0.0061/km^2 with a calculated total population of 528 ± 362. This was based on 53 caribou observed during the transect survey.	Scholten, S.J. 1995. 1995 Aerial Moose Survey of WMU 25. Cochrane District.

1998	Aerial transect moose survey in WMU 25[1] in which a caribou density estimate of 0.064_± 0.115/km^2 with a calculated total population of 2540 ± 4553. This was based on 254 caribou observed during the transect survey.	Chenier, C. 1998. Aerial Moose Survey of WMU 25 for 1998. Cochrane District.
2001	Aerial transect moose survey in WMU 25[1] in which a caribou density estimate of 0.04_± 0.02/km^2 with a calculated total population of 1584 ± 791. This was based on 87 caribou observed during the transect survey.	Chenier, C. 2001. Aerial Moose Survey of WMU 25 for 2001. Cochrane District.
2006	Aerial transect moose survey in WMU 25[1] in which a caribou density estimate of 0.01_± 0.01/km^2 with a calculated total population of 396 ± 396. This was based on 60 caribou observed during the transect survey.	Chenier, C. 2006. Moose Aerial Inventory of WMU 25 for 2006. Cochrane District.
2009	Twenty one GPS collars deployed on adult female caribou as part of the Far North caribou project. A portion of these collared animals extensively used the northern portion of the range winter and summer	Berglund, N.E., G.D. Racey, K.F. Abraham, G.S. Brown, B.A. Pond, and L.R. Walton. 2014. Woodland caribou (*Rangifer tarandus caribou*) in the Far North of Ontario: Background information in support of land use planning. DRAFT. Technical Report TR-147, Ministry of Natural Resources, Thunder Bay, Ontario. 160 pp.
2009	Deployed two satellite collars on adult female caribou in the Nagagami Lake area as part of a SAR stewardship project. Subsequent recruitment surveys followed. Animals remained south of Hwy 11 and west of Hwy 631.	2008-2009 Final Report SARSF Project #108-08-NCN.

[1]Moose survey reports for WMU 25 routinely summarized caribou observations. Caribou summaries within moose survey reports for other WMUs were not made available.

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.

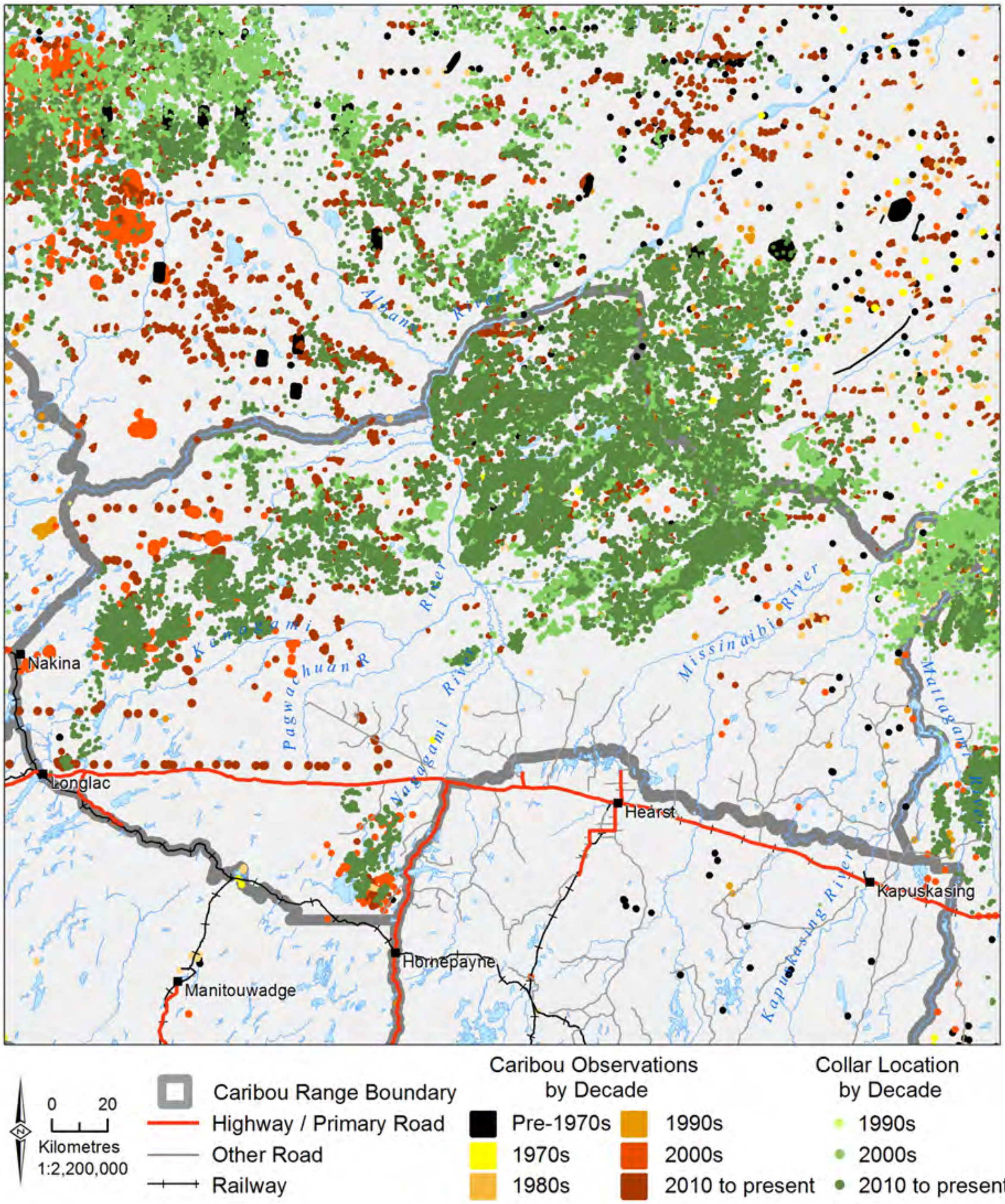


Figure 6. Historical caribou observations[1] within the Pagwachuan Range and surrounding area including observations from aerial surveys, collared caribou locations, research projects, and casual observations.

[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.

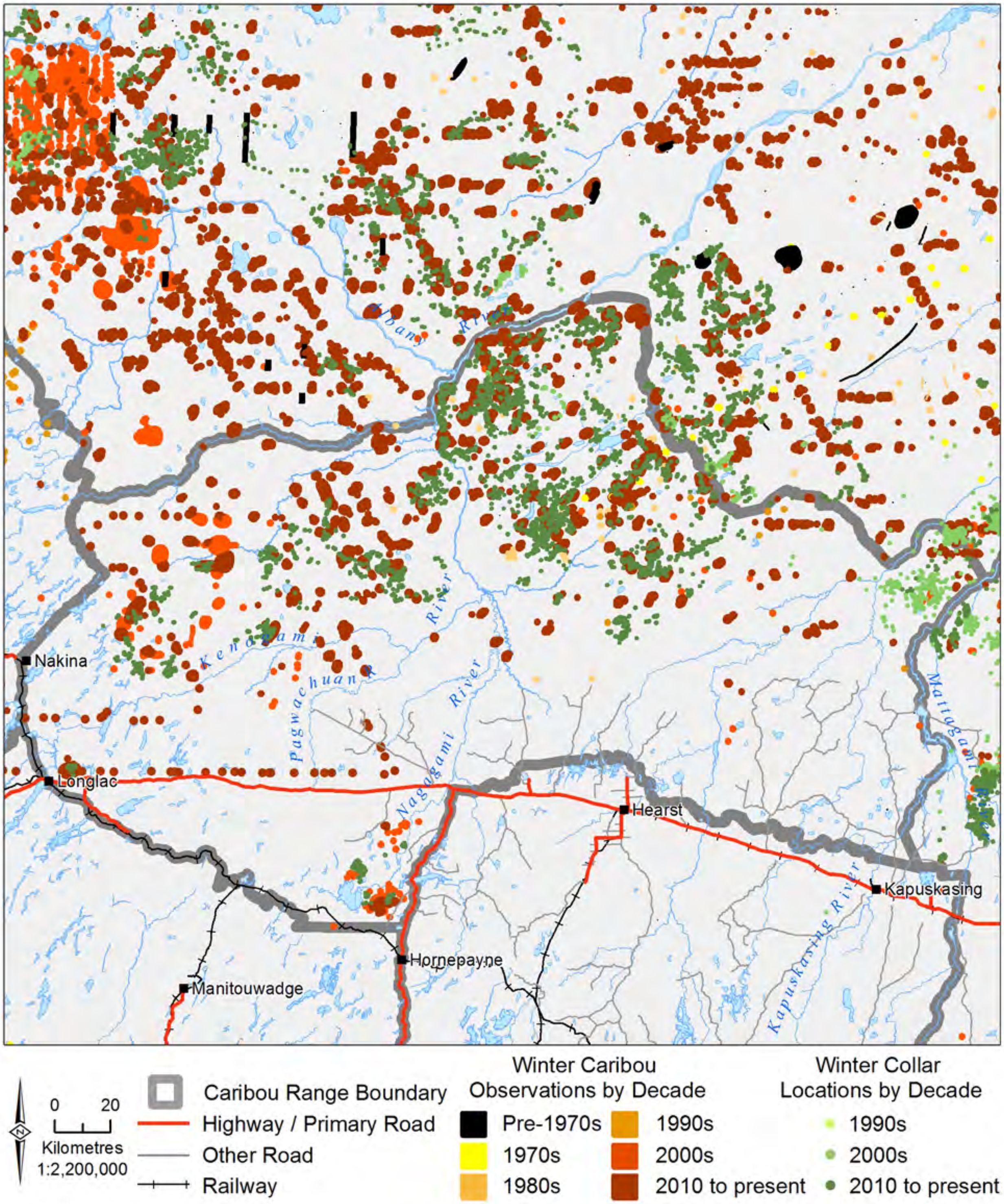


Figure 7. Caribou observations in the Pagwachuan Range during February and March from all observation sources (i.e. aerial surveys, collared caribou locations, and casual observations) as of August 2013.

3.3 Probability of occupancy survey and analysis

Presence of caribou was identified during an aerial fixed-wing transect survey conducted in February and March 2011. 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 Pagwachuan Range were estimated using methods described by MacKenzie et al. (2002).

Few animals or signs were observed in the southern portion of the range. All other observations are mainly above the AOU boundary and were widely distributed across the northern half of the range (Figure 8).

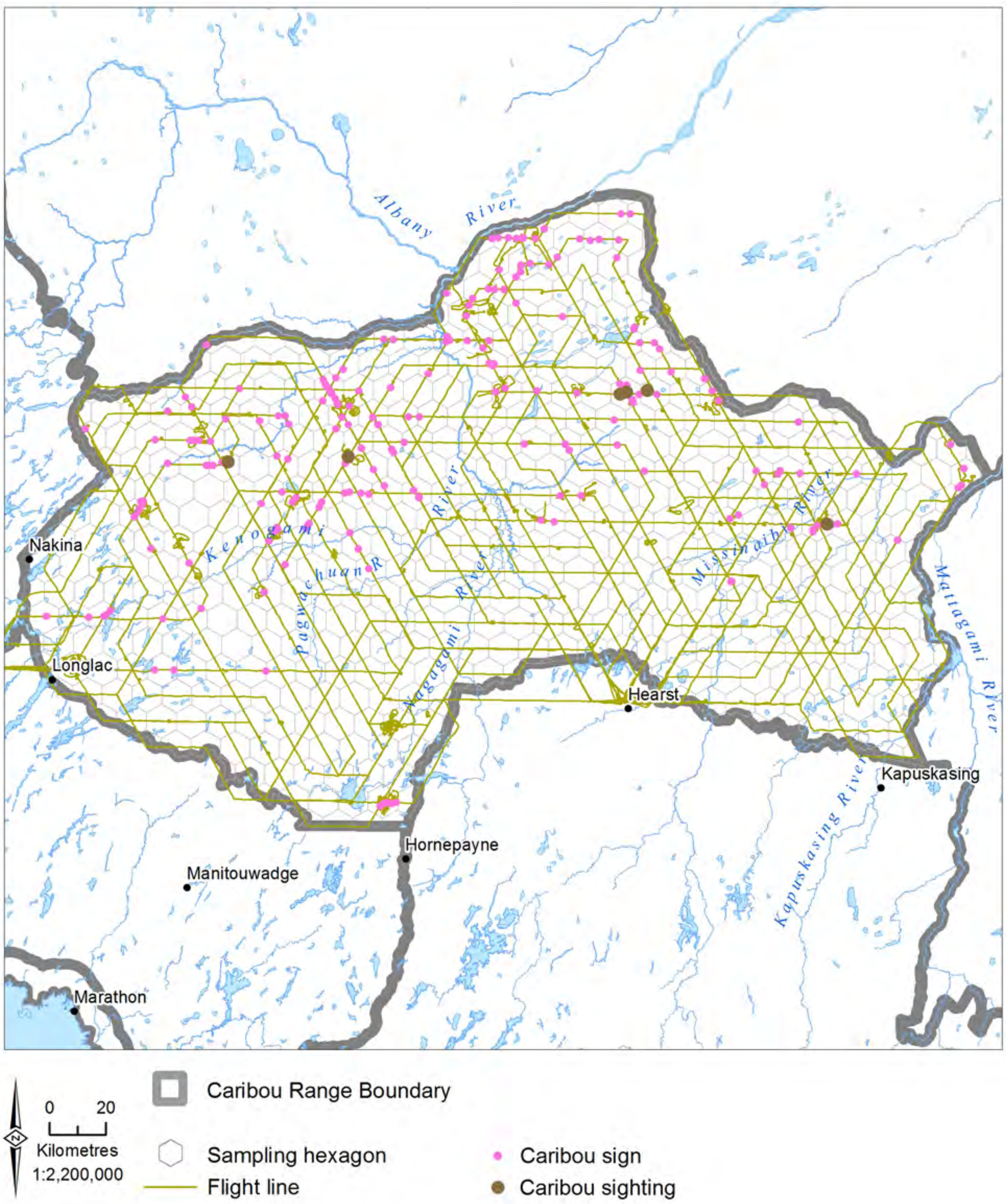


Figure 8. Fixed-wing aerial survey transects on the Pagwachuan Range hexagon sampling grid during the winter of 2011. Observations of caribou and their sign are also shown; any evidence of caribou present within a hexagon contributes to the probability of occupancy calculation.

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 Pagwachuan Range was moderate and that the estimate had relatively high precision (ψ =0.42, SE = 0.06, 95% CI = 0.30-0.54). These standard errors suggest that existing levels of survey effort should detect changes in caribou occupancy with respect to a single estimate for the entire range. Precision may be improved in future surveys through increased visits to each hexagon.

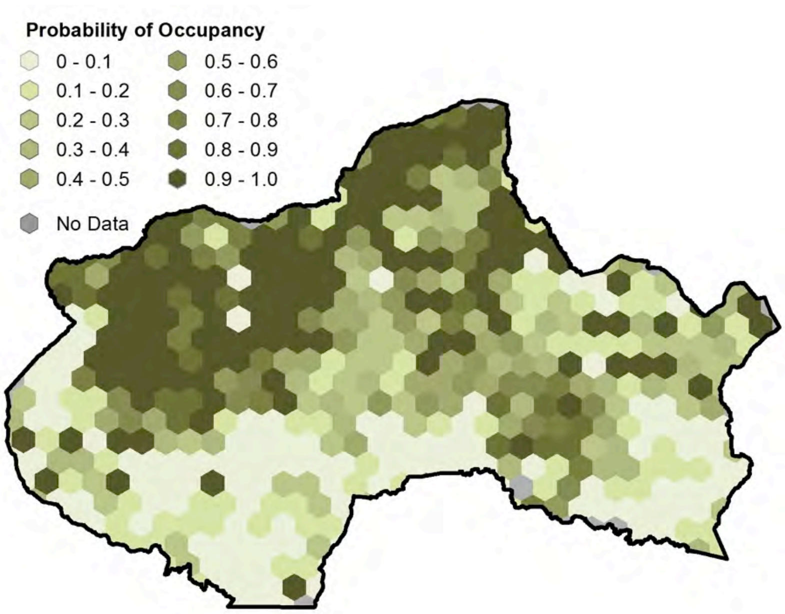


Figure 9. Predicted probability of occupancy of caribou on the Pagwachuan Range based on a model without occupancy covariates and conditional on observation (Probability = 1 for hexagons with detection(s)) from the winter 2011 survey.

The probability of caribou occupancy was significantly correlated with habitat covariates. The best model containing habitat covariates were used to generate estimates of occupancy (Table 3, Figure 10, and Figure 11). The 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 Pagwachuan Range. Parameters shown in bold have confidence intervals that do not contain zero.

Covariate	Coefficient[1]	S.E.	Lower CI	Upper CI
Ψ	**-1.10**	**0.41**	**-1.76**	**-0.43**
Sparse	**17.64**	**5.36**	**8.85**	**26.42**
Disturbance	**-8.28**	**2.22**	**-11.93**	**-4.63**
Detection.intercept	**-36.77**	**0.57**	**-37.71**	**-35.83**
Detection.height	**-0.01**	**0.002**	**-0.02**	**-0.01**
Detection.speed	**0.01**	**0.001**	**0.007**	**0.01**
Detection.course	**-0.0005**	**0.001**	**0.007**	**0.001**
Detection.time	**5.93**	**0.03**	**5.88**	**5.97**
Detection. time^2	**-0.24**	**0.001**	**-0.24**	**-0.23**
Detection.day	**-0.04**	**0.01**	**-0.05**	**-0.02**
Detection.cover	**1.93**	**0.58**	**0.98**	**2.89**

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

The amount of sparse forest and disturbance had the greatest effects in predicting caribou occupancy. Sparse forest on this range is typically characterized by mature conifer dominated stands with an abundance of winter forage (lichen). Disturbed area had lower occupancy (Figure 12).

The relatively low occupancy of caribou southern portions of the Pagwachuan Range is consistent with the observed abundance of young forest, the intensity of human activity, and other anthropogenic disturbances on this range. The observed occupancy patterns are consistent with evidence in other jurisdictions of the negative effects of anthropogenic landscape disturbance on caribou distribution and population persistence, and the positive effect of large contiguous patches of mature conifer (Brown et al. 2007; Wittmer et al. 2007).

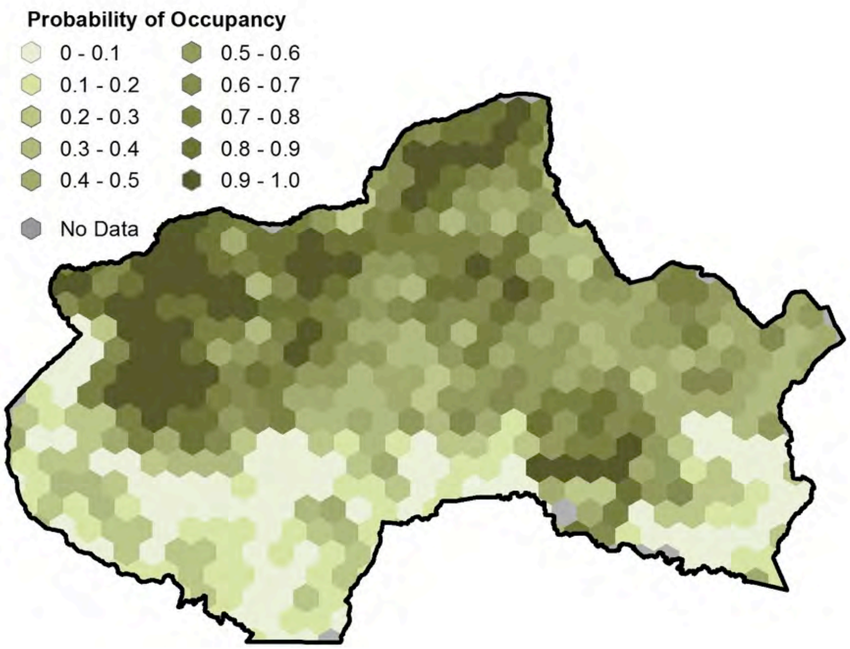


Figure 10. Probability of occupancy determined using habitat covariates across the Pagwachuan Range based on model-averaged estimates using observations for the winter 2011 aerial survey.

