Recommendations for the Pasquia Porcupine Forest Management Area

March 2016

Prepared by:

Saskatchewan Regional Working Group
of the Canadian Boreal Forest Agreement (CBFA)

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ABOUT THE CBFA

The CBFA, which was signed in May 2010, includes six leading environmental organizations, the Forest Products Association of Canada, its 16 member companies, and Kruger Inc. It directly applies to more than 73 million hectares across the country, making it the world's largest conservation initiative.

The CBFA represents a globally significant precedent that seeks to conserve significant areas of Canada's vast boreal forest, protect threatened woodland caribou, and sustain a healthy forest sector by laying a foundation for the future prosperity of the industry and communities that rely on it.

Forestry companies currently participating in the Agreement:
Alberta Pacific Forest Industries Inc., AV Group, Canfor Pulp Limited Partnership, Canfor Corporation, Conifex, DMI, Fortress Paper Ltd., Howe Sound Pulp and Paper Corporation, Kruger Inc., LP Canada, Mercer International, Millar Western Forest Products Ltd., Resolute Forest Products, Tembec Inc., Tolko Industries, West Fraser Timber Co., Weyerhaeuser Company Ltd.

Environmental organizations participating in the Agreement:
Canadian Parks and Wilderness Society, ForestEthics, Ivey Foundation, the Nature Conservancy, the International Boreal Conservation Campaign, Schad Foundation.

The support of the Ivey, Pew and Hewlett Foundations, the Nature Conservancy, the Forest Products Association of Canada (FPAC), and Natural Resources Canada were essential to the negotiation and implementation of the agreement.

For further information on the CBFA, visit www.canadianborealforestagreement.com

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PREAMBLE

The Saskatchewan Regional Working Group (SK RWG) of the Canadian Boreal Forest Agreement (CBFA) is pleased to announce the development of a caribou habitat management plan for the Pasquia Porcupine Forest Management Area (PP FMA) in east central Saskatchewan. The caribou habitat management plan has been recommended to licensees Weyerhaeuser Company Ltd. and Edgewood Forest Products for inclusion in the Forest Management Plan for the FMA.

The SK RWG has also put forward a proposal for a new protected area centred on the Mossy River watershed in the Mid-Boreal Lowland to the northwest of Cumberland House. This recommendation, developed in discussions with the Northern Village of Cumberland House and the Cumberland House First Nation, is being forwarded to the Ministry of Environment for consideration.

Photo credit: Ervin Lungull

ACKNOWLEDGEMENTS

These recommendations have benefited from the involvement of individuals, organizations and governments, both formally and informally, throughout an extensive development process.

The Saskatchewan Regional Working Group would like to thank everyone that has generously contributed to the process with their insight, feedback and analyses. In particular, the members have appreciated the continued willingness of the Government of Saskatchewan and Aboriginal governments to meet and discuss the work undertaken by the Canadian Boreal Forest Agreement in Saskatchewan.

The traditional knowledge and hospitality shared by the elders, leadership and membership of Cumberland House Cree Nation, the Northern Village of Cumberland House, Peter Ballantyne Cree Nation, Red Earth Cree Nation, Shoal Lake Cree Nation, James Smith Cree Nation, Kinistin Saulteaux Nation, and Yellow Quill First Nation has been gracious and invaluable. Representatives of the Saskatchewan Ministry of Environment have also engaged with and advised the working group to help steer the process towards a constructive outcome.

The SK RWG would like to recognize the Forest Management Advisory Committee (FMAC) for facilitating stakeholder engagement in the development of these recommendations.

The following independent contractors provided their expertise and analysis that assisted in the development of these recommendations:

- Al Arsenault, AMEC Foster Wheeler
- David Baldwin, Spatial Works
- Mika Carriere, Prince Albert Model Forest
- Matt Hanneman, Global Forest Watch Canada
- Tom Moore, Spatial Planning Systems
- Erika Quiring, Canada North Consulting

Support for the SK RWG was provided by:

- Robin Freemont, Convening Facilitator
- Alex Grzybowski, Facilitator
- Chanda Hunnie, Coordinator
- Wynet Smith, CBFA Director of Integrated Planning
- Kim Lisgo and Pierre Vernier, Canadian BEACONS Project
- Aran O'Carroll, CBFA Executive Director

The members of the CBFA Saskatchewan Regional Working Group who contributed significantly to the development of these consensus recommendations are:

- Wendy Crosina, Weyerhaeuser
- John Daisley, Weyerhaeuser
- Chris Miller, Canadian Parks and Wilderness Society
- Gord Vaadeland, Canadian Parks and Wilderness Society – Saskatchewan Chapter
- Dave West, Michelle Young, Travis Kiel, Tolko Industries

EXECUTIVE SUMMARY

The Canadian Boreal Forest Agreement (CBFA) Saskatchewan Regional Working Group (SK RWG) has developed a caribou habitat plan for the Pasquia Porcupine Forest Management Area (PP FMA) and recommendations for a new protected area in the boreal forest adjacent to the PP FMA. The plan and protected area recommendations have been developed with provincial government, First Nation, Métis, community and stakeholder engagement. This collaborative process is not complete, and will continue with an emphasis on implementation.

The caribou plan consists of three new management zones – conservation, special management, and development – which together increase the sustainability of caribou, address the need for a caribou action plan that meets the requirements of the federal Species At Risk Act and maintains a timber supply that will support the forestry and milling operations that provide livelihoods for people in the communities in and around the PP FMA.

The Mossy River protected area recommendation is a globally significant area intersecting the largest inland delta in North America. Aboriginal and non-Aboriginal communities are involved and engagement with them will continue as the potential for a protected area is explored and considered.

Mossy River Watershed Photo credit: Garth Lenz/Canadian Geographic

The Lobstick Lake Representative Area Network (RAN) is also recommended for full protection to extend the management regime that is already in place as a result of Pasquia Porcupine Land Use Plan. Together with the existing protected areas and the conservation zones in the caribou plan a robust network of conservation lands is taking shape that will help to conserve the rich biodiversity of Saskatchewan and buffer climate change while also supporting the economy.

THE BOREAL

Canada's boreal forest stretches from Newfoundland and Labrador to the Yukon. It is an iconic Canadian landscape comprised of White and Black Spruce, Jack Pine, Tamarack, Balsam Fir, Balsam Poplar, White Birch, Trembling Aspen and deep peat deposits which together function as one of the world's largest carbon reservoirs.

The boreal forest is home to a rich variety of wildlife including wolves, black bear, moose, caribou, loons, eagles, wolverine, muskrat, martin and beaver along with numerous species of birds and fish.

Seagull Island on Cumberland Lake Photo credit: Garth Lenz/Canadian Geographic

Of equal importance are the 192 rural communities (census subdivisions) across Canada, including First Nations that are dependent on the forest industry. Half rely on it for at least 50 percent of their household income, while a quarter of residents are solely dependent on forestry. Hundreds of thousands of Canadians are employed, directly or indirectly, by the forest industry, with about 240,000 in the forest-products industry alone .