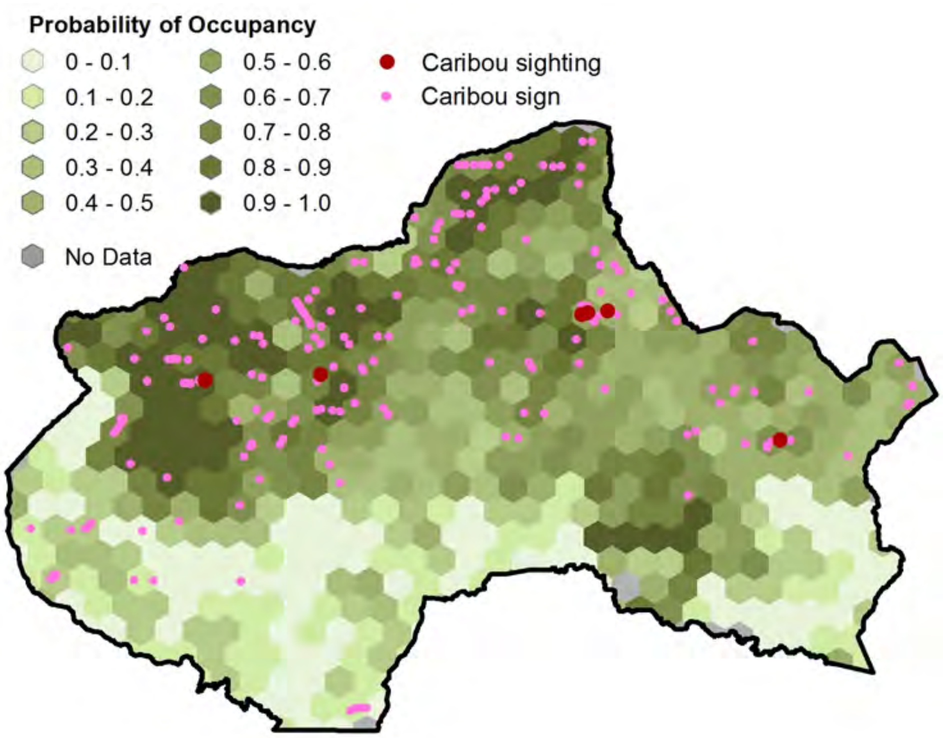


Figure 11. Probability of occupancy determined using habitat covariates in the Pagwachuan Range overlaid with caribou observations and sightings from the winter 2011 aerial survey.

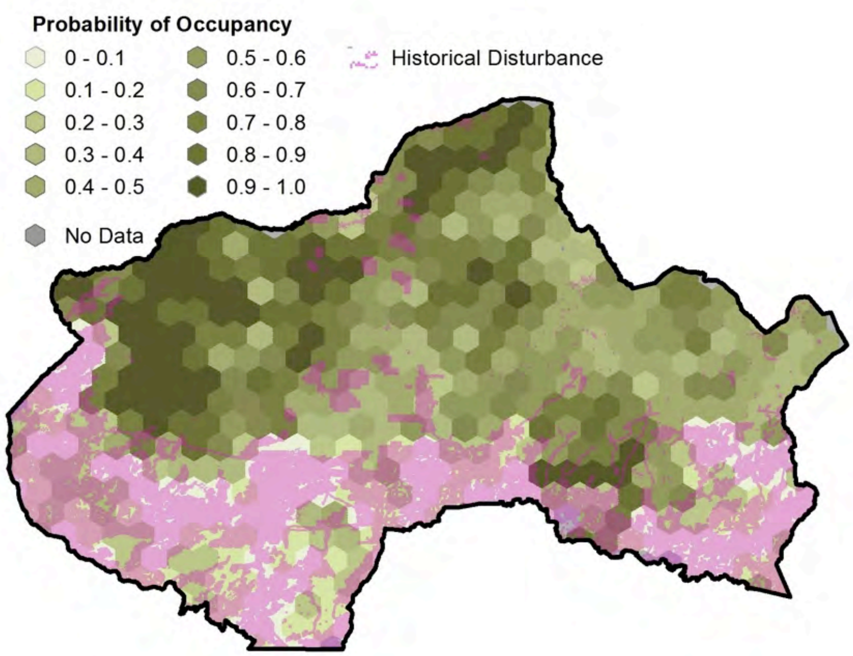


Figure 12. Probability of occupancy determined using habitat covariates across the Pagwachuan Range using observations for the winter 2011 aerial survey overlaid with disturbed areas (i.e. cuts, burns, regenerating depletions).

3.4 Caribou ecology and range narrative

Woodland caribou within the Pagwachuan 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 Pagwachuan Range is uniquely situated across ecozones 2 and 3. This denotes major ecological and climatic differences between the northern half of the range in Ecozone 2 (Hudson Bay Lowlands) and the southern half in Ecozone 3 (Ontario Shield). The two ecozones meet across the central portion of the range creating a transitional interface that is approximately 20 km wide. It is believed that this interface is important to caribou (Berglund et al. 2014) and there are areas within the transition that are used as summer and winter habitat. For example, Stampede Lake is known as a calving lake with lichen-dominated rocky outcrops nearby. Comparatively, string bog complexes in the Hudson Bay Lowlands are significant calving habitat. Although, occupancy in this part of the northern range is lower than northern areas progressively westward.

Caribou of the Pagwachuan Range tend to be dispersed continuously across the north, where the landscape remains mainly undisturbed habitat and is abundant in peatland complexes. From recent collaring, it appears that caribou in this portion of the range tend to make use of broad areas and often travel north of the range boundary into the Missisa and James Bay ranges.

Collaring data in the south indicates that caribou tend to use much smaller areas and appear to be associated with relatively small pockets of habitat. Caribou in the vicinity of Nagagami Lake primarily use older conifer forest bordered by harvest blocks to the southeast, southwest, and north. However, these caribou are using the disturbed areas around Nagagami Lake to some degree. The large peatland complexes in the vicinity of Nagagami Lake may provide some long-term and persistent habitat value supporting occupancy in the southern portion of the range.

In the western portion of the range, collaring data indicates that caribou north of the town of Longlac move northeast-southwest across previously harvested and otherwise disturbed areas frequently. While they exhibit more movement than the caribou near Nagagami Lake, they do not cover the greater distances that caribou further north do. It appears that these animals move from parcels of suitable habitat near Longlac northeastward, through a complex of timber blocks, into areas with many peatlands at the Hudson Bay Lowlands interface, in the vicinity of the Current and Drowning Rivers (subsidiaries of the Kenogami River). The lowland area has a few lakes and a number of bedrock controlled knobs that caribou are drawn to.

Caribou are present along the Mattagami River, which coincides with the boundary with the Kesagami Range, despite high levels of human activity. These areas include the Little Long Dam area, areas near the river just north of Kapuskasing, and in the Remi Lake area to the east of Kapuskasing and south of the southeastern range boundary.

Caribou near Longlac, Nagagami Lake, and the Mattagami River have the commonality of existing near areas that are highly disturbed by human activity, and includes movement through disturbed areas.

There is uncertainty as to the relative value of the Thunderhouse Block, previously burned in 1901. At present, there appears to be old mature forest habitat further north.

The rich clay soils of the eastern side of the range are favourable to hardwood and brush understory. Succession in upland areas often leads to high levels of balsam fir and shrubs, some of which are browse producing or that may contribute to forest conditions with low interior visibility. Succession in the lowland areas may lead to cedar dominated intermediate conifer swamps, which may be less desirable as caribou habitat. The fire regime is very slow, or nearly non-existent on the clay belt. There have been no caribou sightings where there are no ridges or shallow and exposed bedrock.

In general, the northern half of the Pagwachuan Range, particularly above the AOU, may be the most important part of the range in terms of current caribou occupancy. It is largely undisturbed caribou habitat that may provide a source population of caribou to support recovery in the southern portions of the range. Maintaining linkages to southern habitats and isolated populations across the range will be important in the future for the viability for caribou in the Pagwachuan Range.

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

3.5 Influence of current management direction

Recent and current management direction – up to the time of this Integrated Range Assessment, has had several positive influences on the prospects for caribou persistence within the Pagwachuan Range. Direction from the Crown Forest Sustainability Act (CFSA) (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.

During the late 1990s, forest management direction in northeastern Ontario incorporated an adaptive management approach which involved protecting specific caribou values such as calving/nursery areas that evolved into protecting caribou habitat at a landscape level. Current direction has incorporated a Dynamic Caribou Habitat Schedule (all applicable FMPs) that covers a 140-year period, comprised of seven 20-year planning terms. This schedule allows for forestry operations to be conducted within selected blocks while maintaining large tracts of currently suitable caribou habitat across the landscape (Figure 13). The implementation of these habitat schedules are intended to reduce the fragmentation across the landscape and provide for a better arrangement and increased amount of mature conifer and winter suitable habitats than currently exists. Although similar harvest scheduling has been implemented in northwestern Ontario since the 1990s, this was the first time it had been implemented in the northeast.

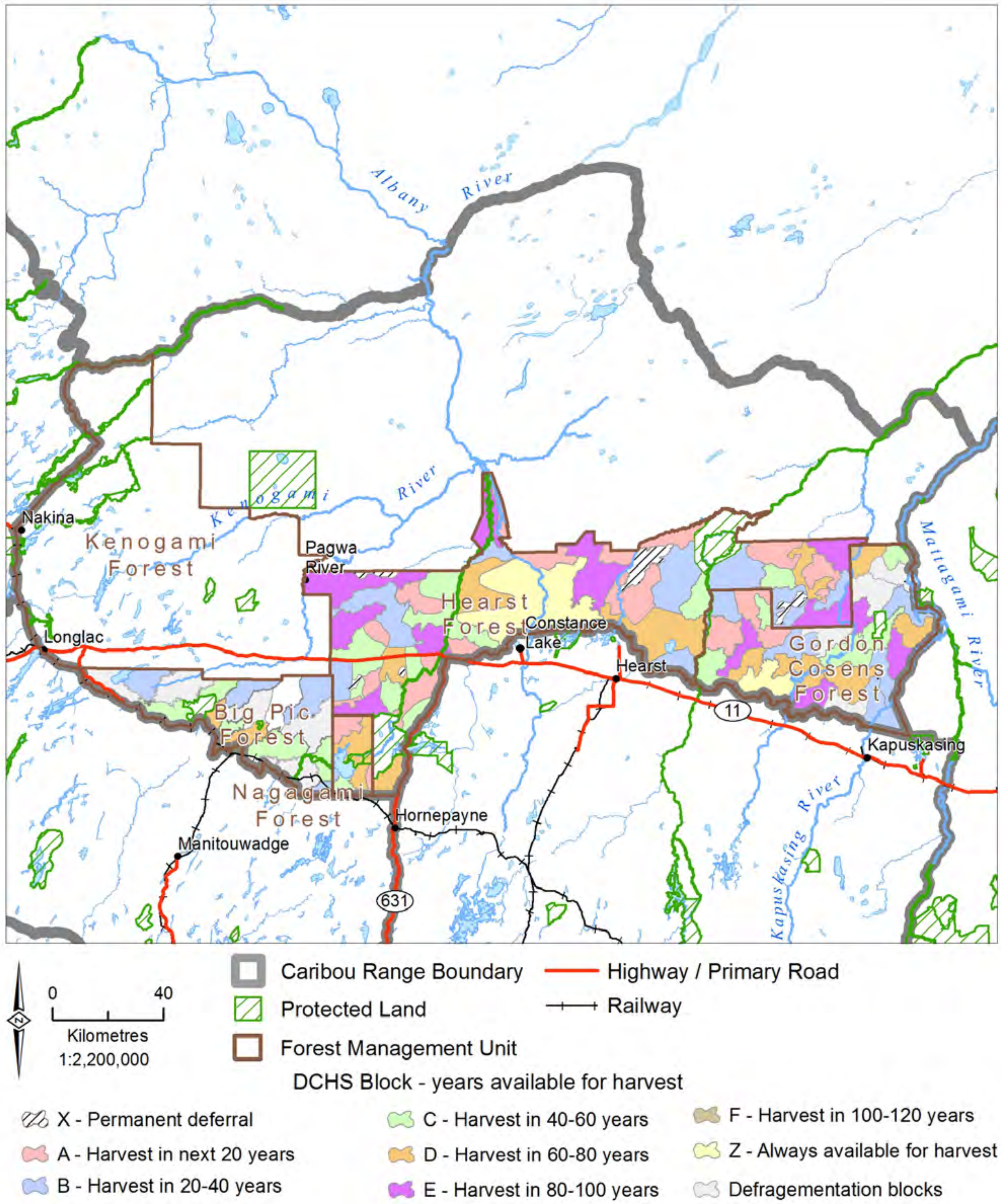


Figure 13. Dynamic Caribou Habitat Schedule (DCHS) for the Pagwachuan Range as reflected within contemporary Forest Management Plans (FMP).

The 1995-2015 Gordon Cosens FMP included a Biological Diversity Strategy that focused on landscape ecology and ecosystem management through the emulation of natural disturbance (of which wildfire is the dominant influence). While the document does not separate out caribou considerations, it did set the framework for local caribou management by providing objectives, targets, and implementation strategies for wildlife habitat at various scales. For biodiversity reasons, the FMP included a large harvest deferral along the northeast boundary of the unit that resulted in the maintenance of north-south connectivity for caribou utilizing this portion of the range.

Successive Hearst Forest FMP initiatives that were directly for caribou set the framework for local caribou management. The 1997 FMP adopted Emulating Natural Disturbances as the primary strategy to conserve long-term forest health and initiated removal of moose corridors to defragment the landscape in areas potentially occupied caribou associated with Nagagami Lake. The 2002 FMP included an objective and forest management strategies for caribou in the Nagagami Lake area. Actions were taken to minimize forestry operations and to reverse landscape fragmentation in areas occupied by caribou associated with the Nagagami Lake area.

Conservation Reserves established through *Ontario's Living Legacy* (OLL) (MNR 1999a) did not consider caribou values. However their locations on the landscape may provide for connectivity in a strategic area of the range. These reserves along with parks and other protected areas are managed as important components of a broad landscape approach to caribou conservation.

The *Forest Management Guidelines for the Conservation of Caribou Habitat; a Landscape Approach* (Racey et al. 1999) provided direction for habitat renewal and roads rehabilitation, which MNRF continues to improve upon implementing with management partners. This direction was reviewed and further improved through development of the *Forest Management Guide for Boreal Landscapes* (OMNR 2014). Caribou habitat management approach is being strengthened to provide greater certainty for the provision of future caribou habitat in areas licensed for forest management within areas of the Continuous Distribution. Habitat management must be long-term because caribou rely on mature and old forests.

More recently, the *Cervid Ecological Framework* (MNR 2009b) provides new overarching policy advice to address cervid management at the broad landscape scale. It consolidates and integrates Ontario's approach to managing cervid species in relation to each other with consideration of the broader ecosystem(s) they share. The *Framework* provides a mechanism to balance the relative priority for habitat management for caribou, moose, elk, and deer while acknowledging and managing risk for a threatened species.

Recent increases in survey and inventory effort has resulted in increased knowledge of caribou which has resulted in more informed management.

3.6 Major data and analysis uncertainties

The most recent year (2013) of population trend data shows a marked decline in lambda resulting in an overall high degree of variability. The cause of this variability is not known but seems to contradict the relatively stable trend data from the previous two years. Adult survival was the primary metric that changed. These results raise the question if in studies such as this, where mortality and recruitment is monitored for multiple years from caribou collared in just the first year, that there is some age-related factor that may be unduly influencing adult caribou survival.

The Forest Resource Inventory (FRI) within the Pagwachuan Range is relatively old and has been manually updated for successive FMPs. This older inventory may be less precise and may not adequately reflect the age class structure and forest composition of the forest that was used to infer the amount and arrangement of habitat.

Because of the underlying ecology in the Pagwachuan Range, two different models (conventional boreal model and the clay-belt model) were used to assess caribou habitat amount and arrangement. These models were based on the available FRI datasets and as a result could not be applied to the northern portion of the range where FRI is unavailable.

Without FRI available for the northern portion of the range, the Provincial Land Cover 2010 (PLC 2010) was used. This product under-represents the amount of tree cover, often classing sparsely treed or treed areas as open fen or bog (Stratton 2012). The habitat model used to determine the amount of winter and refuge habitat classifies treed fen and bog as habitat but not open fen or bog. As a result, this nuance in the PLC 2010 classification should be taken into consideration when interpreting the habitat values used in the habitat assessment.

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 Environmental 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 2011 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 Pagwachuan Range using Ontario data is estimated to be approximately 4.5% greater than that generated using the Environment Canada data. There is some uncertainty in the interpretation of the results of the disturbance analysis using these different datasets in light of the desire to use the best data available.

There is considerable uncertainty in the appropriate treatment of water during the disturbance analysis. The sensitivity of the “total disturbance” parameter to removal of waterbodies of different sizes was identified to inform interpretation of the likelihood of a stable to increasing population growth and evaluation of range status. In the Pagwachuan Range, waterbodies account for a small portion (2.9%) of the range extent. It is unknown whether the inclusion of these waterbodies 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 Pagwachuan 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.

Although the southern portion of the range is highly disturbed, most is associated with potentially temporary disturbance related to forest management. These southern areas (e.g. vicinity of Nagagami Lake) represent a large and significant land base in which to encourage continued use or future recovery as the forest matures. Landscape planning to improve connectivity will be an important strategy to maintaining abundance and distribution across the range.

Recruitment and adult female survival estimates require careful interpretation because most of the results are based on caribou that currently reside in the northern portion of the range where disturbance is low and moose and wolf densities are likely lower. As a result, the population state variables reflect a relatively stable or healthy population in the north but does not adequately describe the high risk to caribou in the southern portion of the range.

Although white-tail deer numbers do not appear to be increasing, they are being observed in more northerly areas. This has the potential to increase caribou mortality due to brainworm (*Paralaphostrongylus tenuis*), and support higher wolf densities (Latham, Latham, McCutchen, and Boutin 2011).

Current estimated wolf densities in the north eastern portion of the range are very low (0.5 wolves / 100 km^2) and well below that suggested as a threshold for caribou persistence (0.65 wolves / 100 km^2) (Bergerud and Elliot 1986; Bergerud 1988). This estimate is consistent with expectations of low wolf abundance in areas with low disturbance and low ungulate prey density (Bowman et al.2010; Messier 1995). Estimates of wolf density are not available throughout most of the range, but are expected to be higher in the southern portion of the range where higher moose densities occur. Current management direction (MNR 2009a) is to maintain caribou distribution throughout the range, and the lack of wolf abundance data is an acknowledged gap in our understanding of conserving caribou in the southern portion of the Pagwachuan Range.

Black bear predation and the impact on calf survival are unknown relative to other mortality factors. Because areas harvested within lowland black spruce areas are adjacent to calving/nursery areas, black bear predation may be of greater concern than anticipated (Pinard et al. 2012; Latham, Latham, and Boyce 2011). Black bear use of mature coniferous forests, bogs, and fens are limited but areas disturbed by forest management are preferred for foraging (Brodeur et al. 2008; Mosnier et al. 2008).

Subsistence harvest is permitted but harvest levels are unknown.

3.8 Other wildlife

The boundaries of the Pagwachuan Range include all or parts of Wildlife Management Units (WMU) 18A, 18B, 19, 21A, 21B, 24, and 25 (Figure 14), within cervid ecological zones A and B (MNR 2009a).

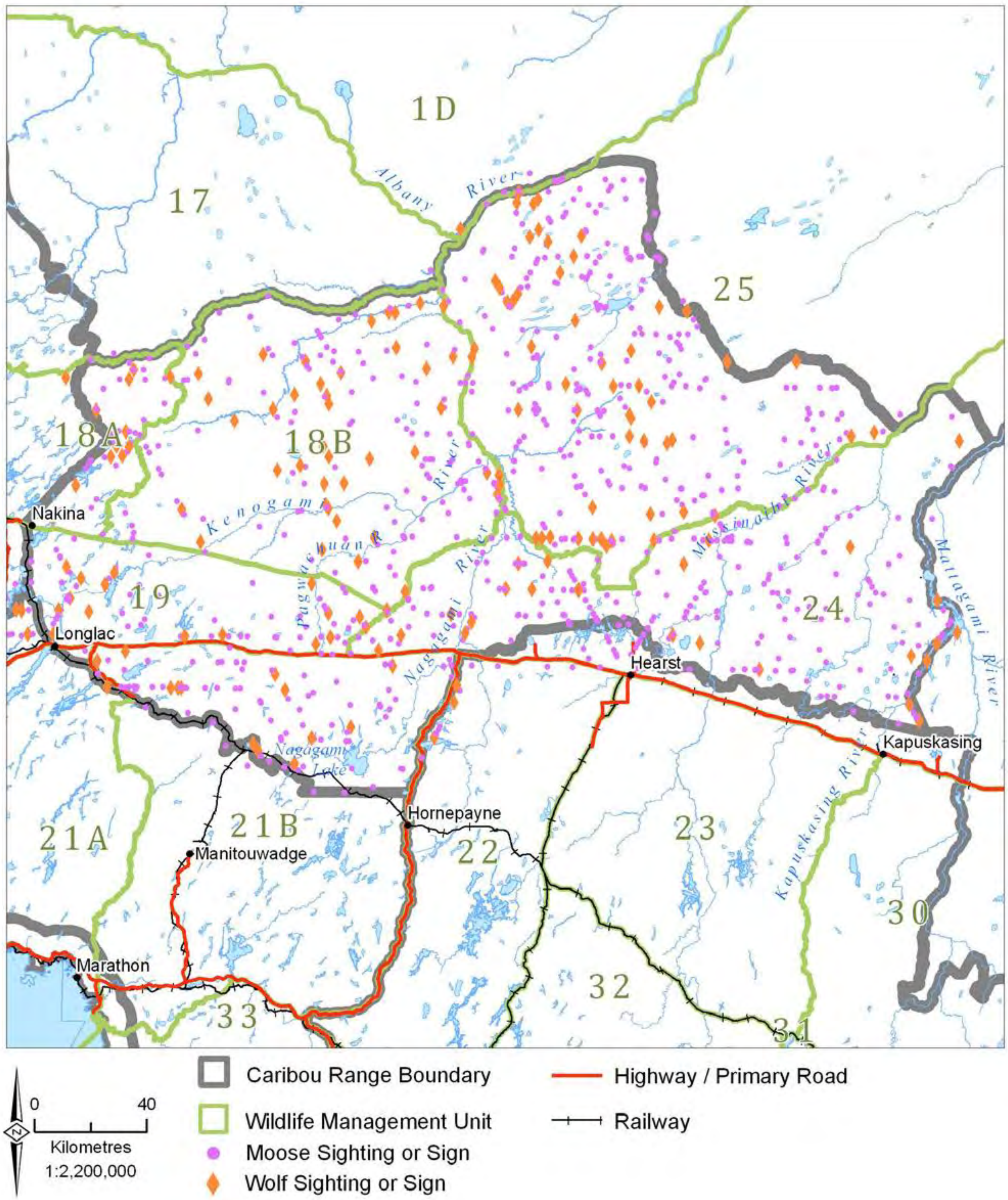


Figure 14. Wildlife Management Units overlapping the Pagwachuan Range with moose and wolf signs or sightings observed during the winter 2011 aerial surveys.