In Saskatchewan indications are that caribou populations have been negatively affected by habitat loss and degradation caused by various factors including forest fires, forest harvesting and mineral exploration. The creation of roads, trails and transmission lines appears to have resulted in both overhunting and an increase in predation.

In 2002 the Committee on the Status of Endangered Wildlife in Canada assessed the boreal population of woodland caribou as threatened and in 2003 the species was designated under the Federal Species at Risk Act (SARA). The obligation to recover this species is the shared responsibility of governments and all land-users in Saskatchewan and across Canada.

TAKING THE INITIATIVE

(Left to right: John Daisley, Weyerhaeuser. Fred Bradshaw, Government of Saskatchewan. Gary Carriere, Northern Village of Cumberland House. Photo credit: Garth Lenz/Canadian Geographic)

The Canadian Boreal Forest Agreement commits members of the Forest Products Association of Canada (FPAC) and participating Environmental Non-Government Organizations (ENGOs) to work with federal, provincial and Aboriginal governments and local communities across the Boreal to develop recommendations for the establishment of Protected Areas and Caribou Conservation Plans. The Saskatchewan Regional Working Group was established to fulfill this commitment for FPAC company tenures in Saskatchewan.

The SK RWG members, Weyerhaeuser and the Canadian Parks and Wilderness Society – Saskatchewan Chapter (CPAWS-SK) have reached agreement on recommendations for a Caribou Conservation Plan within the Pasquia Porcupine Forest Management Area and are committed to jointly advocate for the protection of a large new protected area in the Mossy River watershed and to support the full implementation of the Lobstick Lake RAN. These recommendations reflect the CBFA principle of concurrently achieving high degrees of ecological integrity and socio-economic prosperity in Canada's Boreal region and will make a significant contribution to conservation of the Boreal.

The CBFA Parties recognize that the legal responsibility and authority for land use decisions and for conservation and resource management policy rests with governments, and that successful implementation of many aspects of the CBFA requires the active support and endorsement by all governments including Aboriginal Governments and the support of a broad array of interests including communities.

Aerial view of the Mossy River watershed.
Photo credit: Garth Lenz/Canadian Geographic

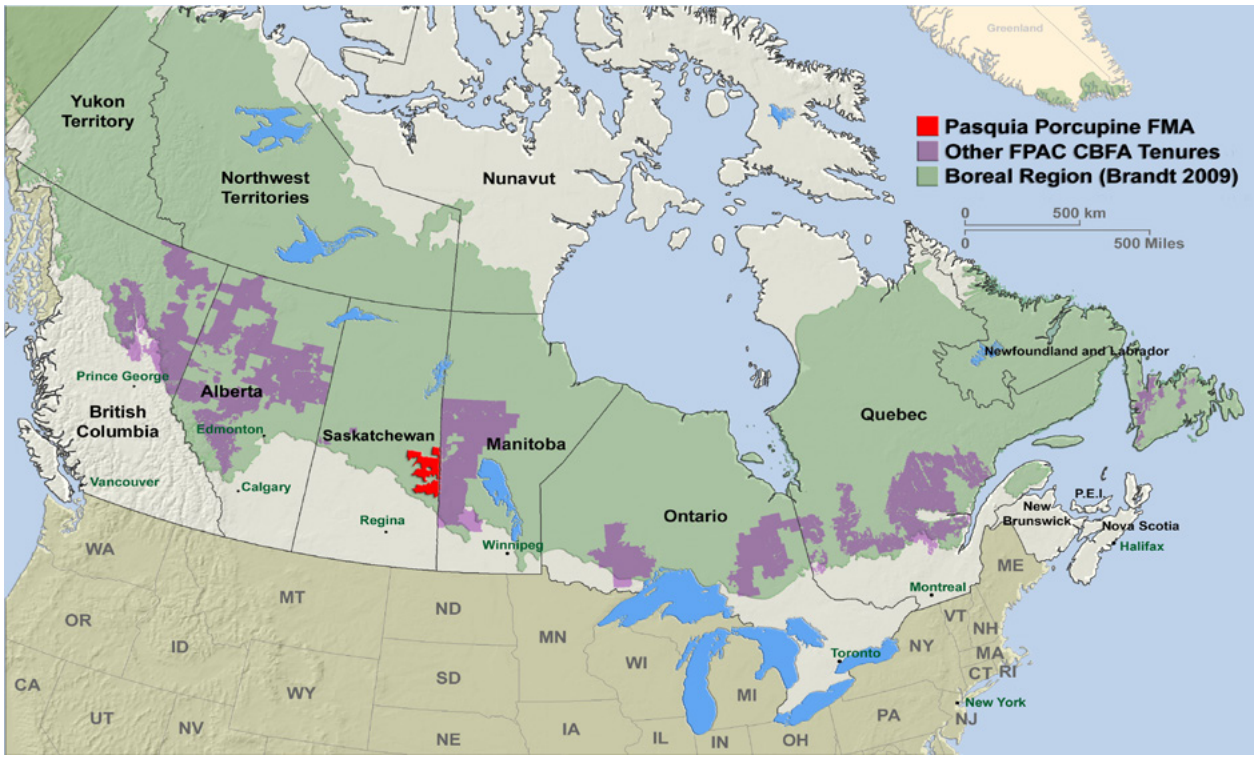
These recommendations are the product of four years of extensive analyses, and deliberations. The process has engaged Provincial and Aboriginal governments; First Nations, Métis and local communities, and stakeholder groups, as well as undertaken extensive professional expert investigation regarding the caribou populations, future timber supply and protected area options. These analyses demonstrate that it is possible to maintain a viable fibre supply on the PP FMA while conserving high value caribou habitat and improving the likelihood of caribou recovery. This meets the CBFA commitment to concurrently achieve high degrees of ecological integrity and socio-economic prosperity in Canada's Boreal region.