Moose densities have been historically low across much of the Pagwachuan Range and are between 1.8-28.6 moose per 100 km^2 (Table 4). Moose densities are particularly low in the northern portion of the range and are largely associated with favourable habitat along stream corridors. Overall, the moose population is considered to be relatively stable with the highest densities occurring in the western and southern portions of the range (Figure 14).

Table 4. Recent moose population estimates for Wildlife Management Units (WMU) within the Pagwachuan Range.

WMU	Cervid Ecological Zone	MAI strata area (km^2)[1]	Moose population estimates no. of moose (survey year)	Moose Density (moose/100km^2± 90% confidence interval)
18A	A	8,500	1,009 (2008)	12.0 ± 3.1
18B	A	4,925	202 (2000)	4.1 ± 1.6
19	B	10,825	1,649 (2010)	15.2 ± 4.3
21B	B	13,500	3,857 (2011)	28.6 ± 7.1
24	A	19,475	1,589 (2008)	8.2 ± 1.8
25	A	39,593	727 (2006)	1.8 ± 0.2

[1]Area is for the WMU

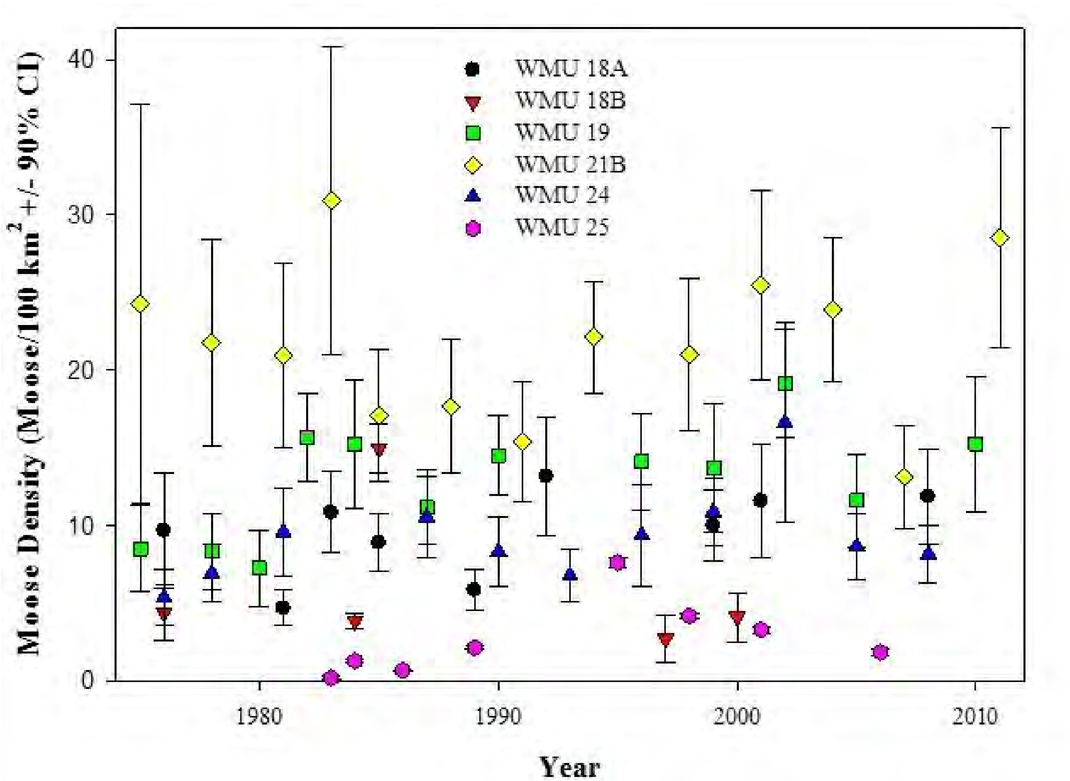


Figure 15. Moose density estimates with 90% confidence intervals for Wildlife Management Units 18A, 18B, 19, 21B, 24, and 25 from 1975-2011.

White-tailed deer densities are chronically low in WMU 24 and considered incidental and unestablished in WMUs 18, 19, and 25. To address the potential of expanding deer populations, new deer seasons were implemented in 2009 within all WMUs of the Pagwachuan Range, with additional deer seal quotas starting in 2010. Trends in deer sightings by deer and moose hunters are not yet available. 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.

Density estimates of bears are currently relatively low and thought to be stable based on harvest assessment trends (A. Genier pers. comm. 2013). An increase in black bear numbers or increased use by black bear of harvested stands adjacent to caribou calving/nursery areas could greatly influence caribou calf survival. Black bear density estimates derived through the implementation of barbed-wire hair trap (BWHT) protocol indicates that densities are relatively low in most of the WMUs within the Pagwachuan Range (12-25 bears/100 km^2) (Table 5) (M. Obbard, MNR unpublished data). Estimated bear densities were below or similar to average densities when compared with other WMUs within each black bear ecological zone, except WMU 21B which was above.

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

WMU	BBEZ[1]	Year	Density (# bear/100km^2) ± SE	Density relative to BBEZ mean	Density relative to regional mean
18A	D	2006/2009	11.8 ± 4.1	Below	Below
18B	A		Unknown		
19	D	2008	12.5 ± 3.4	Below	Below
21B	D	2009/2010	25.0 ± 6.7	Above	Similar
24	C	2010	11.7 ± 3.0	Similar	Below
25	A		Unknown		

[1]Black bear ecological zone

Wolf densities are largely unknown, but an aerial survey flown in 2009 in areas of WMUs 24 and 25 estimated low wolf abundance at 0.05 wolves per 100 km^2 (Figure 16) (B.R. Patterson, MNR unpublished data). Wolves are likely much more abundant in the western and southern portions of the range (WMUs 18, 19 and 21B) where moose densities and levels of disturbance are higher. In the adjacent Nipigon Range, wolf densities were estimated at 0.67 wolves /100 km^2 (B.R. Patterson, MNR unpublished data). This information is to provide context with other wildlife population trends, and is not used in determining range condition.

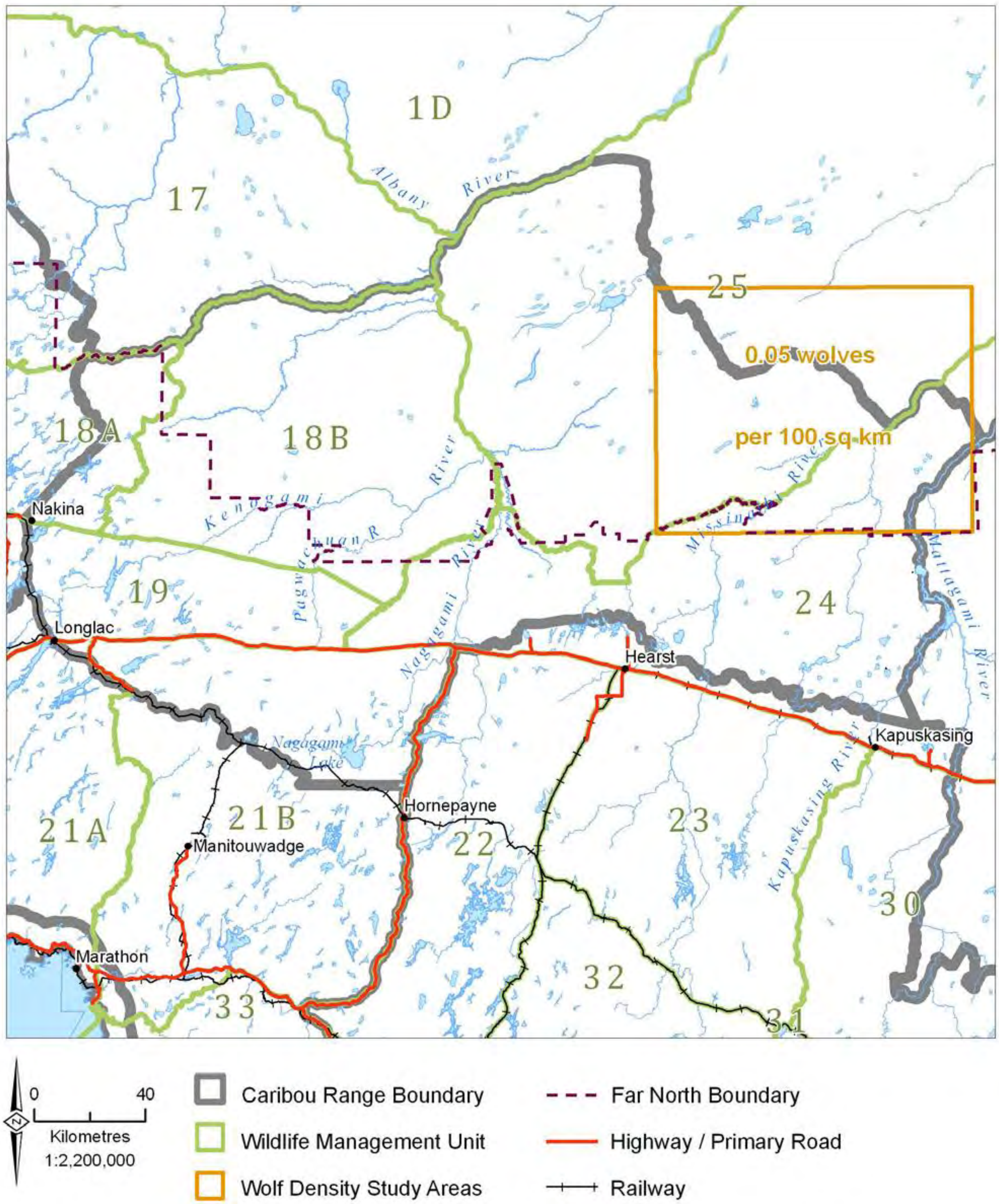


Figure 16. Estimate of wolf density (wolves/100 km^2) during winter 2009 aerial surveys in a study area (yellow outline) in the northeast corner of the Pagwachuan Range (B.R. Patterson, MNR unpublished data).

Trends in wolf population index (moose hunter post card survey) illustrate some variation with wolf sightings peaking in 2008/2009 (Figure 17). The relationship between sightings and actual annual wolf abundance is unknown, but sightings would suggest that the wolf population trend is likely stable, perhaps increasing slightly since 2005.

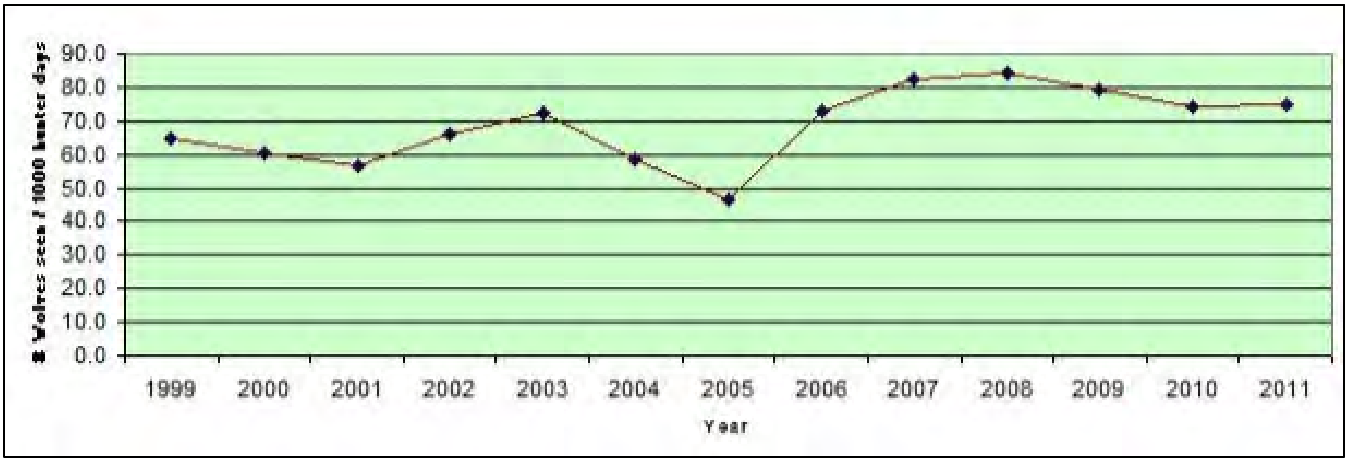


Figure 17. Trend in number of wolves sighted by moose hunters/1000 hunter days, 1999-2011; pooled data for WMUs 24, 25, 21B, 19, 18A, 18B (MNRF, Science and Research Branch, moose hunter post card survey database).

3.9 Results of past range assessments

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

4.0 Integrated Range Assessment Framework

The Protocol (MNRF 2014a) identifies the process to conduct an Integrated Range Assessment (Figure 18) 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 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.

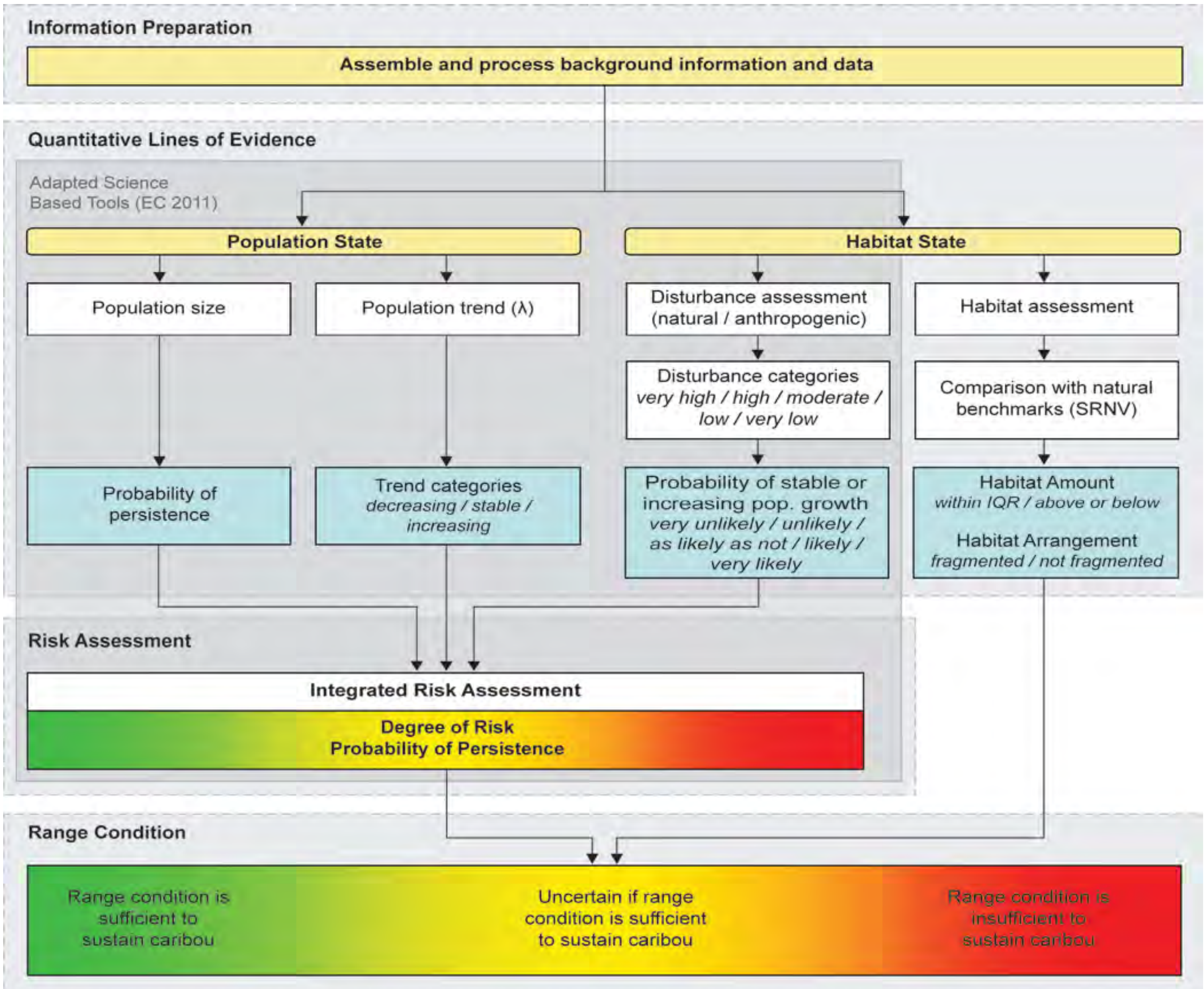


Figure 18. The integrated assessment framework with four quantitative lines of evidence. Three lines of evidence related to population size, trend and habitat disturbance assessment contribute to an integrated risk assessment. The results of the integrated risk assessment are combined with habitat assessment (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 range assessment framework (Figure 18).

The ability to establish population trends 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.

5.1.1 Population state methods

5.1.1.1 Telemetry

Historically, there were studies involving the deployment of telemetry collars on caribou within the Pagwachuan Range (Table 2). Some of these studies were primarily intended to document caribou movement and habitat use within specific areas (such as the Nagagami Lake area) and provide caribou information in areas of immediate interest for resource management decisions.

In February and March 2011, 18 GPS collars were deployed on adult female caribou throughout the Pagwachuan Range. Data generated from these caribou as well as from a number of caribou collared within the northern portion of the Pagwachuan Range for the Far North Caribou Project (Berglund et al. 2014) were used in the Integrated Range Assessment to determine annual survival, recruitment, and refine trend estimates.

5.1.1.2 Winter aerial surveys

Between January 31st and February 26th, 2011, a fixed-wing hexagon-based aerial survey was conducted for the Pagwachuan 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 between February 11th-March 11th, 2011, 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 caribou 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 12-15% 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 survival rates of 85% (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).

Daily survival rate = 1- (# of mortalities/# of animal days) Equation 2

Annual survival rate = (Daily Survival Rate) ^{365} Equation 3

Annual mortality rate = 1- Annual Survival Rate 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 Pagwachuan Range was utilized.

5.1.1.5 Size

The aerial survey methodology 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 and March 2011. 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

One hundred and seventy-six (176) caribou observations were recorded during the 2011 aerial surveys; 20 from the fixed-wing survey, 144 from the rotary-wing survey and 12 in a chance encounter by a pilot en route to Thunder Bay. After removing recounts, two caribou were observed during the fixed-wing survey and 141 caribou in 33 were during the rotary-wing survey. An additional nine caribou were observed during targeted telemetry flights (which were deemed not to be double counts) (Table 6).

Therefore, the total minimum animal count (MAC) was 164, including 16 calves in the Pagwachuan Range during February and March 2011 (Table 6).

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 Pagwachuan Range. Very few caribou were observed during the hexagon-based fixed-wing portion of the survey in the southern half of the range.

Table 6. Minimum animal count observed during a fixed-wing and rotary-wing aerial survey conducted on the Pagwachuan Range, January 31–March 11, 2011.

	Caribou age and sex identification[1]						
Survey method	**UA**	**AM**	**AF**	**Calves**	**UN**	**Total adults**	**Total caribou**
Rotary-wing (RW)	38	39	48	16	0	125	141
Fixed-wing (FW)	1	1	0	0	0	2	2
Chance[2]	0	0	0	0	12	0	12
Collared caribou[3]			9			**9**	**9**
Total	**39**	**40**	**57**	**16**	**12**	**136**	**164**

[1]UA=Adult of unknown sex, AM= Adult male, AF=Adult female, UN=Caribou of unknown age or sex
[2] Chance encounter deemed not to be a recount
[3]Although more than nine caribou were observed on these flights, only the nine collared AF were included here to ensure possible double counts were not included in the MAC

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 2011 aerial survey, the sex ratio of known adult females to known adult males observed during the rotary-wing survey was 0.627. Using this sex ratio to determine the number of AF_{adj} resulted in a recruitment estimate of 22.1 calves per 100 AF_{adj} (Table 7 and Figure 19)

Recruitment of the 2010 Far North caribou project was 17.6 calves per 100 AF_{adj}. And recruitment from a 2011 recruitment survey was 11.3 calves per 100 AF_{adj}.

The 2012 recruitment survey targeted collared adult female caribou and observed 95 caribou, 19 of which were calves. The sex ratio was 0.764, resulting in a recruitment estimate of 32.7 calves per 100 $AF_{adj.}$

The 2013 recruitment survey targeted collared adult female caribou and observed 34 caribou, 7 of which were calves. The sex ratio was 0.796, resulting in a recruitment estimate of 32.7 calves per 100 $AF_{adj.}$

During the first two years (2010 and 2011), recruitment levels were comparatively lower than the last two survey years (2012 and 2013). The lowest estimate occurred during the targeted recruitment survey in 2011, and it is not known why the number of calves observed during that survey is so low. Despite the annual variation, these recruitment estimates provide evidence for good recruitment potential that may exceed the estimated threshold of 28.9 calves per100 AF_{adj} in order to support a stable to increasing population trend. These estimates of recruitment are comparable with studies elsewhere in which caribou populations were known to be stable or in decline (Rettie and Messier 1998; McLoughlin et al. 2003; EC 2008).

Table 7. Counts of caribou and estimates of recruitment from both the rotary-wing and fixed-wing aerial surveys conducted in the Pagwachuan Range during February-March, 2010-2013.

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]
2010	Far North caribou project	52			7		52	59	0.764	39.7	17.6	11.9
2011	Winter distribution (FW/RW)	39	40	48	16	0	127	143	0.627	72.5	22.1	11.2
2011	Recruitment	14	3	31	5	1	48	54	0.933	44.1	11.3	n/a[4]
2012	Recruitment	76			19		76	95	0.764	58.1	32.7	n/a[4]
2013	Recruitment	3	5	19	7	0	27	34	0.796	21.4	32.7	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

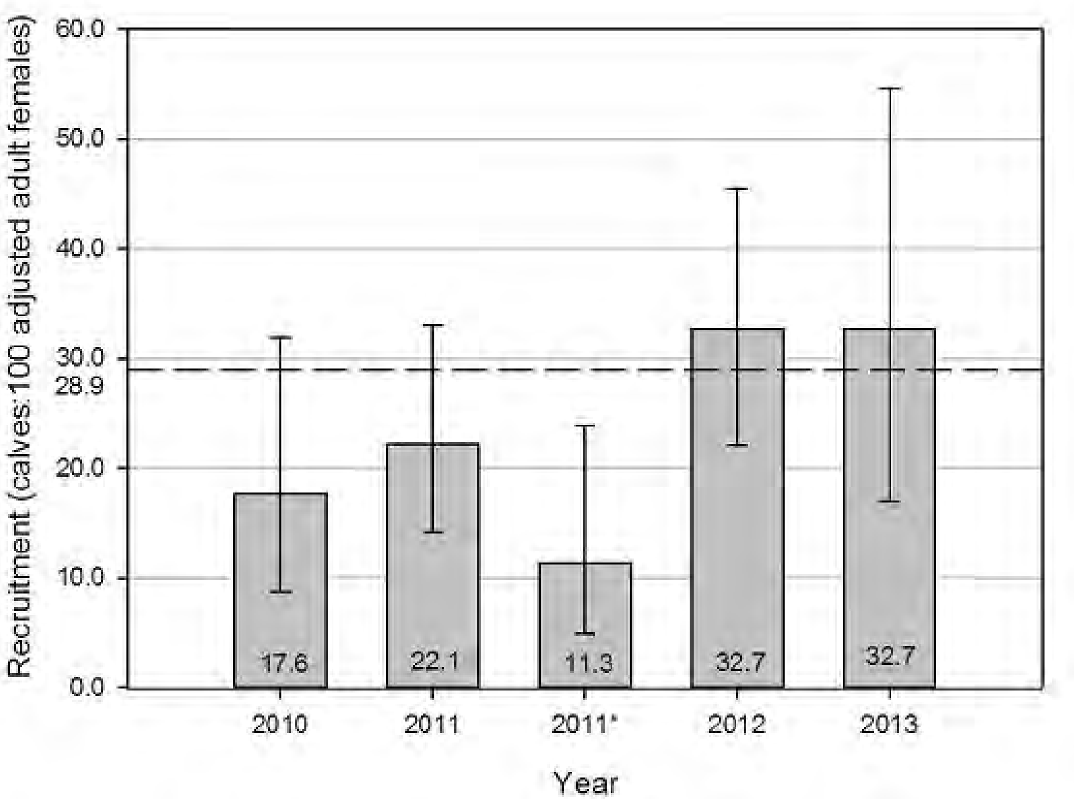


Figure 19. Recruitment estimates (calves/100 AF_{adj}) with 95% confidence intervals from 2010-2013 in the Pagwachuan Range. Dashed line indicates recruitment levels expected for a stable or increasing population (EC 2008). The 2011 estimates were separated to include those from the winter 2011 aerial survey and those from a targeted recruitment survey (2011*).

Annual survival was estimated for all collared adult females that spent the majority of their time within the Pagwachuan Range during the biological year (April 1st to March 31st). The mean annual survival rate was estimated to be 0.82 (95% CI 0.43-1.0). For the biological years 2009-2011 survival rates were good and varied from 0.88-0.92 (Table 8 and Figure 20). However, during the 2012 biological year mortality of collared adult females was much higher and resulted in an annual survival rate of only 0.62. This low survival rate was unexpected, as estimated recruitment levels were comparatively high (though sample sizes were relatively low with only 27 caribou being observed). The spatial and temporal distribution of mortality events were well dispersed and the low observed survival rates could not be explained by any predictable events.

The mean population trend (λ) was 0.94 for the biological years of 2009-2012. An additional estimate was calculated without the 2012 data (if thought to be an anomaly) and was estimated to be 1.0. However, the declining trend is largely driven from the low adult female survival observed in 2012, and highlights the importance of longer term monitoring for a species like caribou.

Table 8. Annual survival rates (S) and population trend (λ) of collared female caribou (n) and number of mortalities (d) during 2009-2012 biological years (April 1st-March 31st).

Biological year	n	d	Exposure Days	Daily survival rate	Survival (S)	Upper 95% CI	Lower 95% CI	Lambda (λ)[1]
2009	16	2	5574	0.9996	0.88	1.0	0.73	0.95
2010	13	1	4422	0.9998	0.92	1.0	0.78	1.02[2] 0.97[3]
2011	31	3	10359	0.999	0.90	1.0	0.80	1.05
2012	19	7	5334	0.9987	0.62	0.88	0.43	0.72
				Survival geometric mean	**0.82**			
				Geometric λ mean (2009-11)				**1.00**
				Geometric λ mean (2009-12)				**0.94**

[1]λ calculated from recruitment (Table 8) from the end of the biological year (i.e. biological year 2012 and recruitment from 2013)
[2]Lambda calculated using the recruitment estimate from 2011 winter distribution survey.
[3]Lambda calculated using the recruitment estimate from 2011 targeted telemetry survey.

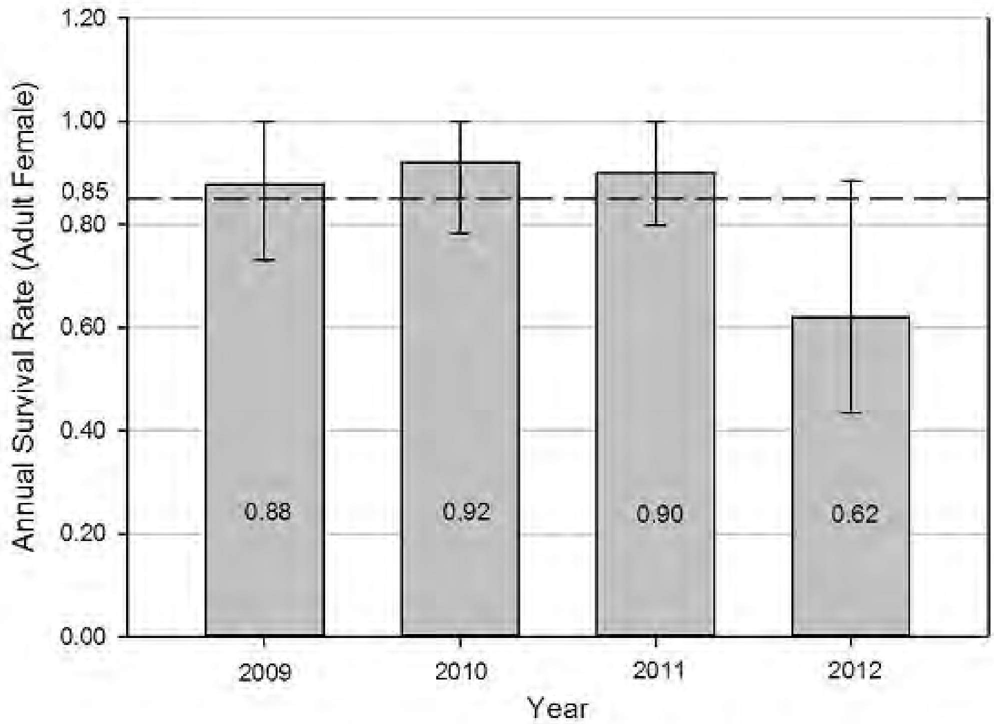


Figure 20. Annual survival rate and 95% confidence intervals of collared adult female caribou which spent the majority of the biological year (April 1st- March 31st) within the Pagwachuan Range. Dashed line represents the 85% survival rate (EC 2008).

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 21).

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.

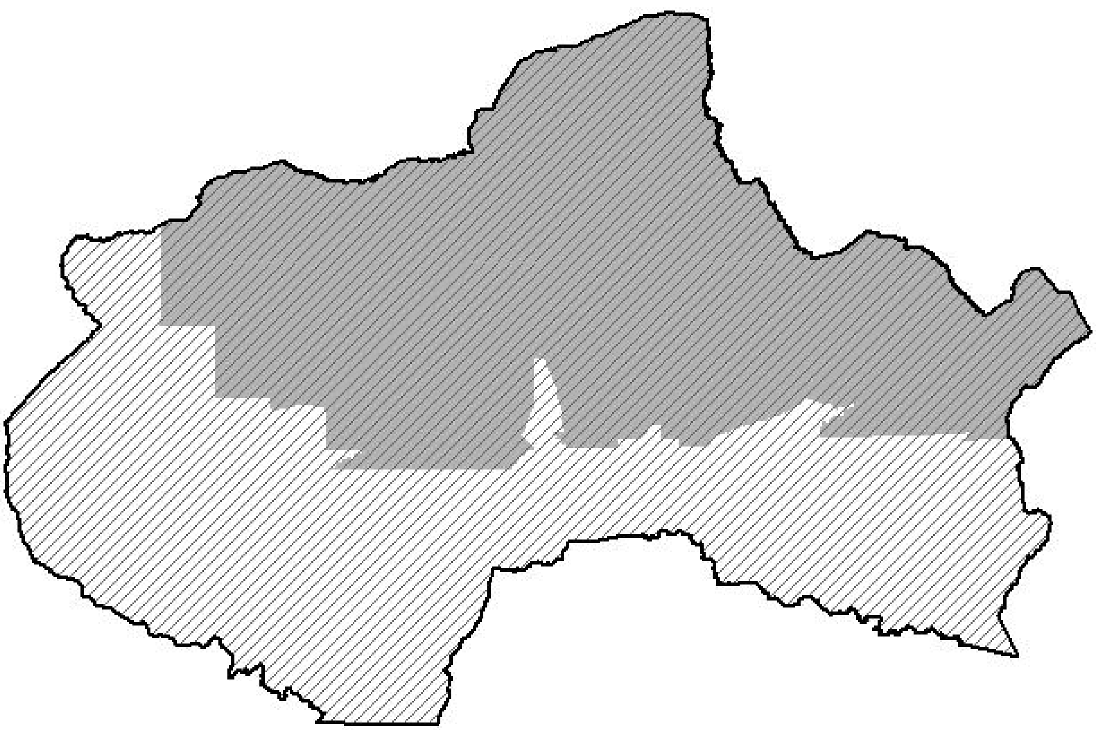


Figure 21. The Pagwachuan Range including the extent of the FRI data (), the extent of 2012 Provincial Satellite Derived Disturbance Mapping data (), and the extent of relevant data from LIO, including PLC 2000 data ().

5.2.2 Disturbance analysis results

The physical disturbance from various sources within the Pagwachuan Range (Figure 22 to Figure 27) contributes to the cumulative disturbance footprint (Figure 22 to Figure 27). 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 2011.

5.2.2.1 Forest harvest disturbance

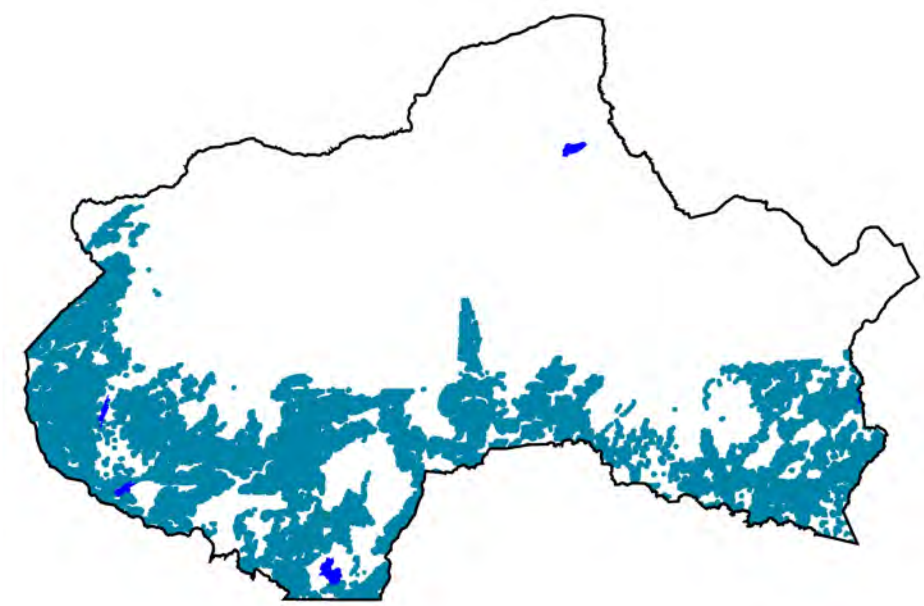


Figure 22. Forest harvest disturbances (■) including 500 metre buffers in the Pagwachuan Range.

Table 9. Forest harvest statistics in the Pagwachuan Range.

Harvest features	Count (n)	Area (ha)	Buffer area (ha)
Harvest blocks (FRI)	59,161	475,444	685,975
Harvest areas (2012 Provincial Satellite Derived Disturbance Mapping)	0	0	0
Harvest areas (PLC 2000)	n/a[1]	307	4,370

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

5.2.2.2 Other industry disturbance

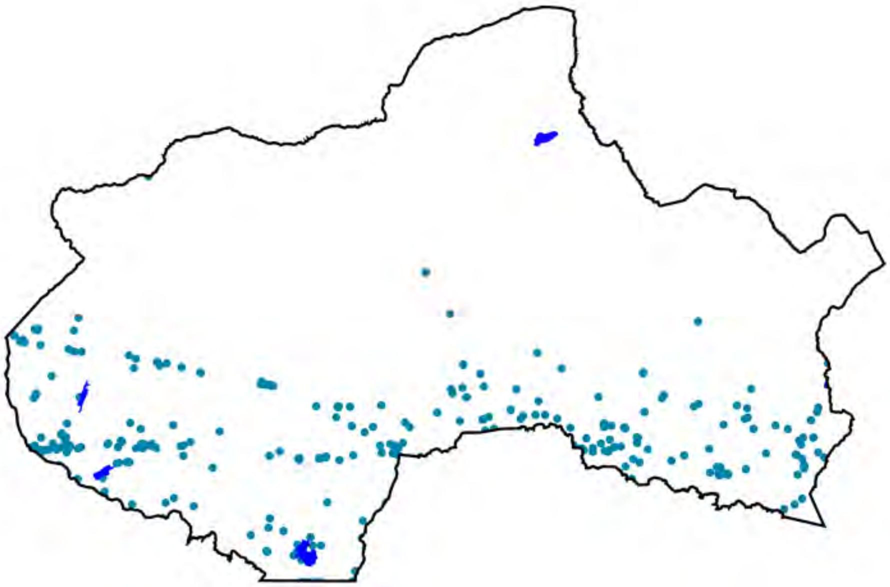


Figure 23. Other industry features (■) including 500 metre buffers in the Pagwachuan Range.

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

Other industry features	Count (n)	Area (ha)	Buffer area (ha)
Agriculture	0	0	0
Airports	3	27	505
Buildings	1,300	14,390[1]	102,102
Dams	0	0	0
Forest processing facilities	2	n/a[1]	116
Trap Cabins	78	n/a[1]	5,969
Towers	29	n/a[1]	1,750
Utility Sites	0	0	0
Waste disposal sites	17	6	1,503
Water power generating stations	5	n/a[1]	285
Work camps	0	0	0

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

5.2.2.3 Linear features disturbance

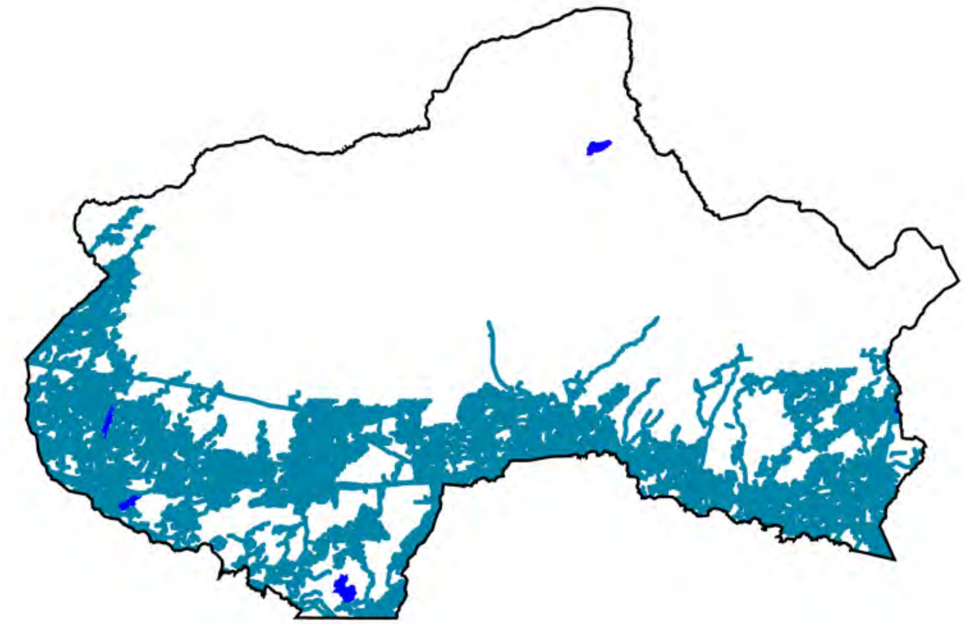


Figure 24. Linear features (■) including 500 metre buffers in the Pagwachuan Range.

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

Linear feature	Count (n)	Area (ha)	Buffer area (ha)
Roads	n/a[1]	n/a[2]	1,054,162
Trails	n/a[1]	n/a[2]	42,883
Railways	n/a[1]	n/a[2]	29,684
Utility lines	n/a[1]	n/a[2]	27,809

[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

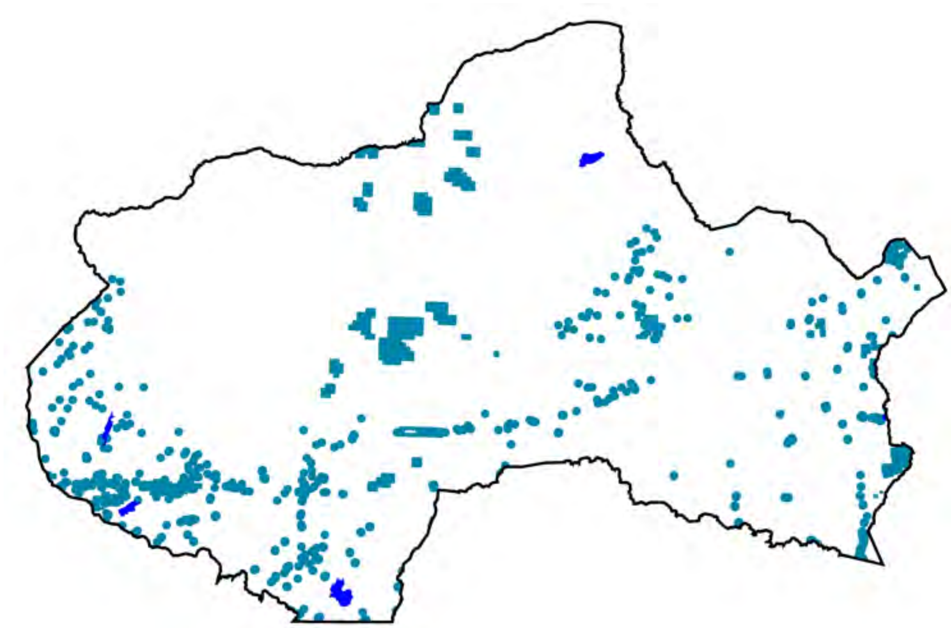


Figure 25. Mining features (■) including 500 metre buffers in the Pagwachuan Range.