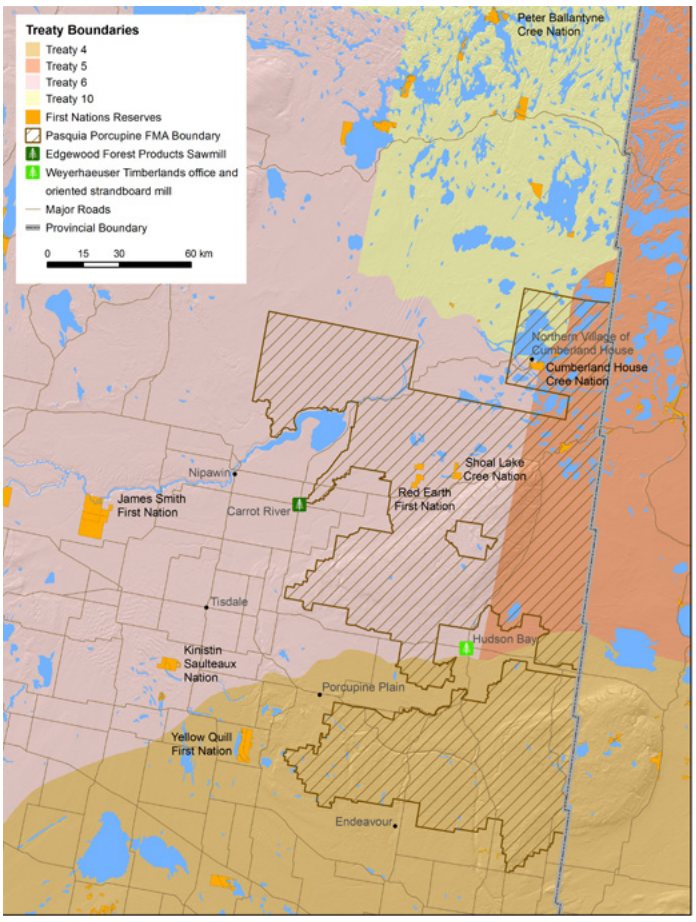
These recommendations will help achieve the provincial goal to sustain and enhance woodland caribou populations and maintain the ecosystems they require throughout their current range and also keep disturbance below the threshold recommended by Environment Canada's Boreal Woodland Caribou Recovery Strategy. They are also consistent with the Methodological Framework for Caribou Conservation Planning[1], the CBFA's guidance document for caribou conservation planning developed by the CBFA Science Committee.

1 Antoniuk, T., E. Dzus, and J. Nishi. 2015. A Methodological Framework for Caribou Action Planning in Support of the Canadian Boreal Forest Agreement: Iteration 2. Website: http://cbfa-efbc.ca/wp-content/uploads/2015/11/CBFACaribou_guidelinesIteration2_EN.pdf.

BACKGROUND

Map 1





Map 2

The Pasquia Porcupine Forest Management Area is approximately two million hectares in size and is located in the most southeasterly portion of the Northern Provincial Forest and the Porcupine Provincial Forest along the Saskatchewan-Manitoba border in Treaty territories 4, 5 and 6 **(See Map 1)**. It surrounds the communities of Hudson Bay, Red Earth First Nation, Shoal Lake Cree Nation, Cumberland House Cree Nation and the Northern Village of Cumberland House while the communities of James Smith First Nation, Kinistin Saulteaux Nation, Yellow Quill First Nation, Peter Ballantyne Cree Nation, Endeavour, Porcupine Plain, Nipawin, Carrot River and Tisdale are located adjacent to the FMA **(See Map 2)**.

Like most Boreal Forests, the PP FMA area consists nearly equally of forest and non-forested area. The non-forested areas are composed of wetlands and water. In addition to forestry, oil, gas, and mineral exploration are permitted in much of the PP FMA and those activities are expanding. This forest also provides for many recreational opportunities such as hunting, big game outfitting, fishing and snowmobiling, which are important activities in the region. Traditional uses within the PP FMA include hunting, fishing, gathering and trapping. Trapping occurs on all 18 Saskatchewan Fur Blocks on or overlapping the PP FMA area though is reduced from historical levels.

Weyerhaeuser Company Ltd. and Edgewood Forest Products jointly manage the PP FMA. Weyerhaeuser, a CBFA signatory, has invested in Saskatchewan since 1986 and operates a Timberlands office and an oriented strand board (OSB) mill in Hudson Bay that utilizes the hardwood harvest from the PP FMA. Edgewood Forest Products is responsible for the northern portion of the PP FMA and operates the Carrot River Sawmill which, utilizes the softwood harvested from the PP FMA. Although not a signatory to the CBFA, Edgewood has agreed to have the caribou conservation plan incorporated into the Twenty Year Forest Management Plan.

Hudson Bay OSB mill. Photo Credit: Ervin Lungull

The forestry sector provides a large portion of the employment and is one of the main economic drivers for the communities within and near-to the PP FMA. The 10-year regional economic profile indicates that Weyerhaeuser's forestry activities provided 6,739 person years of employment and contributed approximately $69,000,000 to timber dues, property taxes and the Forest Management Fund.[2] These jobs are important to these northern communities and are hard to replace. Protecting these jobs, sourcing a viable fibre supply and protecting the boreal forest are paramount to the CBFA signatories.

A regenerated aspen cutover

The forestry industry in Saskatchewan is recovering from economic and social challenges in recent years. All of the mills associated with the PP FMA experienced closures in 2007 and 2008 as a result of a worldwide recession. The Hudson Bay OSB mill has been idle since 2008.

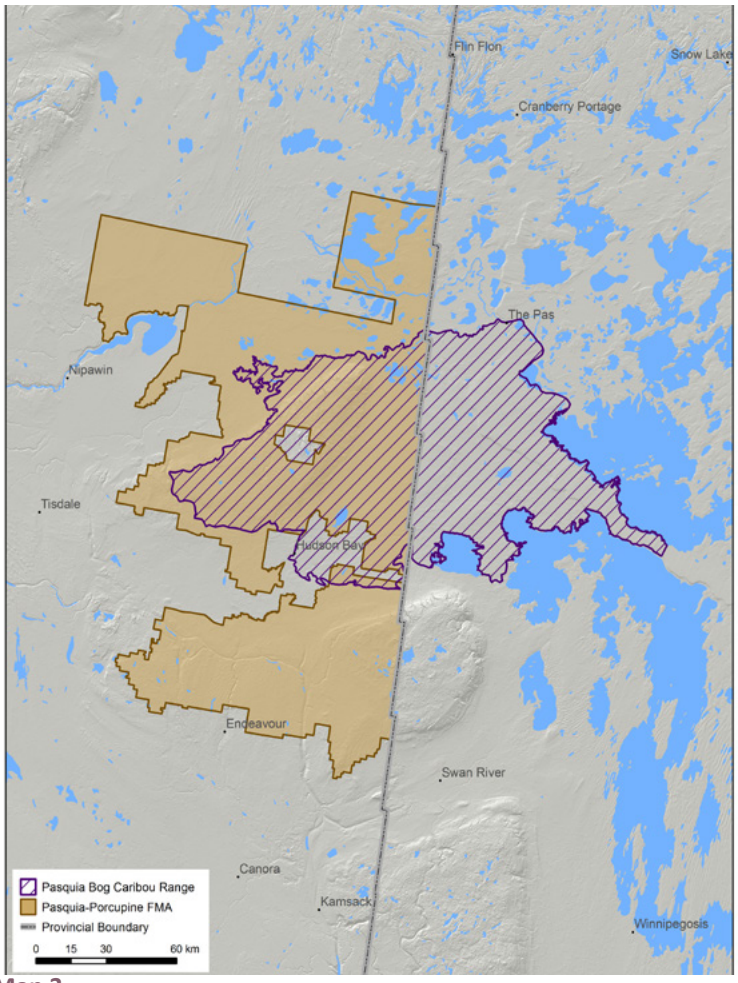
Woodland caribou populations in Canada are a serious conservation concern because of declining populations overall and their disappearance from the southern extents of their historical range. Occurring naturally at low densities, woodland caribou reproduce slowly and are therefore extremely sensitive to even minor changes in mortality rate.[3] They require specialized habitats of contiguous distribution. Human-caused habitat disturbance poses a direct threat to the sustainability of these populations.