Table 12. Mining feature disturbance statistics in the Pagwachuan Range.

Mining feature	Count (n)	Area (ha)	Buffer area (ha)
Active mining claims	495	100,028	n/a[2]
Aggregate sites – authorized	199	n/a[1]	18,580
Aggregate sites – un-rehabilitated	0	0	0
Drill holes	429	13,575[1]	33,694
Mining locations	0	0	0
Mine (shafts, open pit)	0	0	0
Petroleum wells	37	0	2,698
Pits and quarries	327	686	23,944

[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

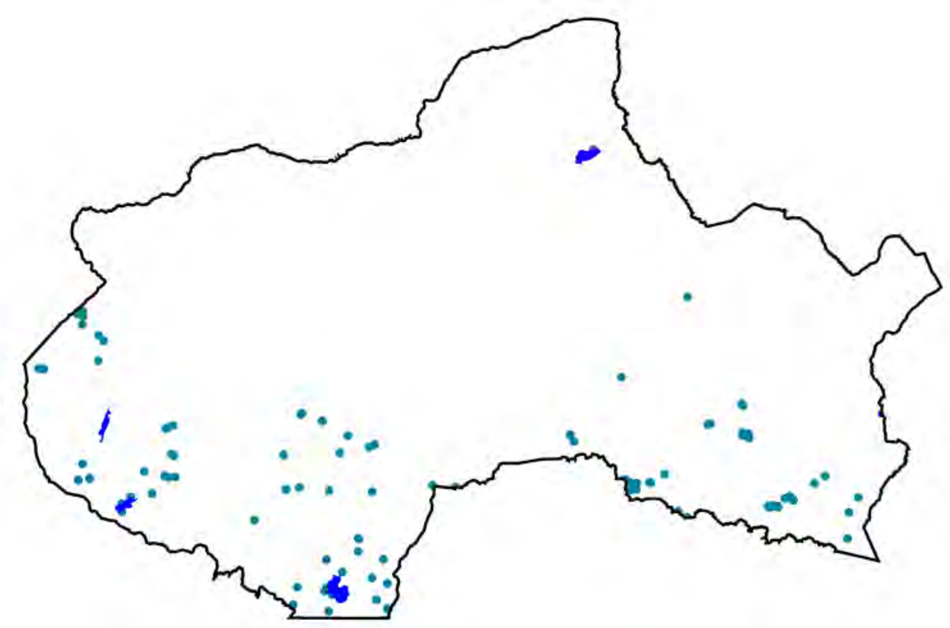


Figure 26. Tourism infrastructure features (■) including 500 metre buffers in the Pagwachuan Range.

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

Tourism feature	Count (n)	Area (ha)	Buffer area (ha)
Cottage areas	10	<1	788
Cottage and residential sites	91	8	5,040
Commercial campgrounds/ Main base lodges/ Remote outposts	37	6	3,064
Recreational camps	5	<1	401

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.

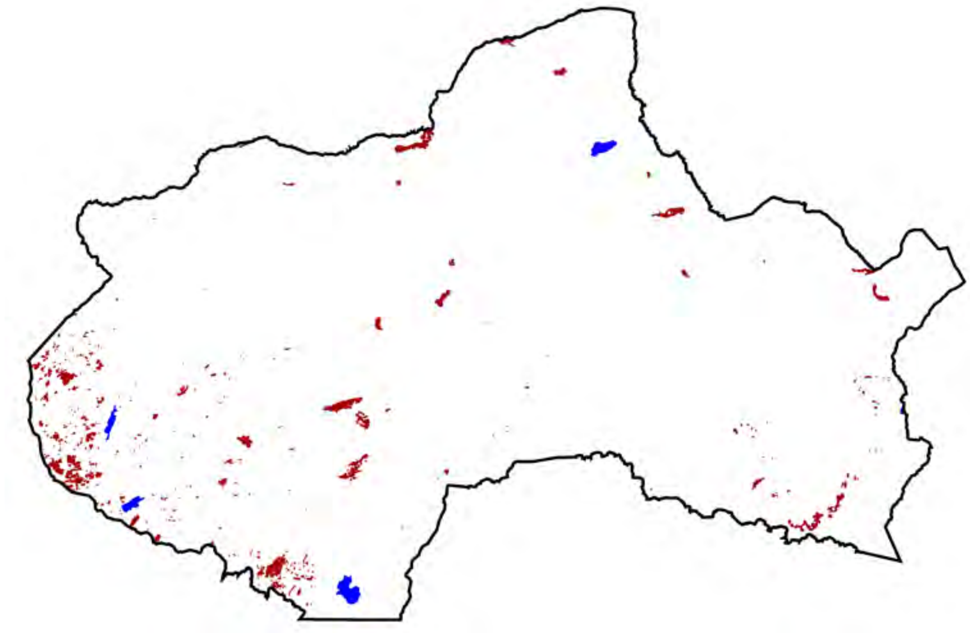


Figure 27. Natural disturbances from fire, blowdown, snow, and insect damage (■) in the Pagwachuan Range.

Table 14. Natural disturbance statistics in the Pagwachuan Range.

Natural feature	Count (n)	Area (ha)	Buffer area (ha)
Fire (FRI)	1,804	20,730	n/a[2]
Fire (2012 Provincial Satellite Derived Disturbance Mapping)	n/a [1]	200	n/a[2]
Fire (PLC 2000)	n/a [1]	6,021	n/a[2]
Fire (LIO)	13	4,963	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 approximately 2.9% of the area within the Pagwachuan Range (Table 15). Approximately 52.2% of the land area of the range is represented by data sources other than the FRI. 5 includes range statistics which assist with the interpretation of disturbance statistics and map (Figure 28). The amount of area, inferred as functional habitat loss identified from the disturbance analysis amounts to 1,396,820 ha, or 31.0% of the Pagwachuan Range. Natural disturbance accounts for 0.5% of the range and anthropogenic disturbance accounts for 30.5% of the range. The overlap of natural and anthropogenic disturbances accounts for 0.2% of the range area and 0.6% of the total disturbance, this value is counted as part of anthropogenic disturbance.

Table 15. Pagwachuan Range landscape statistics.

Range component	Area (ha)	%
Total range area	4,500,854	100.0
Water	129,589	2.9
Non-water	4,371,265	97.1
FRI extent[1]	2,153,125	47.8
Non-FRI extent[1]	2,347,729	52.2
Total disturbance within range	1,396,820	31.0
Natural[2]	21,810	0.5
Anthropogenic[2]	1,375,010	30.5
- Overlap of natural and anthropogenic disturbance[3]	8,661	0.2
Not disturbed within range	3,104,034	69.0

[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

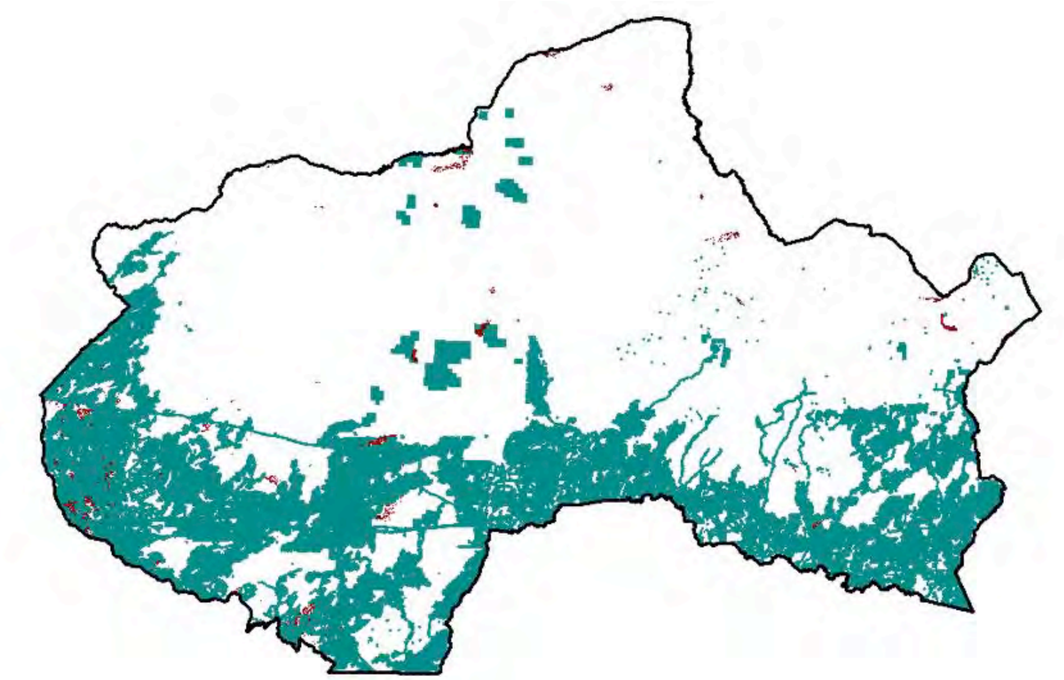


Figure 28. Anthropogenic[1] (■) and natural (■) disturbances (i.e. forest <36 years) in the Pagwachuan Range.

[1]Anthropogenic disturbances include a 500 m buffer. When anthropogenic disturbances overlap with natural disturbances it is counted as anthropogenic.

The functional habitat loss inferred from the disturbance analysis amounts to 1,396,820 ha or 31% of the Pagwachuan Range. Considering overlap of disturbance types, natural disturbances covers 21,810 ha or 0.5% of the landscape and anthropogenic disturbances covers 1,375,820 ha or 30.5%. Disturbance distribution is heavily weighted to the southern portion of the range with some disturbances scattered and sparse above the AOU boundary (Figure 29).

The pattern of disturbance across the Pagwachuan Range reflected in 100 km^2 hexagons (Figure 29). A high concentration of disturbance, primarily a result of anthropogenic causes, is distributed in the southern portion of the range.

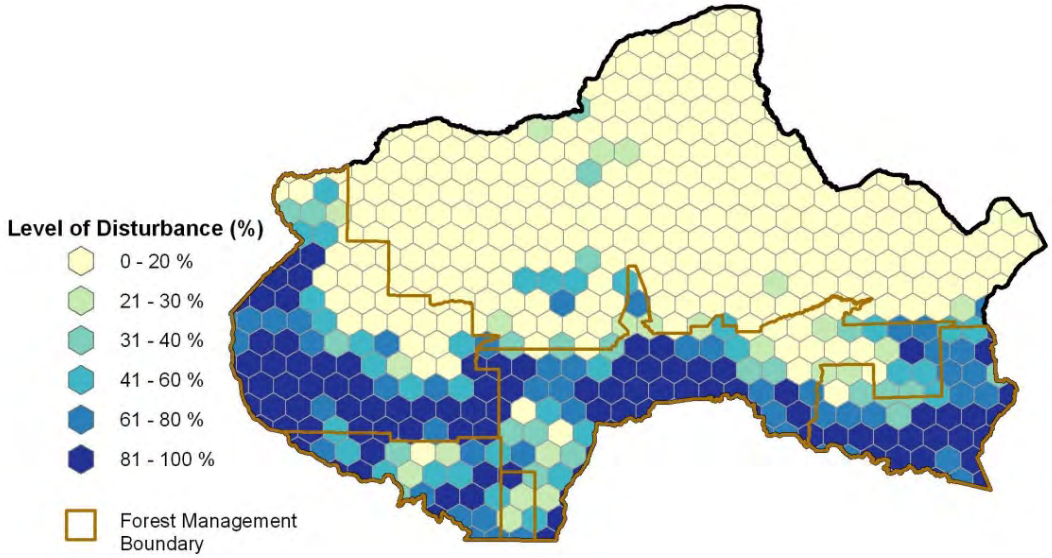


Figure 29. The concentration of natural and anthropogenic disturbances on the Pagwachuan Range within 100 km^2 hexagon grid cells (used for the probability of occupancy survey, Section 3.3).

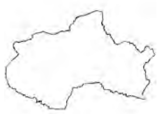
In addition to the physical landscape disturbance representing functional habitat loss as described using these methods, sensory disturbance (not addressed in this analysis) may also contribute to range quality to some degree. Sensory disturbance includes the displacement of caribou due to human recreational or industrial activities.

5.2.4 Disturbance considerations related to water

Water accounts for a substantial portion of the Pagwachuan Range (2.9%) 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 1,295 km^2 of the range and disturbance ranges from 0-2.9%, depending on the inclusion of water.

Table 16. Disturbance sensitivity analysis. The percent disturbance is estimated by removing waterbodies of differing 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).

Pagwachuan Range	Waterbody	Water ha (%)	Disturbance (%)		
			Natural	Anthropogenic	All
	Range extent	0 (0.0)	0.5	30.5	31.0
	> 10000 ha removed	0 (0.0)	0.5	30.5	31.0
	> 5000 ha removed	5,378 (0.1)	0.5	30.6	31.1
	> 1000 ha removed	34,436 (0.8)	0.5	30.8	31.3
	> 500 ha removed	49,796 (1.1)	0.5	30.9	31.4
	> 250 ha removed	64,202 (1.4)	0.5	31.0	31.5
	All water removed	129,589 (2.9)	0.5	31.5	32.0

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 Pagwachuan Range, both the amount and arrangement SRNV are compared against 2012 amounts and 2010 arrangement as inferred from the FRI (Figure 30). The relative difference is a measure of how close or how far away the range condition is to the natural levels of habitat. This comparison informs the interpretation of the probability of persistence. The SRNV values may be compared to the land, water, and inventory coverage for the Pagwachuan Range (Table 16).

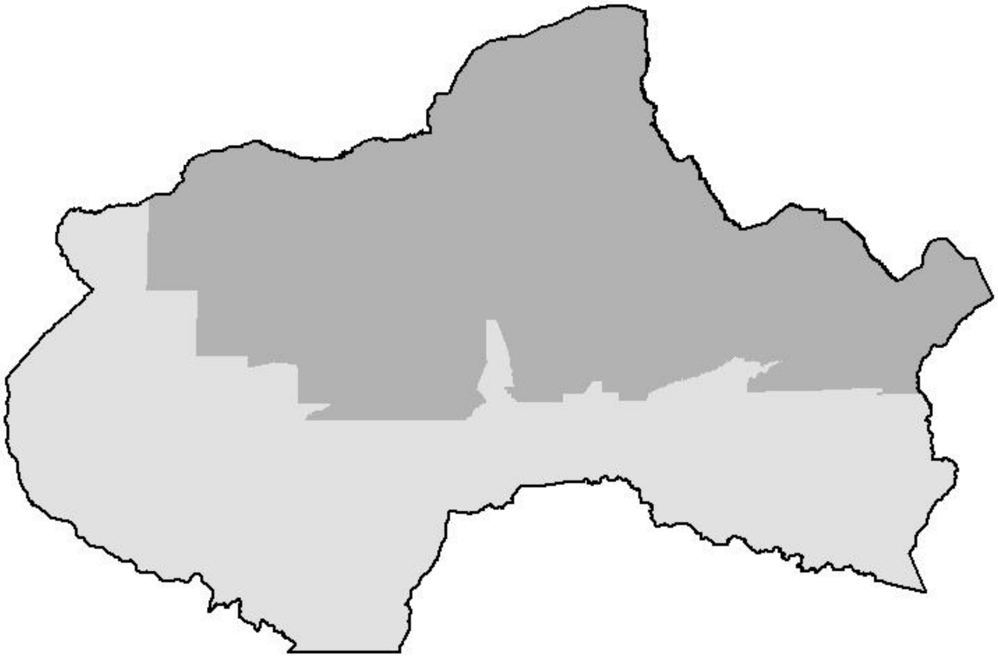


Figure 30. The Pagwachuan Range including the extent of the FRI data ( ) and the extent of PLC 2012 data ( ).

5.2.6 Habitat assessment results

5.2.6.1 Caribou habitat SRNV amount

In the western portion of the Pagwachuan Range, where the SRVN was analyzed using the conventional boreal model (MNRF 2014a), the amount of winter and refuge habitat are below the lower quartile range of what is expected in a natural system (Figure 31). The values shown for each FMU include 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.

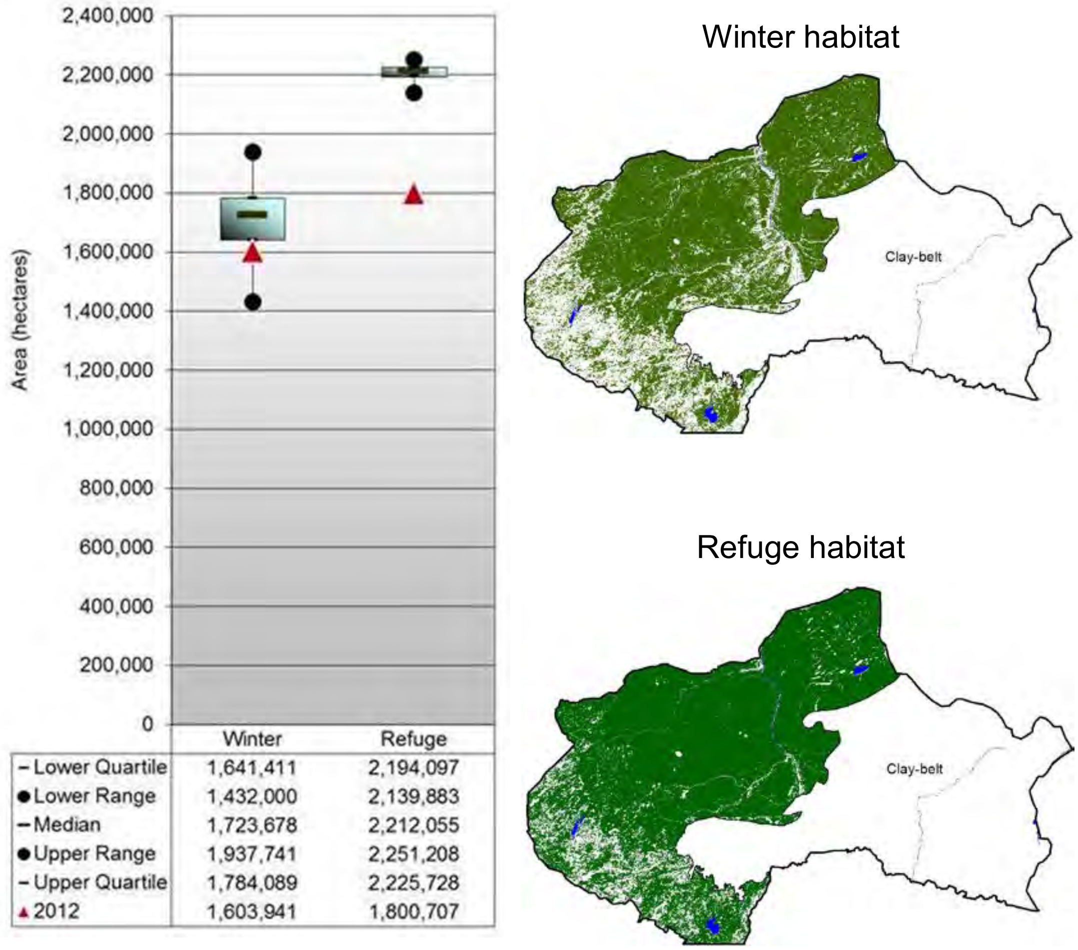


Figure 31. Box and whisker plot of caribou winter and refuge habitat amounts in the western portion of Pagwachuan Range (conventional boreal model) as compared to the SRNV.

Current winter habitat amounts across the Pagwachuan Range were examined according to Forest Management Unit (FMU) (Figure 32). Winter caribou habitat is near the lower quartile range for both the Kenogami and Big Pic FMUs on the western side of the range (conventional boreal model).