In 2002 the Committee on the Status of Endangered Wildlife in Canada assessed the boreal population of woodland caribou as "threatened" and in 2003 the species was listed as "threatened" under the federal Species At Risk Act. Although recommended for designation as "threatened" provincially under the Wildlife Act in 2000, boreal woodland caribou have not yet been listed under Provincial laws. The Province does consider the southern Boreal Plain caribou local population at high risk of extirpation and the Boreal and Taiga Shield populations are deemed to be low or medium risk given their distance from human activities.[4] Together with the Federal SARA listing, these provincial priorities mandate action to ensure the survival of the caribou.

2 Volume I Background Information for 1999 to 2009 for the Renewal of the Pasquia-Porcupine Forest Management Area Twenty-Year Forest Management Plan, Weyerhaeuser. August 2009.

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

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



Map 3

The Bog herd is an interprovincial herd with a range of 12,640 km² that extends across Manitoba and Saskatchewan **(See Map 3)**. The Bog herd is estimated to be between 225-275 animals and is genetically linked to the North Interlake herd in Manitoba resulting in a combined population that is collectively above the federal recommended minimum viable population (MVP)[5]. It is estimated that 25 to 50 Bog herd caribou are present in Saskatchewan and the remainder occur in Manitoba[6]

As a Boreal Plain population located at the southern periphery of caribou range, these animals are more susceptible to environmental change and habitat degradation. Climate change predicts a northward shift or recession of geographic range for caribou that can result in compromised population growth, low survival of young and adults, low productivity, nutritional deficiency and poor genetic diversity because of low landscape connectivity and poor connectivity to other populations.

The Bog herd range is bounded by agricultural land to the northwest, west and southwest, by the Cumberland Delta to the north and by large water bodies (Cedar Lake/Reservoir and Lake Winnipegosis) to the east, which restricts their movement and opportunity for genetic exchange.

The Bog Herd occurs in the Boreal Plain Ecozone where caribou tend to be sedentary, do not move seasonally throughout the range, maintain fidelity to calving and rutting areas and where interactions between individuals occupying different peatland complexes is limited.

For these reasons, forest companies and environmental groups are working together as part of the CBFA to take action for the long-term recovery and survival of the woodland caribou while also providing for a viable fibre supply and protecting northern jobs all in the context of providing economic, social and ecological sustainability for present and future generations.

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5 Arsenault, A.A. 2014. Recommendations and Proposed Contributions Towards a Caribou Conservation Plan: Pasquia Bog Boreal Caribou Population. An AMEC Environment & Infrastructure report prepared for the Canadian Boreal Forest Agreement; and Ball, M.C, L. Finnegan, M. Manseau & P. Wilson. 2010. Integrating multiple analytical approaches to spatially delineate and characterize genetic population structure: an application to boreal caribou (Rangifer tarandus caribou) in central Canada. Conserv. Genetics 11: 2131-2143

6 Arsenault, A.A. 2003. Status and conservation management framework for woodland caribou (Rangifer tarandus caribou) in Saskatchewan. Saskatchewan Environment. Fish and Wildlife Technical Report 2003-03. 40 pp. Arsenault, A.A. 2014. Recommendations and Proposed Contributions Towards a Caribou Conservation Plan: Pasquia Bog Boreal Caribou Population. An AMEC Environment & Infrastructure report prepared for the Canadian Boreal Forest Agreement.

Caribou Habitat Management Plan

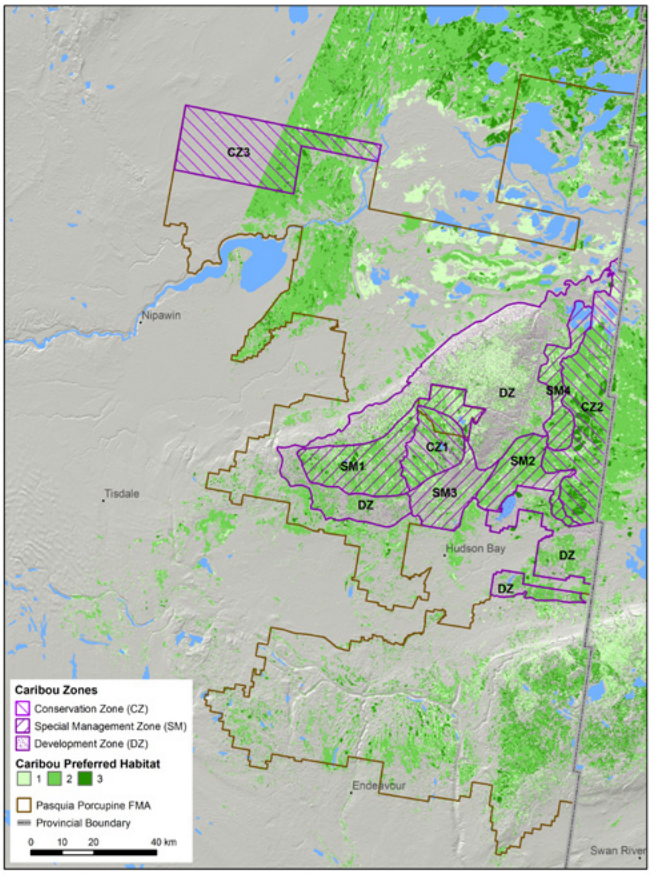
Recommendations for the Pasquia Bog Local Population

The RWG developed this Caribou Habitat Management Plan for the Pasquia-Bog as a substantial input to the formal PP FMA planning process, which was completed in September of 2015. The process had to account for the full range of interests on a technical level as well as those expressed through an Advisory Committee. The Forest Management Advisory Committee included representatives of First Nations whose territories overlap the PP FMA as well as various stakeholder groups with an interest in forest management on the FMA. The FMP planning process enabled the recommended caribou plan to be assessed within the broader context of the full range of forest values and interests. The results were full incorporation of the recommended caribou plan into the new Forest Management Plan for the PP FMA.

Forest Management Advisory Committee field trip.
Photo credit: Weyerhaeuser staff

The caribou plan utilizes a 3-zone approach **(see Map 4)** including:

1. Conservation zones in areas that are most important for caribou;
2. Special management zones where forestry practices are tailored to buffer conservation zones and provide connectivity between them; and,
3. Development zones with less significant caribou habitat where forestry will be more concentrated.