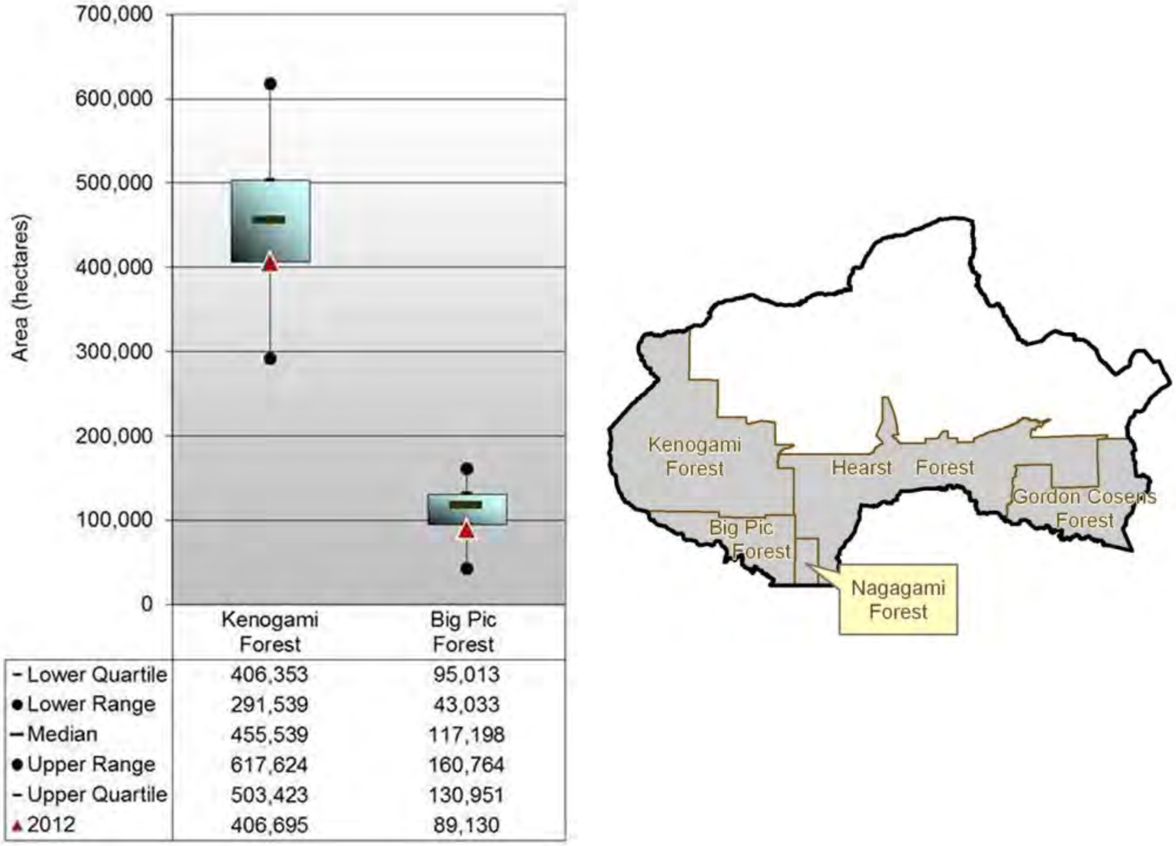
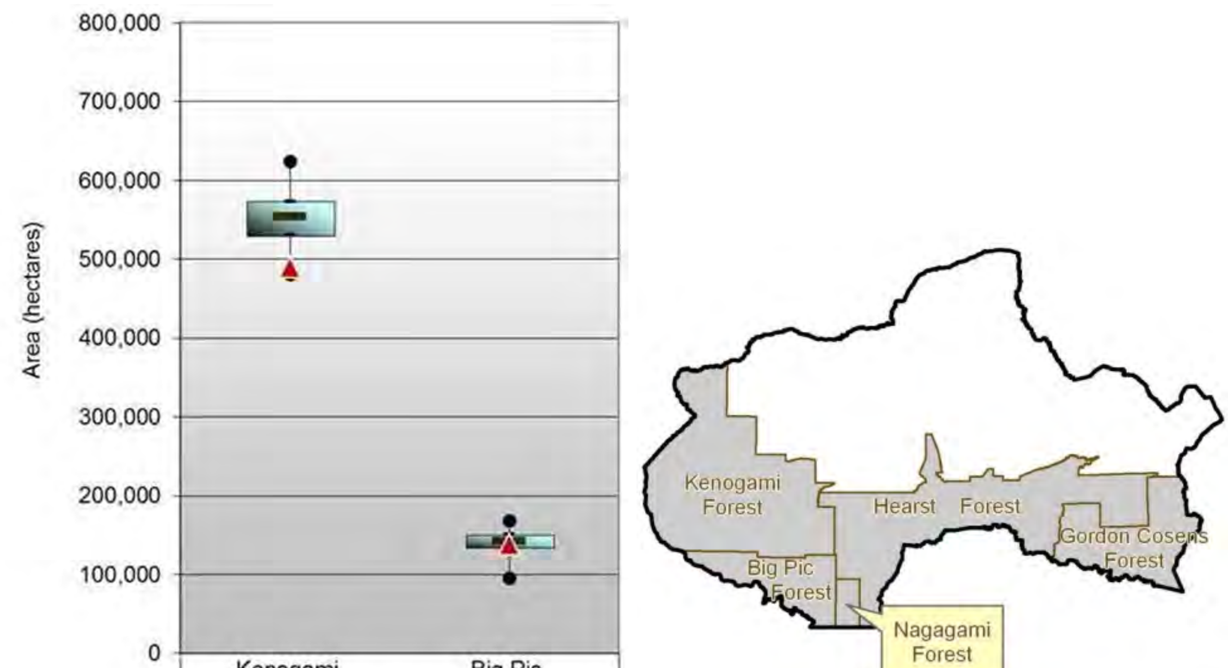


Figure 32. Box and whisker plot of winter habitat amount for two Forest Management Units within the western portion of the Pagwachuan Range as compared to the SRNV.

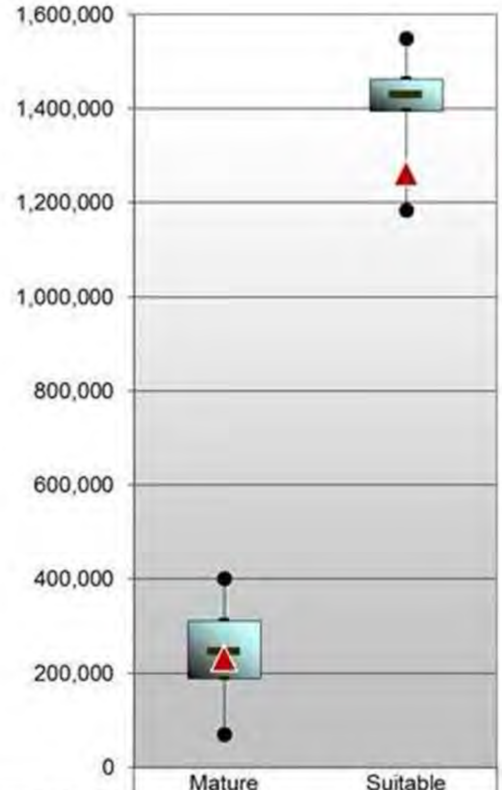
Refuge habitat within the Big Pic Forest is below the median but within the interquartile range. In the Kenogami Forest, refuge habitat is just above the lower range and well below the interquartile range (Figure 33).



	Kenogami Forest	Big Pic Forest
- Lower Quartile	530,267	133,657
● Lower Range	480,762	95,715
- Median	553,092	142,023
● Upper Range	623,763	168,231
- Upper Quartile	573,353	150,427
▲ 2012	490,023	137,673

Figure 33. Box and whisker plot of refuge habitat amount for two Forest Management Units within the western portion of the Pagwachuan Range as compared to the SRNV.

In the eastern portion of the Pagwachuan Range (clay-belt boreal model), the current amount of mature conifer and winter suitable are both below the median of what is expected in a natural system, however the amount of winter suitable habitat is also less than the lower quartile range (Figure 34). The value shown for each FMU include 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.



	Mature	Suitable
- Lower Quartile	188,452	1,396,348
● Lower Range	69,445	1,184,239
— Median	244,392	1,428,217
● Upper Range	400,590	1,548,325
- Upper Quartile	312,168	1,463,792
▲ 2012	230,763	1,263,101

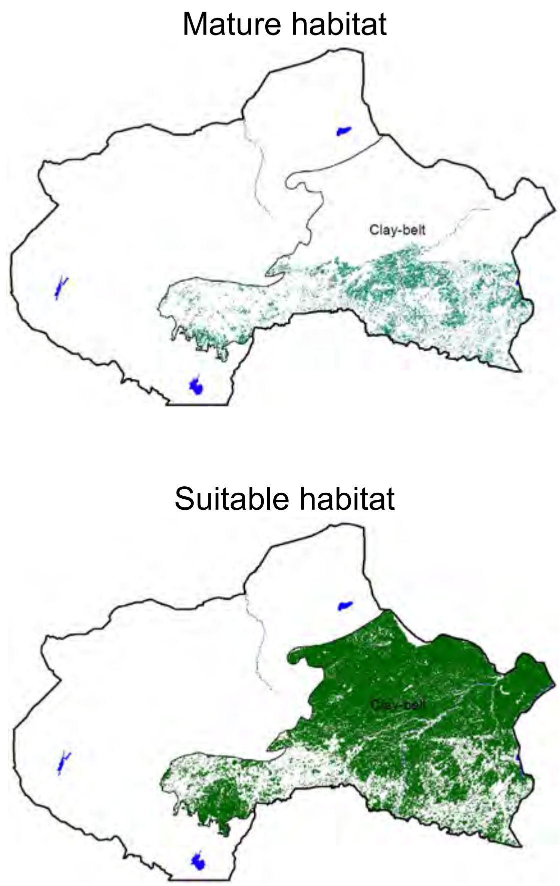
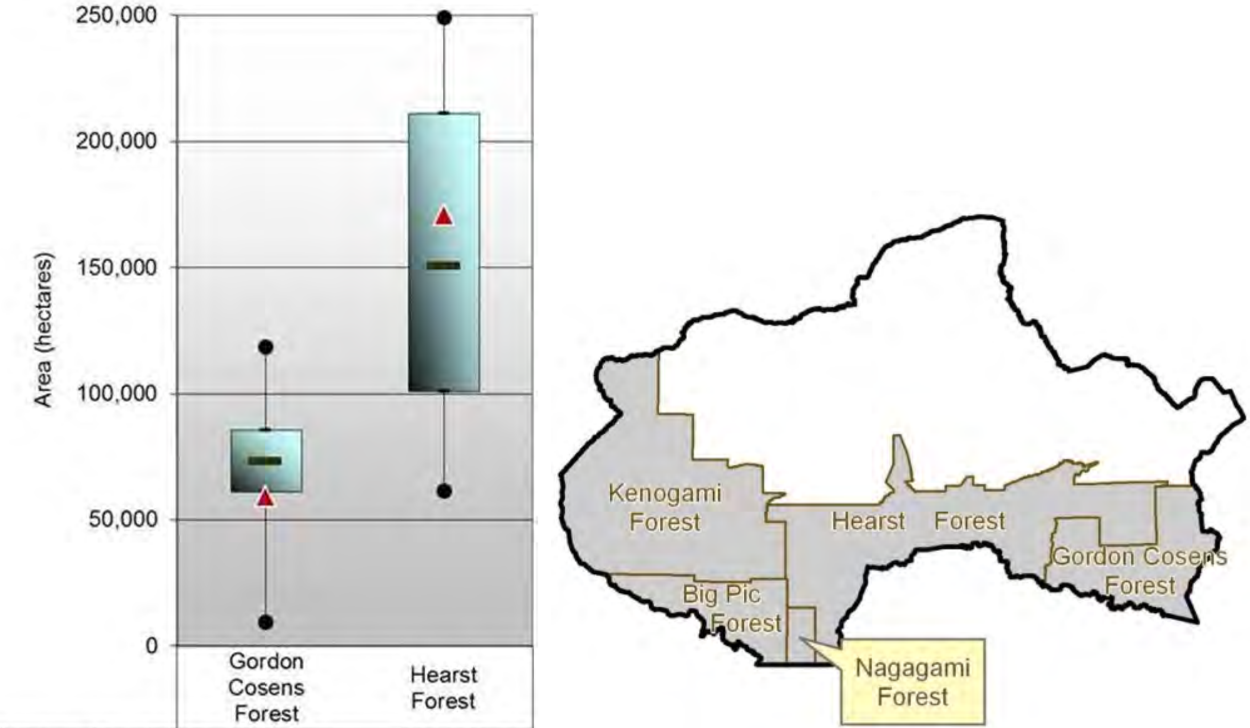


Figure 34. Box and whisker plot of caribou mature conifer and winter suitable habitat amounts in the eastern portion of Pagwachuan Range (clay-belt model) as compared to the SRNV.

In the eastern portion of the Pagwachuan Range, the current amount of mature conifer is below the lower quartile range in the Gordon Cosens Forest and above the median value of the SRNV in the Hearst Forest (Figure 35).



	Gordon Cosens Forest	Hearst Forest
– Lower Quartile	61,114	101,089
● Lower Range	9,296	61,437
– Median	72,962	150,565
● Upper Range	118,343	248,982
– Upper Quartile	85,338	211,001
▲ 2012	59,369	170,894

Figure 35. Box and whisker plot of mature conifer habitat amount for two Forest Management Units within the eastern portion of the Pagwachuan Range as compared to the SRNV.

The current amount of winter suitable habitat is below the lower quartile range in both the Gordon Cosens and the Hearst FMUs (Figure 36).

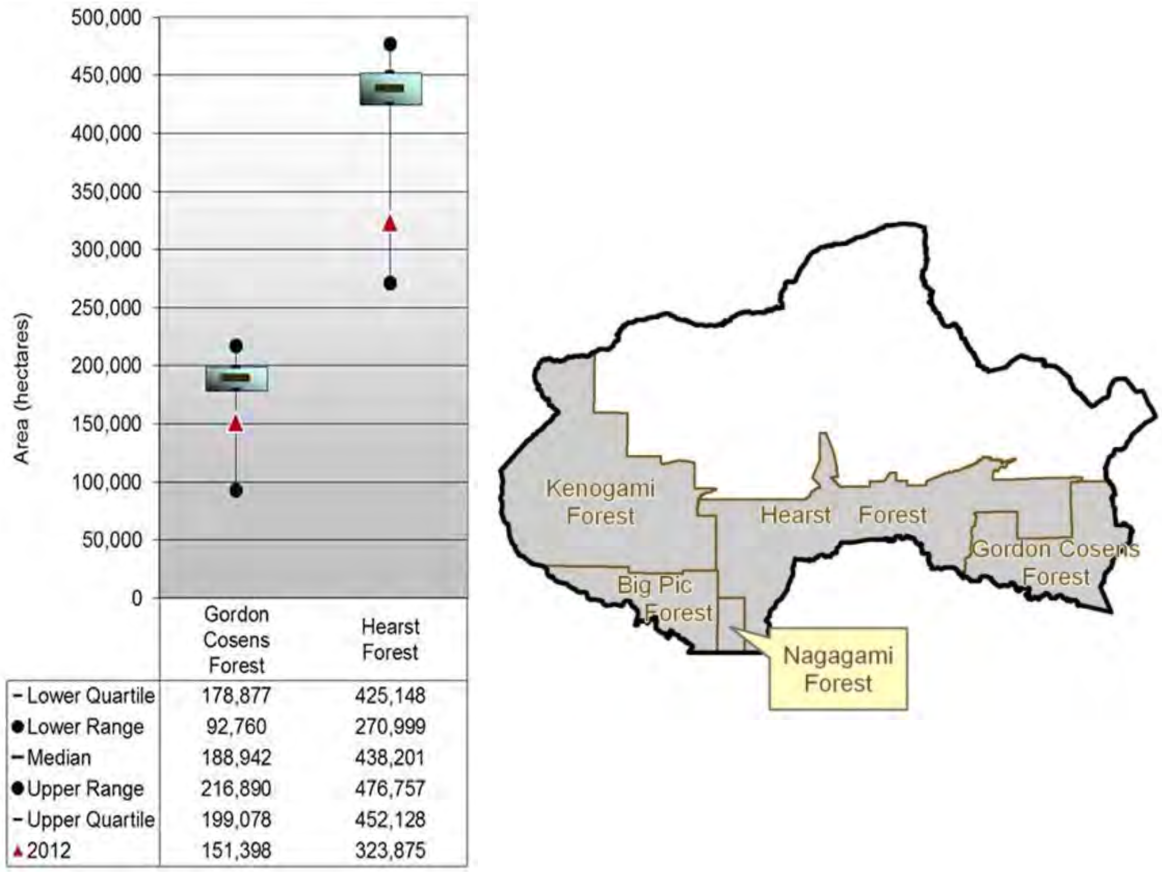


Figure 36. Box and whisker plot of winter suitable habitat amount for two Forest Management Units within the eastern portion of the Pagwachuan Range as compared to the SRNV.

5.2.6.2 Winter habitat arrangement

The arrangement analysis of winter habitat was conducted on the FRI portion of the western side of the range (conventional boreal model portion).

At the 6,000 hectare level, 43.7% (0.181 + 0.256 = 0.437) of the hexagons have 61% or more winter caribou habitat. The mean from the SRNV is greater with 78.9% (0.305 + 0.484 = 0.789) of the hexagons having more than 61% winter caribou habitat. This represents a present arrangement value 35.2% below the SRNV.

At the 30,000 hectare level, 38.2% (0.159 + 0.223 = 0.382) of the hexagons had 61% or more winter caribou habitat. The mean from the SRNV is greater with 82.7% (0.4+ 0.427 = 0.827) of the hexagons having more than 61% winter caribou habitat. This represents a present arrangement value 44.5% below the SRNV (Figure 37).
Currently, caribou winter habitat measured at the 6,000 and 30,000 ha levels are fragmented relative to our estimates of the natural landscape.

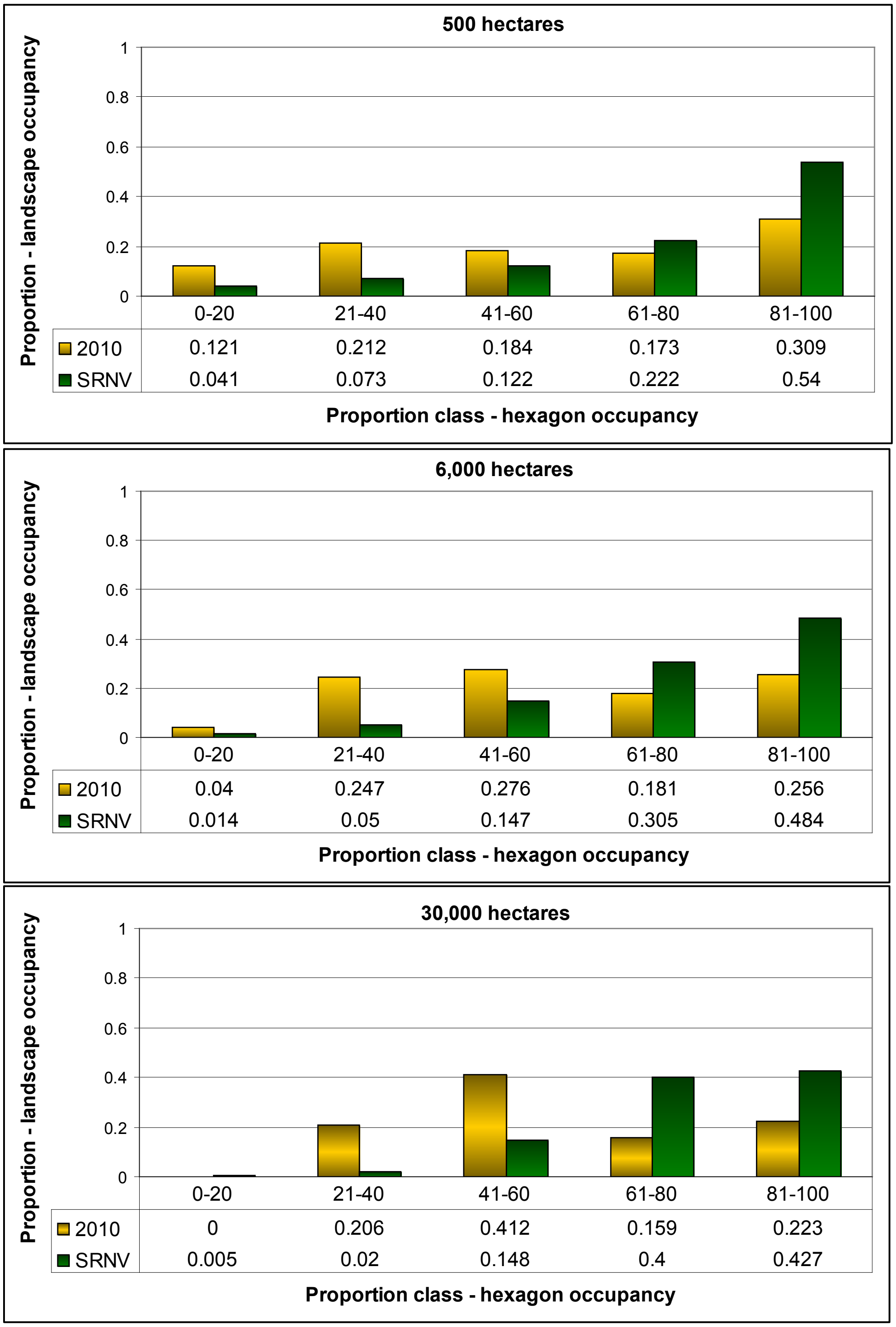


Figure 37. Caribou winter habitat texture histogram compared to means from the SRNV at the 500, 6,000, and 30,000 hectare levels for the Pagwachuan Range.

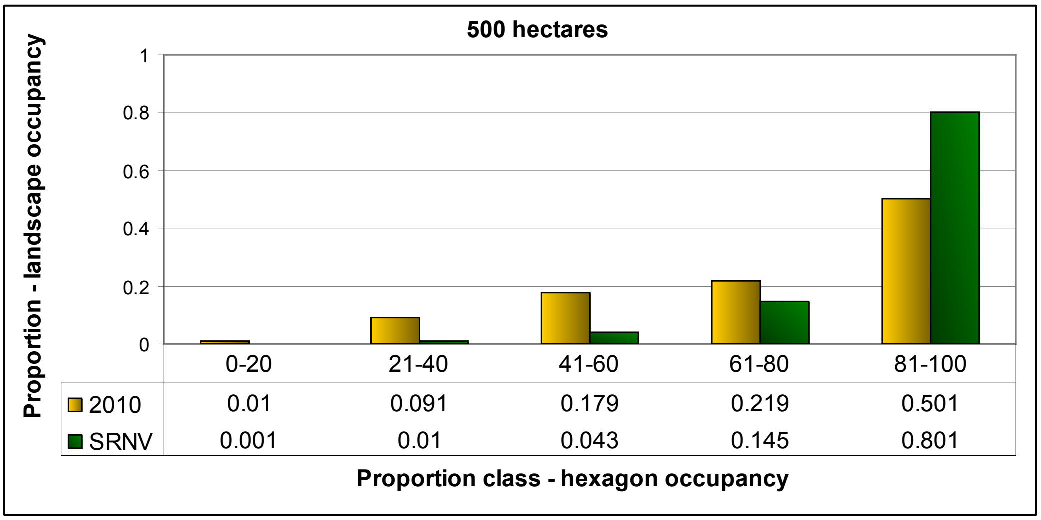
5.2.6.3 Refuge habitat arrangement

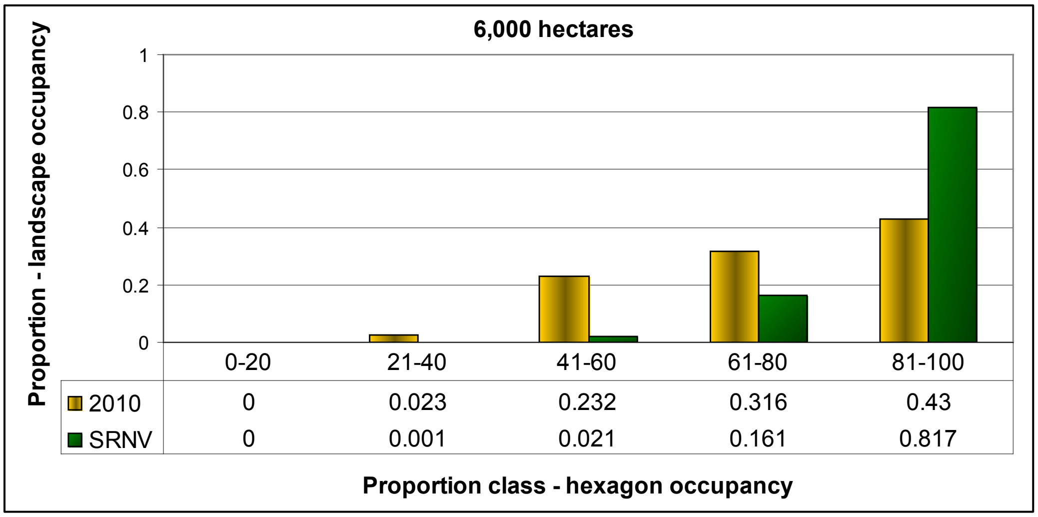
The arrangement analysis of refuge habitat was conducted on the FRI portion of the western side of the range (conventional boreal model portion).

At the 6,000 hectare level, 74.6% (0.316 + 0.43 = 0.746) of the hexagons have 61% or more refuge habitat (Figure 38). The mean from the SRNV is greater with 97.8% (0.161+ 0.817= 0.978) of the hexagons have 61% or more refuge habitat. This represents a present arrangement value 23.2% below the SRNV.

At the 30,000 hectare level, 77.0% (0.351 + 0.419 = 0.770) of the hexagons have 61% or more refuge habitat. The mean from the SRNV was greater with 99.6% (0.144 + 0.852 = 0.996) of the hexagons have 61% or more refuge habitat. This represents a present arrangement value 22.6% below the SRNV.

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





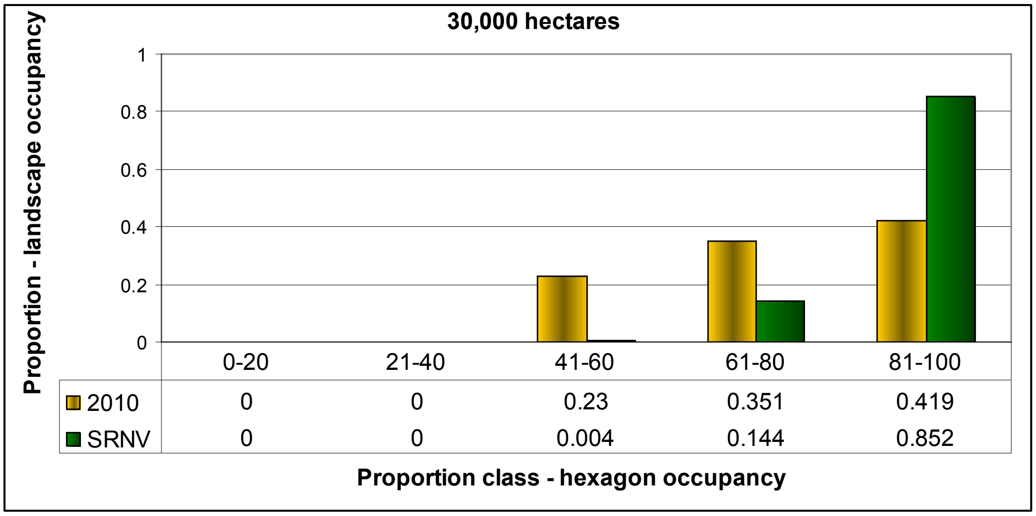


Figure 38. Caribou refuge habitat texture histogram compared to means from the SRNV at the 500, 6,000, and 30,000 hectare levels for the Pagwachuan Range.

5.2.6.4 Winter suitable habitat

The arrangement analysis of winter suitable habitat was conducted on the FRI portion of the eastern side of the range (clay-belt portion).

At the 6,000 hectare level, 35.7% (0.164 + 0.193 = 0.357) of the hexagons have 61% or more winter suitable habitat (Figure 39). The mean from the SRNV is greater with 59.7% (0.275 + 0.322 = 0.59.7) of the hexagons having 61% or more winter suitable habitat. Most of this difference occurs in the >75% proportion class. This represents a present arrangement value 24.0% below the SRNV.

At the 30,000 hectare level, 30.3% (0.15 + 0.153 = 0.303) of the hexagons have 61% or more winter suitable habitat. The mean from the simulations has 59.3% (0.37 + 0.223 = 0.593) of the hexagons have 61% or more winter suitable habitat. This represents a present arrangement value 29.0% below the SRNV.

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

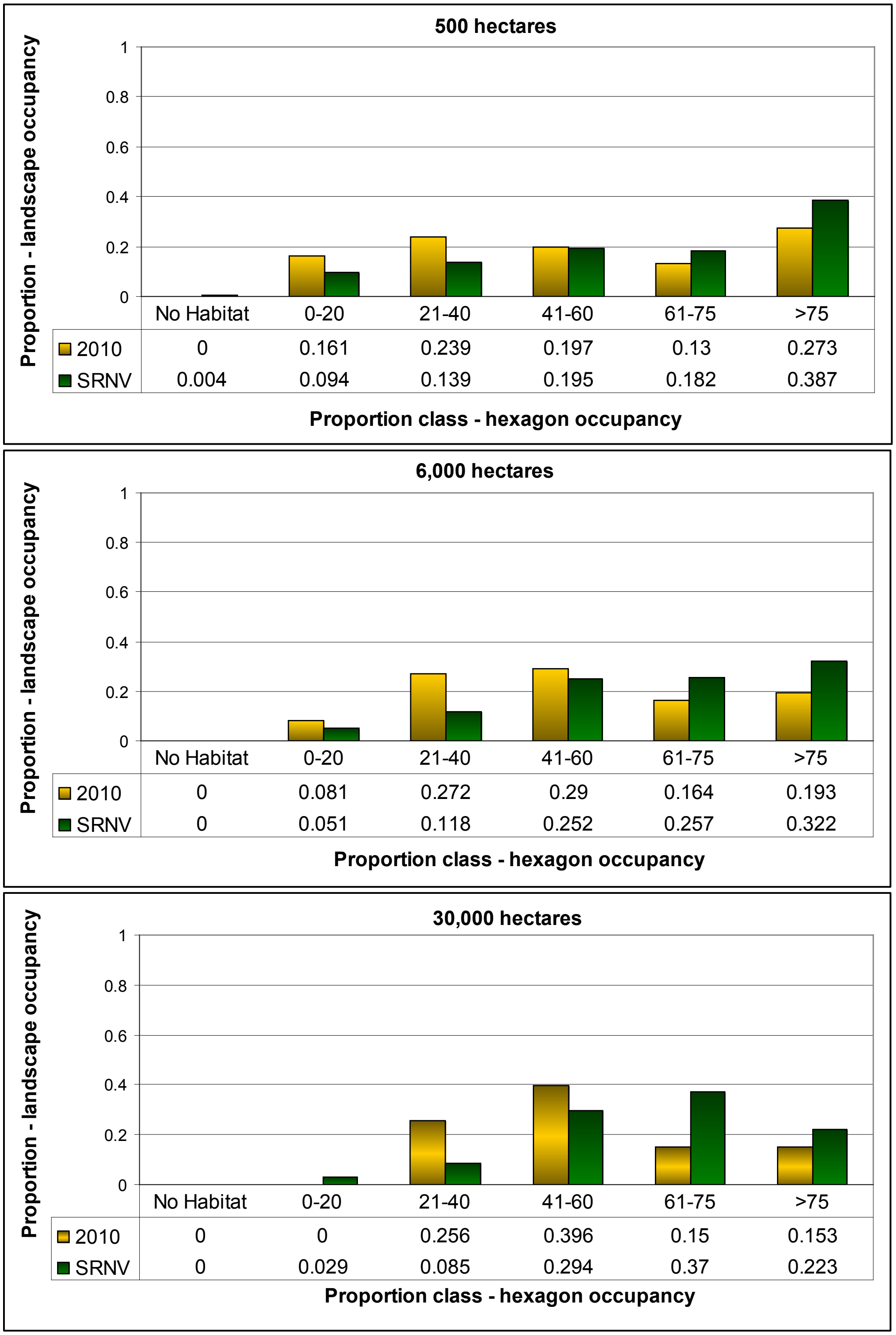


Figure 39. Caribou winter suitable habitat texture histogram compared to means from the SRNV at the 500, 6,000, and 30,000 hectare levels for the Pagwachuan Range.

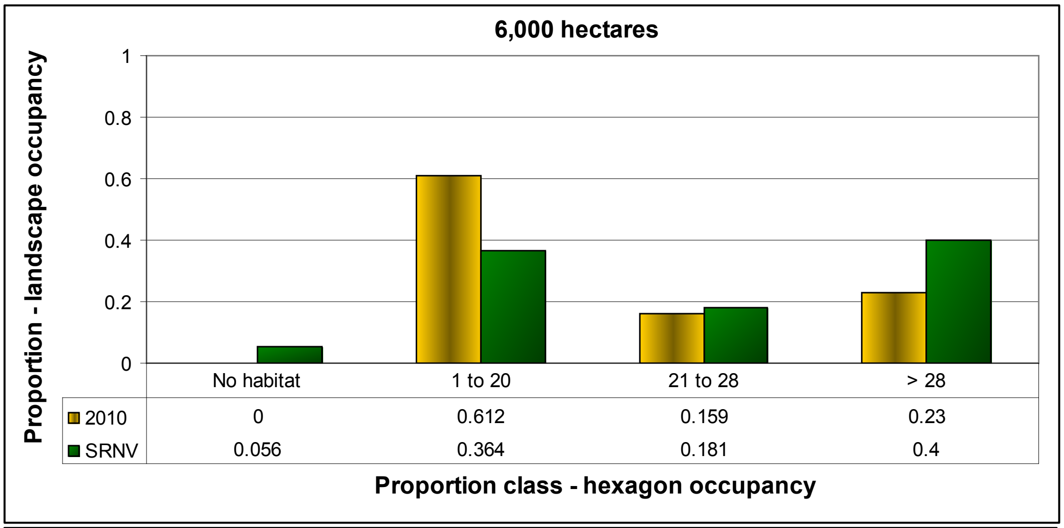
5.2.6.5 Mature conifer habitat arrangement

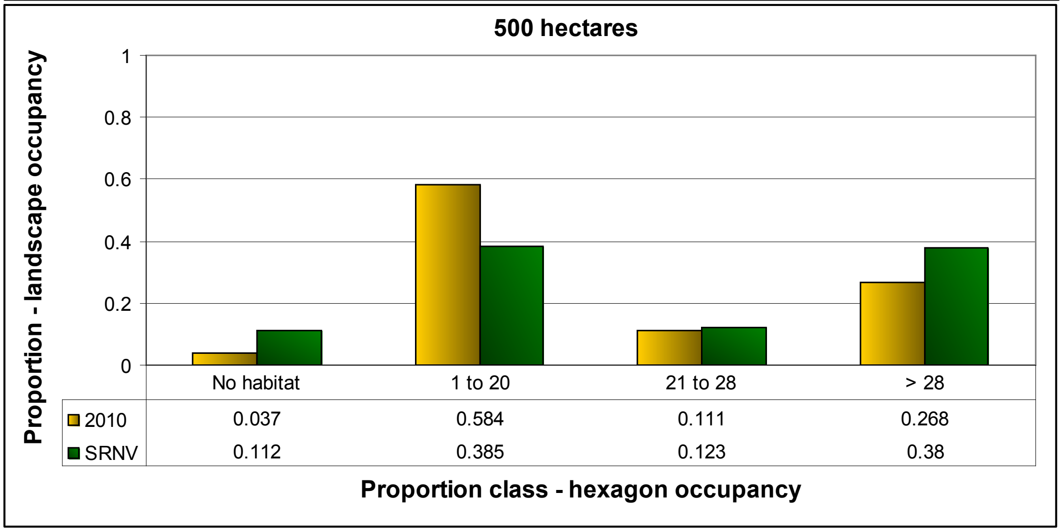
The arrangement analysis of mature conifer habitat was conducted on the FRI portion of the eastern side of the range (clay-belt portion).

At the 6,000 hectare level, 38.9% (0.159 + 0.23 = 0.389) of the hexagons have more than 21% mature conifer habitat (Figure 40). The mean from the SRNV is greater with 58.1% (0.181 + 0.4 = .0.581) of the hexagons having more than 21% mature conifer habitat. This represents a present arrangement value 19.2% below the SRNV.

At the 30,000 hectare level, 41.3% (0.214 + 0.199 = 0.413) of the hexagons have more than 21% mature conifer habitat. The mean from the SRNV is greater with 63.5% (0.237+ 0.398 = 0.635) of the hexagons having more than 21% winter caribou habitat. This represents a present arrangement value 22.2% below the SRNV.

Currently mature conifer habitat measured at the 6,000 and 30,000 ha level are fragmented relative to our estimates of the natural landscape.





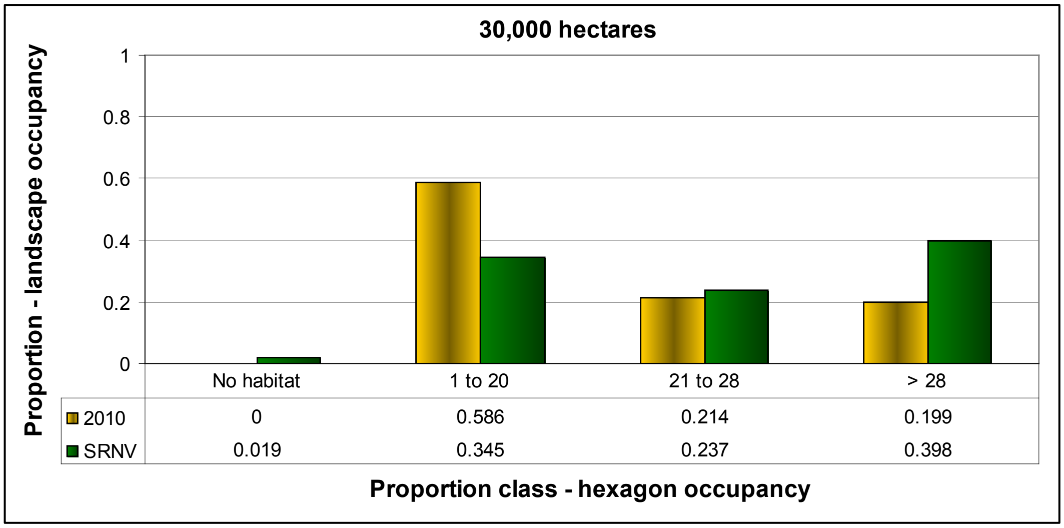
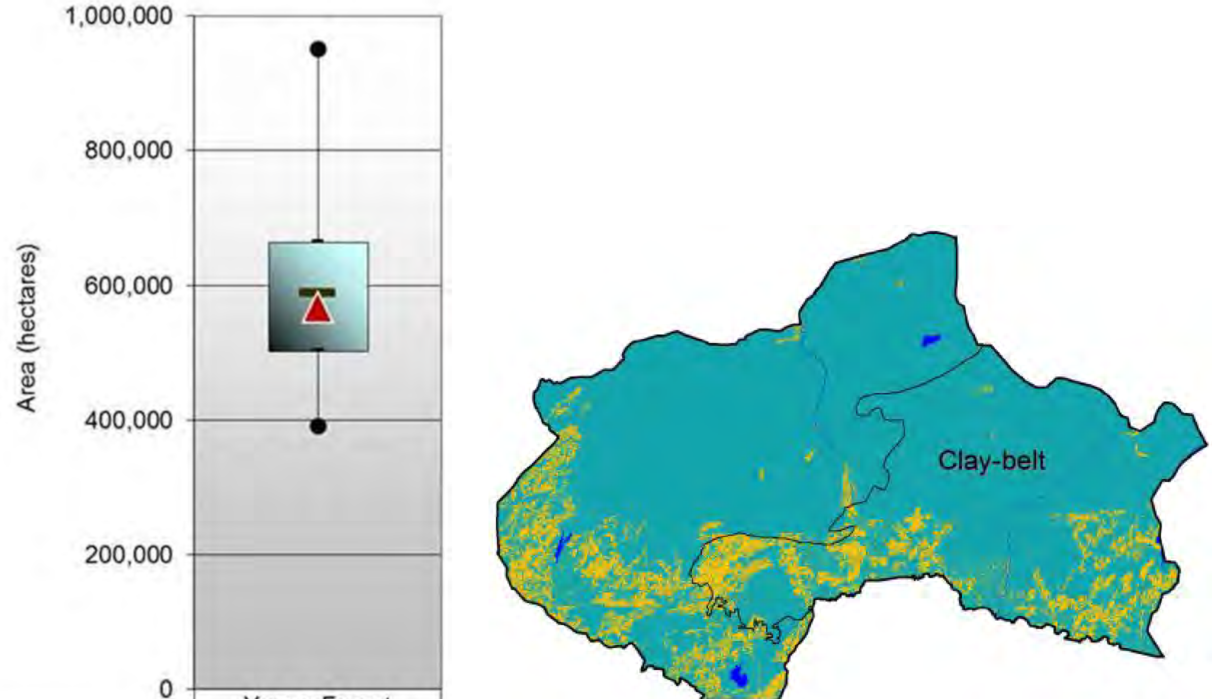


Figure 40. Caribou mature conifer habitat texture histogram compared to means from the SRNV at the 500, 6,000, and 30,000 hectare levels for the Pagwachuan Range.