Map 4: Caribou Habitat 3-Zone Management Approach

Overall, the habitat disturbance within the caribou zone will be kept below the threshold recommended by Environment Canada (65% undisturbed). The projected disturbance area includes buffers that account for functional habitat loss adjacent to disturbance. These buffers will be defined using a regionally appropriate risk rating system developed by the SK RWG.

This zoning scheme provides enhanced protection for caribou while simultaneously supporting the timber harvesting that is necessary to support the mills and associated employment that depend on the forestry activity on the PP FMA. It is also consistent with the Methodological Framework for Caribou Conservation Planning developed for the CBFA by nationally recognized caribou experts. Information and guidance from the federal and provincial caribou recovery strategies, and relevant peer reviewed science were also utilized. **See Appendix A**.

The goal of CBFA caribou conservation planning is to maintain or enhance self-sustaining boreal caribou populations within the plan area, and is directly linked to the factors affecting their federal "at risk" designation. This is directly linked to CBFA Goal 2 of maintaining viable populations of native species in natural patterns of abundance and distribution across the Boreal landscape. We believe this goal meets the intent of Environment Canada's proposed long-term recovery objective for Boreal caribou, which is to achieve self-sustaining local populations throughout their distribution in Canada to the extent possible.[7] In addition, the recommendations contribute to the provincial goal to sustain and enhance woodland caribou populations and maintain the ecosystems they require, throughout their current range.[8]

Conservation Zones CZ1, CZ2, and CZ3

CZ1, CZ2 and CZ3 are zones where conservation is the priority. For the current 20-year management-planning horizon, no harvesting will occur in these deferral areas. Decisions on what happens in CZ1 and CZ2 beyond this 20-year period will be determined on the basis of the best available information and leading scientific principles for caribou management at that time. These zones include significant concentrations of best available habitat including lichen-rich open softwood peatlands and mature (>60 years) upland open jackpine with arboreal and terrestrial lichen, within a matrix of well-connected mature conifer-dominated forest cover. These habitats offer the critical functions of:

- Provision of habitat for predator avoidance, home range occupancy and persistence of caribou population sub-species.
- Redundancy in habitat availability to respond to local threats or disturbance (e.g. roads, fire).
- Seasonal abundance of forage resources.
- Connectivity to facilitate effective accessibility to preferred habitat patches.

These conservation zones are managed with a protection and conservation emphasis within the natural disturbance regime, to protect the ecological integrity of the high quality caribou habitat (lichen-rich treed peatlands, mature upland jackpine, calving habitat, winter habitat), and to maintain an adequate supply of this habitat at relevant spatial and temporal scales.

These conservation zones are connected to existing and proposed protected areas, contributing to a broader network of conservation area across and beyond the PP FMA. CZ1 is geographically connected to the Wildcat Hills Provincial Park and the Fir River RAN. CZ2 is geographically connected to the Overflow River RAN, the Pasquia RAN, the Nakuchi Lake RAN and the proposed Lobstick RAN. CZ3 is geographically located close to the Seeger Wheeler RAN and adjacent to the CBFA proposal for the Suggi/Mossy River Plain Protected Area.

Caribou habitat in Conservation Zone - CZ1

Special Management Zones SM1, SM2, SM4

These zones are intended to act as a disturbance buffer to ensure the integrity of the Conservation Zones. Planned harvest must consider buffering Conservation Zones to ensure the disturbance levels do not change within the Conservation Zones. The disturbance goal for SM2 and SM4 is to maintain less than 35% disturbance of caribou habitat over time. SM1 will be managed with an emphasis on habitat enhancement, harvest consolidation and research.

7 Environment Canada (EC). 2012. Recovery Strategy for the Woodland Caribou (Rangifer tarandus caribou), Boreal population, in Canada. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa

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

Harvesting within these zones will only take place during the winter months (December – March). New roads will be reclaimed as soon as possible after harvest. Old roads within harvest events will be reclaimed if agreement can be reached with other stakeholders and the Government of Saskatchewan approves. A 1000 metre Area of Concern will be applied to all known calving areas and an appropriate management prescription will be developed for those areas. These zones include habitat with the highest potential for active caribou habitat restoration activities.

Special Management Zone SM3

SM3 will be managed to provide connectivity between the Pasquia Bog and the Pasquia Hills. The boundaries of SM3 are based on the best available information and subsequent research may indicate that these boundaries need to change in order to effectively fulfill this connectivity function. This zone has been developed as a summer operating area and will continue as such. SM3 is also intended to act as a disturbance buffer for CZ1 which is adjacent to it. Planned harvest must consider buffering of CZ1 to ensure that the disturbance level within CZ1 does not change. In order that this zone can serve a connectivity function, preferred habitat in this zone will be buffered by 250 metres. The principle of providing "stepping stones" of habitat within this zone will be incorporated into development planning. In addition a 1000 metre Area of Concern will be applied to all known calving areas and an appropriate management prescription will be developed for those areas. This zone also includes habitat that has the highest potential for active caribou habitat restoration activities.

Development Zones

The development zones will have a higher level of disturbance due to the lower amount of caribou habitat they contain, and in order to make up for the reduction in harvest opportunity in the Conservation and Special Management Zones. The Provincial Natural Forest Pattern Standards will be applied within these zones and Best Management Practices for caribou habitat will be applied in areas proximate to other zone types.

Figure 1: Status and condition of the recommended three zones for caribou management for the Pasquia Bog local population within the Pasquia Porcupine FMA[9]

<table>
<tr><th>Conservation Zones: CZ1, CZ2</th><th>Special Management Zones: SM1, SM2, SM4</th><th>Development Zones</th></tr>
<tr><td>* Area: 130,307 ha
* Current level of disturbance: 21%
* Caribou preferred habitat and known caribou occupancy
* Consists of complexes of preferred habitat patches of lichen-rich open softwood peatlands and mature (>60 years) upland open jackpine with arboreal and terrestrial lichen, within a matrix of well connected mature conifer-dominated forest habitat</td><td>* Area: 136,701 ha
* Current level of disturbance: 22%
* Acts as a disturbance buffer to ensure the integrity of the Conservation Zones</td><td rowspan="3">* Area: 279.105 ha
* Current level of disturbance: 36.1%
* Designed to have a higher level of disturbance in order to make up for the reduction in harvest opportunity in the Conservation and Special Management Zones</td></tr>
<tr><th>Conservation Zone: CZ3</th><th>Special Management Zone: SM3</th></tr>
<tr><td>* Area: 92,378 ha
* Current level of disturbance: 3.7%
* Although no known caribou occupancy, the area consists of the same complexes of preferred habitat as CZ1 and CZ2
* Geographically adjacent to the CBFA proposed Mossy Plain/ Suggi Lowlands Protected Area</td><td>* Area: 36,021 ha
* Current level of disturbance: 63.8%
* Connectivity corridor between the Pasquia Bog and the Pasquia Hills based on best available information[10]
* Geographically borders CZ1 to act as a disturbance buffer</td></tr>
</table>

9 Subsequent research may indicate that these boundaries will change.

Analysis of the Pasquia Bog Caribou Plan

Assessing Timber Supply Impacts

Timber supply analysis was undertaken using a variety of zoning scenarios in order to achieve the best combination of caribou habitat conservation and timber supply management. The timber supply impacts associated with the recommended caribou habitat management plan for the softwood and hardwood timber supply is detailed in the following tables.