5.2.6.6 Young forest SRNV area results

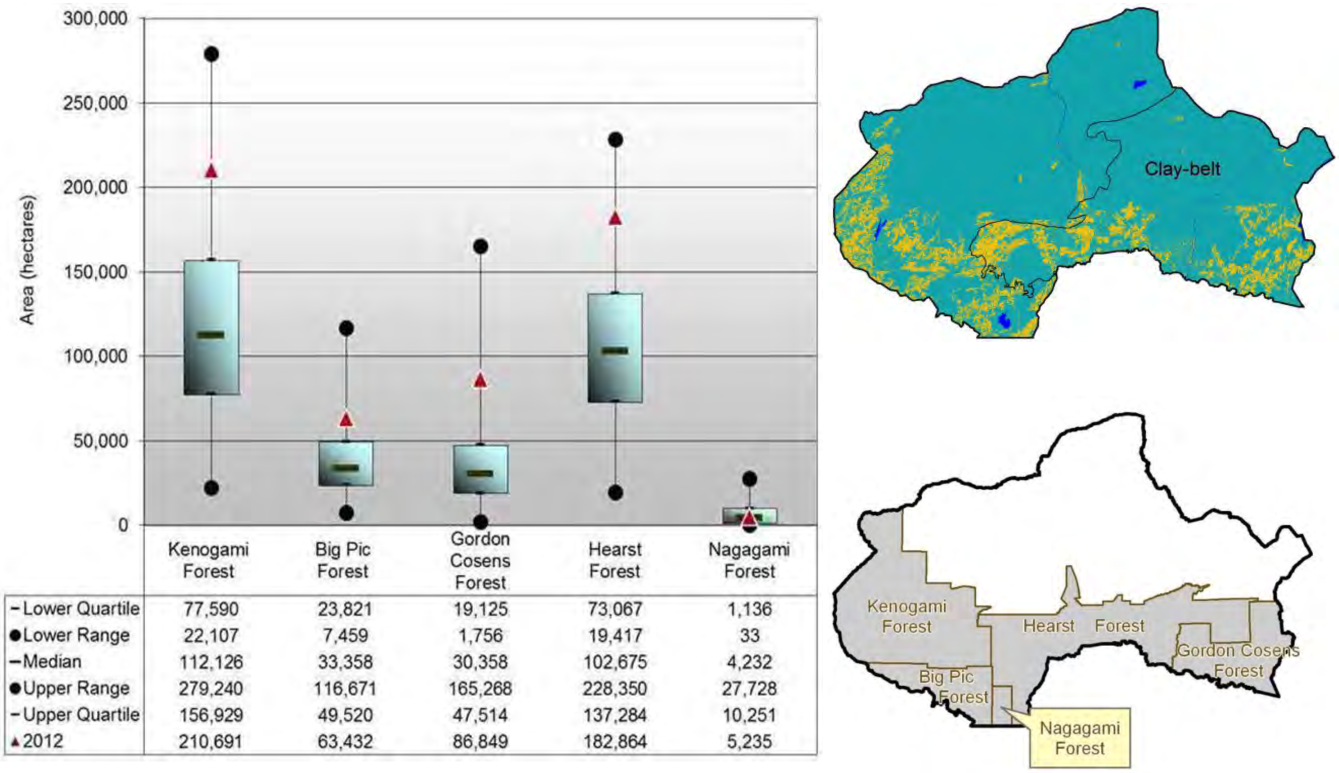
The current amount of young forest is within the interquartile estimated by the SRNV (Figure 41). This indicates that the current amount is about what would be expected in a natural system. Young forest includes all young forests regardless of origin and includes forest areas created by fire, forest 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.



	Young Forest
- Lower Quartile	502,833
● Lower Range	390,548
– Median	587,995
● Upper Range	951,508
- Upper Quartile	664,349
▲ 2012	567,813

Figure 41. Box and whisker plot of young forest (i.e. <36 years) and permanent disturbance in the Pagwachuan Range as compared to the SRNV.

Young forest is above the median or upper range in all of the FMUs in the Pagwachuan Range (Figure 42). Further increases in young forest by timber harvest or natural disturbance has the potential to push the amount of young forest above the median, thus contributing to range deterioration.



	Kenogami Forest	Big Pic Forest	Gordon Cosens Forest	Hearst Forest	Nagagami Forest
Lower Quartile	77,590	23,821	19,125	73,067	1,136
Lower Range	22,107	7,459	1,756	19,417	33
Median	112,126	33,358	30,358	102,675	4,232
Upper Range	279,240	116,671	165,268	228,350	27,728
Upper Quartile	156,929	49,520	47,514	137,284	10,251
2012	210,691	63,432	86,849	182,864	5,235

Figure 42. Box and whisker plots of young forest (i.e. <36 years) and permanent disturbance in the Forest Management Units within the Pagwachuan Range as compared to the SRNV.

6.0 Interpretation of Lines of Evidence

6.1 Interpretation of the population state

The minimum number of caribou occupying the Pagwachuan Range during winter 2011 was 164 based on the combined aerial surveys (Section 5.1.2). Considering that animals also travel in and out of the range and only a small portion of the total range area (assuming an observable strip width of 0.5 km from aircraft) was surveyed, the actual number of animals is likely much greater. Comparison of observations between the northern and southern portions of the range would suggest there are many more caribou in the northern portion of the range than the south where level of disturbance is greatest.

Current recruitment rates are variable (Table 8), with three of the five estimates being 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). However, during 2012 and 2013, recruitment was estimated to be 32.7 calves per 100 AF_{adj}, suggesting that recruitment potential in the Pagwachuan Range is good. During the first three years (2009-2011) estimates of adult female survival were good and ranged from 88%-92% (Table 9). However, mortality rates during the 2012 biological year were very high and resulted in an annual survival estimate of only 62%. The resulting average population growth rate (λ) was in decline (0.93), though largely driven by the low survival observed during 2012. The average population growth rate (λ) during 2009-2011 was 1.0 suggesting that the population was likely stable during these years, as long as the collared caribou represent an unbiased sample. Given that these results are based on caribou primarily occurring in the northern half of the range, caution is warranted to extend these results to caribou existing in southern portions of the range (i.e. Nagagami Lake area).

The probability of occupancy estimates were higher in northern portion of the range as compared to the south. The average range-wide probability of caribou occupancy without habitat covariates is moderate (0.42; ±0.12) 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.

Although there is evidence that caribou traverse the northern range boundary in both directions, the extent to which immigration and emigration contribute to population state in the Pagwachuan Range is unknown.

6.2 Interpretation of habitat state

Disturbance is heavily concentrated in the southern half of the Pagwachuan range and is primarily human-caused. The northern half of the range has considerably less disturbance, mostly because it is situated above the zone of current forest management (AOU) and because wildfires are less prevalent on the peatland dominated landscape.

The level of disturbance on the Pagwachuan Range is 31.0% (all waterbodies included). As a result, the likelihood of a stable-or-increasing population growth is uncertain, with a probability of 0.5 (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 Pagwachuan Range may be as great as 32.0% (all waterbodies excluded) which would lower the probability of persistence slightly to 0.45.

Collectively, there are a number of anthropogenic disturbance types not addressed in the above analyses such as 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 western portion of the Pagwachuan Range, the amount of winter habitat is currently below the interquartile range, whereas the refuge amount is well below the interquartile range of the SRNV. Increasing or maintaining the amount of mature conifer and winter suitable habitats throughout the Pagwachuan 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.

In the eastern portion of the Pagwachuan Range, the amount of mature conifer habitat is just below the median SRNV whereas the amount of winter suitable habitat is well below the lower quartile. Similar to habitat amount, creating and retaining strategically placed large contiguous patches of mature conifer and winter suitable habitat would create conditions that would have more commonly occurred in landscapes to which caribou have adapted.

In the western part of the Pagwachuan Range (boreal model), the arrangement of both winter and refuge habitats are fragmented compared to the SRNV at both the 6,000 and 30,000 ha scales. In the eastern part of the Pagwachuan Range (clay-belt boreal model), mature conifer and winter suitable habitats are also fragmented at both the 6,000 and 30,000 ha scales as compared to the SRNV.

At present, the amount of young forest (including permanent disturbances) within the Pagwachuan Range is below the median, but above the lower quartile of the SRNV. Retaining the amount of young forest within the interquartile range would create landscapes to which caribou adapted.

7.0 Integrated Risk Assessment

7.1 Population size

The minimum number of caribou on the Pagwachuan Range based on the MAC from the winter 2011 survey and two additional sources (Table 7) is 164 (Figure 43). The Pagwachuan Range is part of Continuous Distribution in Ontario, some immigration and emigration likely occurs. By using the minimum animal count of 164, estimates of probability of persistence are likely conservative. The probabilities of persistence for 20 and 50 years, under the assumption of a stable or increasing population, would be approximately 0.90 and 0.75, respectively (Figure 43) (MNRF 2014a; EC 2011).

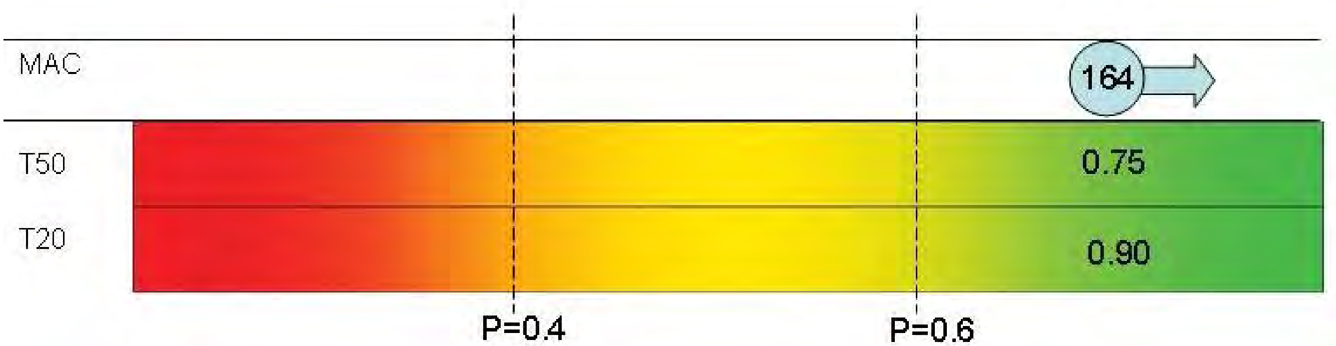


Figure 43. Minimum animal count (MAC) in the Pagwachuan Range estimated from the 2011 winter aerial survey as compared to probability of persistence in 20 years (T20) and 50 years (T50).

7.2 Population trend

The current estimate of trend, based on the 2009-2012 biological years, suggests the short-term population trend is likely stable to declining (λ = 0.94) (Figure 44). Uncertainty exists regarding this estimate because the survival estimate for 2012 was very low compared to the previous years (Table 9). Without the 2012 data, trend is stable (λ = 1.0). Future recruitment and survival estimates from collared adult females will continue to inform and support the population trend information.

Long-term trend indicators for the southern portion of the range (see Table 2) and local trend through time observations (i.e. Nagagami Lake and Longlac areas) suggest that populations in these areas are stable or declining. Considering the long and short-term trend, we conclude that current population trends may be declining under the environmental conditions that existed prior to 2012.

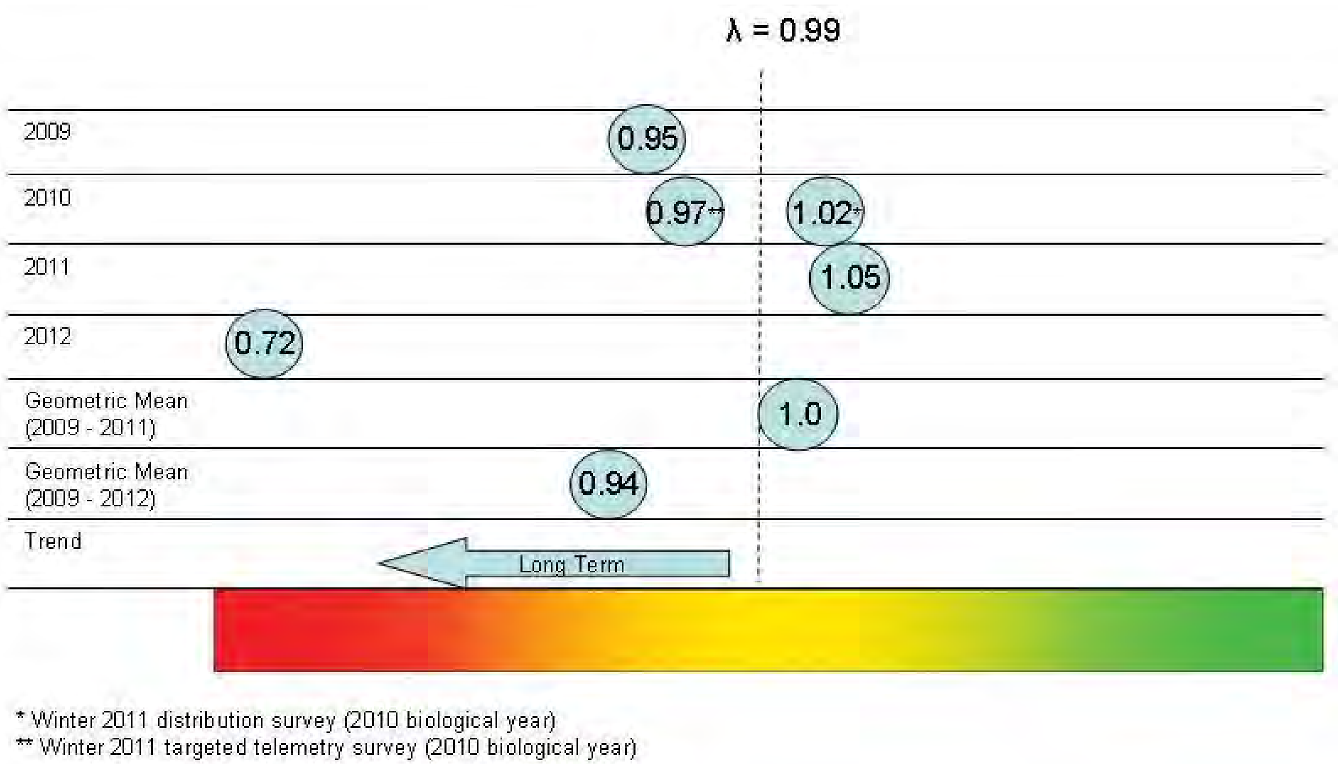


Figure 44. Estimated population trend (λ) for the Pagwachuan Range according to the source of the data (i.e. survey) and the corresponding biological year (not the survey year), as well as the short-term trend (geometric mean) and long-term trend as determined from other trend indicators.

7.3 Disturbance analysis

The Pagwachuan Range is 31.0% disturbed (Figure 45). Calculated values of disturbance range from 31.0-32.0%, 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 31.0% provides a realistic depiction of the amount of disturbance in the Pagwachuan Range. This level of disturbance would suggest that the likelihood of stable or increasing population growth is approximately 0.65 and is considered likely.

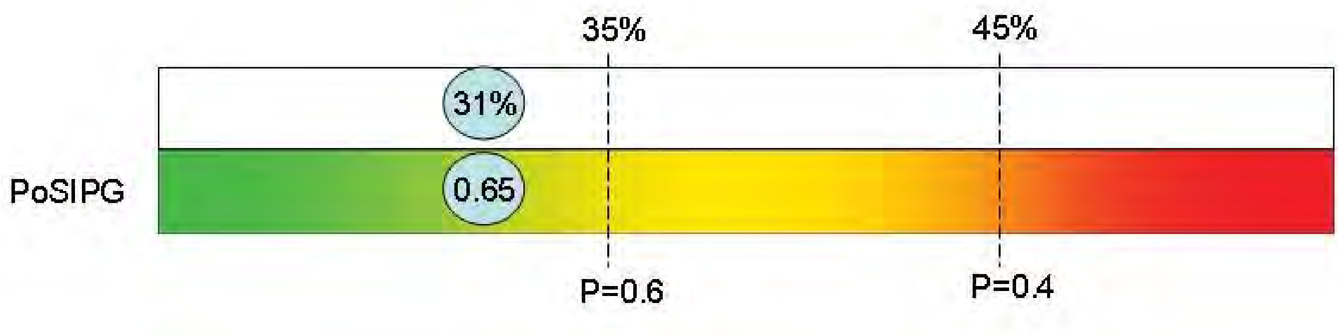


Figure 45. Disturbance estimate as a percentage of area within the Pagwachuan Range as it relates to the probability of stable or increasing population growth (PoSIPG).

7.4 Integrated risk assessment process

The six steps of the risk assessment process as identified in the Protocol (Figure 15 in MNRF 2014a) lead to a conclusion of the degree of risk.

Step 1: Lambda is less than 0.99 and likelihood of stable or increasing population growth is greater than 0.4; MAC is greater than 80.

Step 2: Lambda is available and is less than 0.99

Step 5: Likelihood of stable-or-increasing population growth based on the level of landscape disturbance is greater than 0.6; *AND* lambda is considered reliable; *AND* the population is not maintained by population management actions.

Step 6: Likelihood of stable-or-increasing population growth is greater than 0.4; *AND* the probability of persistence based on the MAC of 164 is greater than 0.6 (for T=20).

Based on this analysis, risk to caribou in the Pagwachuan Range is intermediate.

7.5 Range condition

Risk is estimated to be intermediate in the Pagwachuan Range. The amount of habitat is below the interquartile range and the 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 it is uncertain if the range condition is sufficient to sustain caribou.

8.0 Involvement of First Nation Communities

A presentation was made to Constance Lake First Nation (CLFN) in July 2010 to inform community members about the implementation of the Caribou Conservation Plan and its implications.

In August 2011, a presentation was made to chief and council members in attendance with updates on caribou work in the area. In January 2012, a meeting with CLFN was held to discuss the Integrated Range Assessment work.

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 the available information and specific methodologies used by EC (2011), it was determined that caribou occupying the Pagwachuan Range were likely self-sustaining. EC concluded that the Pagwachuan Range was 27% 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 164
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 2011 distribution survey collared caribou resulted in lambda calculations that suggest a 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 range condition, which was not considered by EC.

10.0 Literature cited

Bergerud, A.T., 1988. Caribou, wolves and man. *Trends in Ecology and Evolution* 3: 68-72.

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 J. P. Elliot, 1986. Dynamics of caribou and wolves in northern British Columbia. *Canadian Journal of Zoology* 64:1515-1529.

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.

Berglund, N.E., G.D. Racey, K.F. Abraham, G.S. Brown, B.A. Pond, and L.R. Walton. 2014. Woodland caribou (*Rangifer tarandus caribou*) in the Far North of Ontario: Background information in support of land use planning. DRAFT. Technical Report TR-147, Ministry of Natural Resources, Thunder Bay, Ontario. 160 pp.

Bowman, J., J.C. Ray, A.J. Magoun, D.S. Johnson, and F.N. Dawson. 2010. Roads, logging, and the large-mammal community of an eastern Canadian boreal forest. *Canadian Journal of Zoology*, 88:454-467.

Brodeur, V., J.-P. Ouellet, R. Courtois and D. Fortin. 2008. Habitat selection by black bears in an intensely logged boreal forest. *Canadian Journal of Zoology*, 86: 1307-1316.

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.

Brown, G.S., F.F. Mallory, and W.J Rettie. 2003. Range size and seasonal movement for female woodland caribou in the boreal forest of northeastern Ontario. *Rangifer*, Special Issue 14:227-233.

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.

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. Environment Canada. Ottawa, Ontario. 72 pp + Appendices

EC. 2011. Scientific Assessment to Inform the Identification of Critical Habitat for Woodland Caribou (Rangifer tarandus caribou), Boreal Population, in Canada*:* 2011 Update. Environment Canada, Ottawa, 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]. 2014. Lands Information Ontario Warehouse. Peterborough, Ontario: Ministry of Natural Resources and Forestry. Digital database.

Latham, A.D. and M.C. Latham, N.A. McCutchen, and S. Boutin. 2011. Invading white-tailed deer change wolf-caribou dynamics in northeastern Alberta. *Journal of Wildlife Management*, 75:204-212.

Latham, A.D. and M.C. Latham, and M.S. Boyce. 2011. Habitat selection and spatial relationships of black bears (*Ursus americanus*) with woodland caribou (*Rangifer tarandus caribou)* in northeastern Alberta. *Canadian Journal of Zoology*, 89:267-277.

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.

Messier, F. 1995. On the functional and numerical responses of wolves to changing prey density. Pages 187-198 *in* Carbyn,L.N., Fritts,S.H., Seip,D.R. editors. Ecology and conservation of wolves in a changing world. Canadian Circumpolar Institute.

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.

Mosnier, A., J.-P. Ouellet, and R. Courtois. 2008. Black bear adaptation to low productivity in the boreal forest. *Ecoscience*, 15:485-497.

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. 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. 11 pp.

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

OMNR. 2014. Forest Management Guide for Boreal Landscapes. Toronto: Queen's Printer of Ontario. 104 pp.

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.

Pinard,V., C. Dussault, J.-P. Ouellet, D. Fortin, and R. Courtois. 2012. Calving rate, calf survival rate, and habitat selection of forest-dwelling caribou in a highly managed landscape. *Journal of Wildlife Management*, 76:189-199.

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.

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., P. Drapeau, M.-H. St. Laurent, and L. Imbeau. 2012. Status of Woodland Caribou (*Rangifer tarandus caribou*) in the James Bay Region of Northern Quebec. Scientific report presented to the Ministère des Ressources naturelles et de la faune du Québec and the Grand Council of the Crees (Eeyou Istchee). Montreal, QC. 72 pp.

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.

Stratton, C. 2012. Far North Calibration Plot Sampling. Ring of Fire Summer 2010. File Report. Northwest Science and Information, Ontario Ministry of Natural Resources, Thunder Bay, Ontario. 56 pp + tables and maps.

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.