Figure 2: Hardwood harvest impacts of the caribou habitat management plan

Scenario Name	Hardwood harvest by period (m3/year)				
	Minimum periodic harvest	Maximum periodic harvest	Average		
			First 20 years	First 100 years	200 years
V4_Prot_Sc1EC_ RelaxDevZone	637,342	846,262	715,462	673,422	702,209

Figure 3: Sawlog harvest impacts of the caribou habitat management plan

Scenario Name	Sawlog harvest by period (m3/year)				
	Minimum periodic harvest	Maximum periodic harvest	Average		
			First 20 years	First 100 years	200 years
V4_Prot_Sc1EC_ RelaxDevZone	236,251	314,453	294,598	272,841	275,611

Mitigating Timber Supply Impacts

This Caribou Habitat Management Plan for the Pasquia-Bog is based on the CBFA twin pillars approach. The zoning scheme provides for enhanced/high probability of persistence of the Pasquia Bog in Saskatchewan while supporting a timber supply necessary to support the mills. Potential impacts on timber supply can be further mitigated by implementing the following jointly supported mitigation measures:

- Use of variable width buffers to compensate for the differences between the data used by Environment Canada and the more detailed local disturbance data. The Boreal Caribou Science Assessment by Environment Canada characterizes the footprint of industrial disturbance with a 500-m buffer and uses 2008-2010 Landsat imagery (1:50,000). The Saskatchewan Forest Vegetation Inventory (SFVI; 1:15,000) includes much more detailed and reliable disturbance information however some of the disturbances included would have been excluded by Environment Canada and do not warrant a 500m buffer. The SK RWG derived a regionally-appropriate variable width buffer scheme to apply using this detailed data that reduces the size of the buffered area based on type of impact and time since disturbance. The variable width buffers substantially mitigate the impact of the disturbance control measures in the Pasquia Bog caribou range. The SK RWG is working on adaptive management research to refine this approach to buffering in a manner that maintains the standard of risk management that is inherent in the Environment Canada approach.
- Criteria used in the Saskatchewan Natural Forest patterns (NFP) standard initially indicated old and very old forest was to be retained on the FMA – 10% required in the old class and 5% in the very old class. The SK RWG advocated for a change to the standard which resulted in the new requirement of 15% old and very old of which a minimum of 5% is to be very old.
- The SK RWG was also successful in achieving the grouping of eco-districts into five management units on the Pasquia Porcupine FMA down from eleven. These will be the units within which the old/very old forest requirements will be measured.

Because the Licensees have no management control over private land, agricultural lands were excluded from the CBFA plan and any recommendations made to Weyerhaeuser and Edgewood.

Assessing Impacts on Caribou Habitat

The SK RWG commissioned analyses of the future condition of the PP FMA portion of the Pasquia Bog range in parallel with the timber supply analyses based on the zoning scheme and timber supply scenarios outlined above. The table below outlines the scenario targets set for undisturbed area within the zones.

Figure 4: Caribou Zone Disturbance Scenario Targets

Scenario	Undisturbed area in caribou zone		
	Conservation Zone (CZ)	Special Management Zone (SMZ)	Development Zone (DZ)
Scenario 1	100%	80%	65%
Scenario 2	100%	65%	45%
Scenario 3	80%	65%	45%

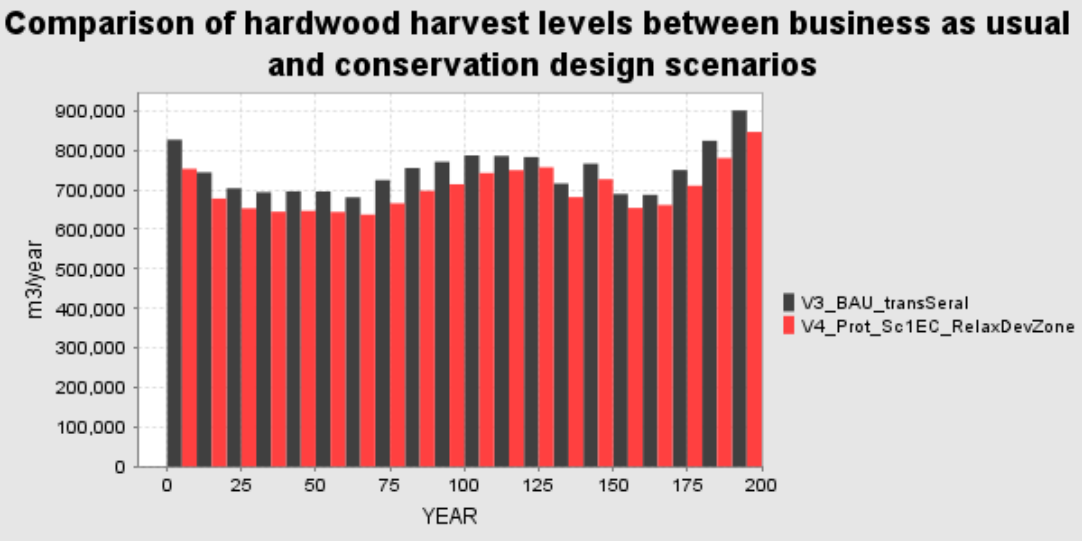
Information from these simulations came back to the RWG, who then adjusted the targets and zone distributions to achieve a balance between conservation gains and mitigation of timber supply impacts.

Ultimately the estimated impact of the proposed conservation program was within acceptable levels, as compared to the estimated base case.

GIS was used to summarize existing disturbance, as well as how the current disturbance would recover over the next 40 years. These summaries were calculated for each of the management planning zones. The disturbance estimates include historic fire and harvest (buffered) that is less than 40 years of age (years 1975 and later). In 10 years time the historic disturbance footprint would include the historic disturbance and buffers from 1985 and later. This was done for years 0, 10, 20 and 30 years in the future. At age 40 the historic disturbance would have recovered, and only future disturbance was assessed.

Once these baseline disturbances values were determined, they were combined with the disturbance limits in each zone to determine the amount of additional permitted future disturbance. This value would represent the additional disturbance that could be added to the historic disturbance, and still remain under the threshold value for the zone. These values were calculated for the additional cumulative disturbance allowed at years 0, 10, 20, 30 and 40+. In some cases the historic disturbance exceeded the threshold and no additional disturbance was permitted. In other cases the historic disturbance was low and did not limit harvest levels.

Figure 5: The relative wood supply projections of the SK RWG's recommended scenario versus the business as usual base case for a 3-zone approach to caribou conservation planning in the PP FMA portion of the Pasquia Bog range.



The Patchworks model was used to carry out these timber supply and disturbance analyses and depict the spatial distribution of disturbance and available timber and caribou habitat through time. This allowed explicit forecasts of the locations of the harvest and transportation activities required to implement any given scenario, as well as tracking the gradual rehabilitation of legacy disturbances.

Scenarios were assessed for their changing disturbance foot print over time in terms of the Environment Canada protocol. This assessment was used to confirm that not only were the overall disturbance threshold levels acceptable, but that high valued habitat was protected from disturbance to the greatest degree possible, according to the caribou conservation zone design.

See Appendix B

Traditional Ecological Knowledge

Traditional Knowledge

Widely acknowledged as a unique knowledge system, Traditional Knowledge (TK) can be defined as a collection of beliefs, observations, practices, arts, and wisdom derived from generations of close association with nature, and passed among individuals through story-telling, teaching and spirituality.[10] This information can be used by planners and decision-makers to ensure that relevant knowledge is represented in the ongoing management and conservation of caribou populations.

TK was gathered in the course of this work from participants considered to be key resource users and knowledge-holders in their communities. People who spend significant time on the land often possess a multi-generational understanding of a particular place and can provide valuable contributions to the knowledge of species such as woodland caribou including habitat, population, predators and sources of impacts, and how all these aspects have changed over time.

Two individual knowledge studies were conducted with multiple communities within and adjacent to the Pasquia Porcupine Forest Management Area. One included the Fur Block Conservation Area H-25, which comprises the communities of James Smith Cree Nation, Kinistin Saulteaux Nation, and Yellow Quill First Nation. Another had participation from the communities of Cumberland House Cree Nation, Métis Nation of Saskatchewan Eastern Region I, Red Earth First Nation and Shoal Lake Cree Nation.

Conclusions derived from the TK gathered indicate that caribou are historically not especially common in the Pasquia Porcupine FMA and have not been within the lifetime of any of the study participants. Caribou sightings are rare. While caribou are not considered to be an important source of food or traditional value to the residents of the communities, it is clear that viable populations of caribou, and all wildlife, is regarded as important.

Regardless of the prevalence of caribou in the PP FMA, the knowledge the community members possess can meaningfully contribute to conservation and management decisions affecting the PP FMA. The CBFA signatories have committed to using the best available information, including Indigenous traditional knowledge, in the development of their recommendations. Recognizing the distinct knowledge system represented by TK and the importance of engaging Indigenous knowledge-holders in land-use planning decision-making, the SK RWG chose to support Indigenous communities in east central Saskatchewan in recording their TK and providing it directly to the Province. The SK RWG believes that inclusion of indigenous knowledge systems as inputs into regulatory decision-making provides a more complete understanding of the species and enables Indigenous people to influence decisions that affect their community, culture and lifestyle. The SK RWG encourages the Province to fulfill its obligation to consult directly with these communities and engage their knowledge-holders regarding provincial caribou action planning. The TK collected for this project does not constitute either engagement or consultation.

10 Stevenson, M.G. 1996. Indigenous knowledge in environmental assessments. Arctic 49(3): 281.; Simeone, T. 2004. Indigenous Traditional Knowledge and Intellectual Property Rights. (PRB 03-38E). Parliamentary Research Branch, Library of Parliament, Ottawa.

Left to Right: Robert McAuly and Lennard Morin: Photo credit: Garth Lenz/Canadian Geographic

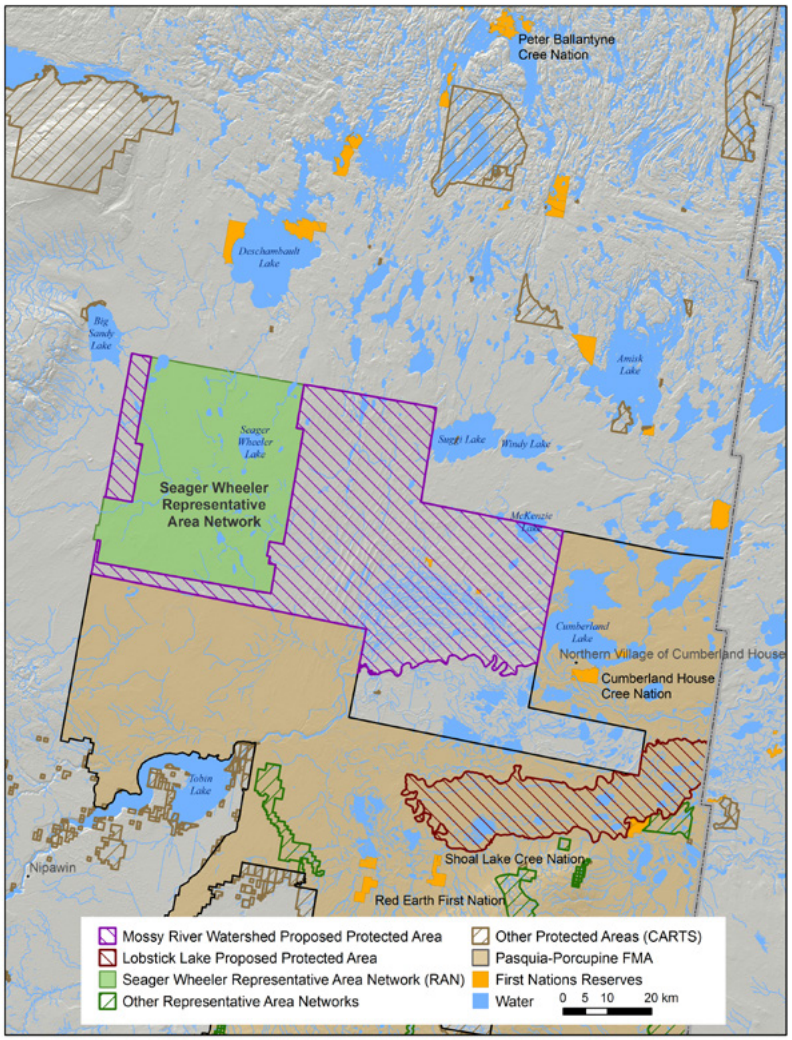
See Appendix C.

Protected Area Recommendations

The RWG Protected Area recommendations build on protected area planning processes previously undertaken by the Government of Saskatchewan and ecological benchmark analyses undertaken for the RWG within the relevant ecological zones. The RWG focused on protected area options in the vicinity of the PP FMA.

The SK RWG recommends that a new protected area be established centred on the Mossy River watershed (See Map 5). Establishment of this protected area will complement the Caribou Habitat Management Plan while also providing a significant contribution to the Saskatchewan protected area system in terms of representation of ecosystems. This protected area will contribute significant natural features to the provincial system as well as providing a benchmark for monitoring the evolution of ecosystems that are disturbed by resource development activity. The RWG has undertaken representation and benchmark analyses of the proposed Mossy River protected area, which are summarized in **Appendix D.**

The SK RWG also supports formalizing the status of the Lobstick Lake RAN area (**See Map 5**).



Map 5: Protected Areas Recommendations

Mossy River Protected Area

Supported by the conservation analysts of the Canadian BEACONS Project and guided by the *Methodological Framework for Protected Areas Planning in Support of the Canadian Boreal Forest Agreement*[11], a potential system-level benchmark was identified in the Mid-boreal Lowland Ecoregion that includes the Seager Wheeler Lake Representative Area Network.

Aerial view of the Mossy River Watershed. Photo credit: Garth Lenz/Canadian Geographic

The Mossy River system-level benchmark encompasses a portion of Cumberland Delta. It is a largely an intact forest landscape without significant industrial potential. Traditional hunting, trapping, fishing and gathering activities persist as important resource uses.

left to right: John Daisley, Weyerhaeuser. Gary Jr. Carriere, Northern Village of Cumberland House.
Photo credit: Garth Lenz/Canadian Geographic

11 Leroux, Shawn J. and Strittholt, James R. 2012. Methodological Framework for Protected Areas Planning in Support of the Canadian Boreal Forest Agreement. Website: http://cbfa-efbc.ca/wp-content/uploads/2014/12/CBFAProtectedAreas_guidelines_EN1.pdf

The SK RWG proposes the Mossy River watershed as a new protected area. This protected area would make a significant contribution to conservation values globally and locally, where the provincial analysis indicates the eco-region is under-represented. The RWG is committed to continuing to work with the provincial government and other area stakeholders to further develop and advocate for protection of the Mossy River area. Continued work on this file should be advanced through the appropriate provincial government processes and the RWG looks forward to participating and providing assistance where possible.

Lobstick Lake Protected Area

Part of the Cumberland Delta, the Lobstick Lake RAN, is a diverse complex of shallow lakes, meandering creeks, forested levees, shrub-dominated meadows, marsh wetlands and fen-bogs. A Manitoba maple forest grows along with tree species such as black spruce, white spruce, balsam poplar, white birch and trembling aspen. Representing 86,444 ha of important habitat for moose, furbearers and provincially rare birds in the Mid-boreal Lowland ecoregion, protecting Lobstick Lake would secure recreation wildlife and traditional use values.

The Lobstick Lake Protected Area was identified for protection in the 1990 Saskatchewan Parks System Plan to represent the Cumberland Lowlands. It was also defined as part of the Representative Area Network in the Pasquia Porcupine Integrated Forest Land Use Plan which was prepared by Saskatchewan Environment and Resource Management in 1998. Notwithstanding the recognition of the representative nature of Lobstick and the fact that industrial resource extraction has not been permitted the Lobstick area has yet to be designated as a Park or other type of Protected Area.

The SK RWG supports the Saskatchewan Government in the process to establish Lobstick Lake as a protected area including continued local stakeholder and First Nations engagement.

Representation and Benchmark Analysis of the Mossy River and the Lobstick

Forest management areas including the Pasquia-Porcupine FMA, Prince Albert FMA and Mee-Toos TSL surround the proposed Mossy River protected area. As a non-allocated region, it is in a favorable location for establishing an ecological benchmark without impacting the forest industry. To determine the benchmark potential of the Mossy River region, an assessment was conducted based on the benchmark characteristics of representation, intactness, and size.

In general, the proposed Suggi benchmark was most effective at representing the indicators of environmental variation at the scale of ecoregion 148 (Mid-Boreal Lowland). However, among individual land cover types, wetland-shrub and dense broadleaf and mixed wood forests were under-represented within the benchmark. Representation of climate moisture index is expected to decrease over time because of projected dryer conditions outside of the proposed benchmark, especially in the southern portion of the ecoregion.

The representation of existing and proposed protected areas (Lobstick RAN + proposed Suggi benchmark) was also assessed at the full extent of the SK planning region using a set of 16 conservation features. Twelve of the features were effectively represented within the protected areas, with the exception of enduring features, Cape May Warbler, Olive-sided Flycatcher and lake sturgeon. Representation of songbirds are projected to vary over time without any strong directional trends (see appendix X for more details).

left to right: Leonard McKenzie, Elder, Northern Village of Cumberland House; Gord Vaadeland, SK RWG, Canadian Parks and Wilderness Society; Aran O'Carroll, Executive Director, CBFA. Photo credit: Garth Lenz/Canadian Geographic

Conclusion

The Saskatchewan Regional Working Group has developed a caribou habitat plan for the Pasquia Bog caribou range within the Pasquia Porcupine Forest Management Area and has made recommendations regarding protected areas within and adjacent to the PP FMA.

The caribou plan features three management zone types (conservation, special and development) which will help recover caribou consistent with the National Recovery Strategy for Boreal Caribou. This approach is also consistent with the CBFA's Twin Pillars - the achievement of high degrees of both social and economic prosperity and ecological integrity – by maintaining viable and prosperous forestry operations that provide livelihoods for people in the communities in and around the PP FMA.

The proposal of a new protected area centered on the Mossy River watershed and the support for the Lobstick Lake RAN builds on the planning process previously undertaken by the Government of Saskatchewan.

Together with the caribou conservation plan, a robust network of conservation lands is taking shape that will help to conserve the rich biodiversity of Saskatchewan and buffer climate change while also supporting the economy.

The recommendations outlined herein are a specific package for caribou conservation and protected areas planning in and around the Pasquia Porcupine FMA in Saskatchewan and are not intended to create a precedent in other forests in Saskatchewan or Canada.

The CBFA signatories recognize that legal responsibility and authority for land use decisions and for conservation and resource management policy rests with governments, including Aboriginal governments, and that successful implementation will require the support of and/or actions by governments and the support of a broad array of interests. The SK RWG will continue to participate in a collaborative process that engages the provincial government, Indigenous peoples, communities and stakeholders.

Figure 6: Timeline of SK RWG Activities and Milestones

	Activity/Milestone
2013-2014	Secured background technical work on caribou management and protected area benchmark analysis; developed and analyzed scenarios; undertook Aboriginal community outreach and engagement of Government of Saskatchewan
Oct 2014	Reached provisional agreement subject to additional Aboriginal and Government of Saskatchewan outreach and review in the FMP process
Ongoing	Engagement of Aboriginal peoples, Forest Management Advisory Committee, and Government of Saskatchewan representatives
2015	Aboriginal communities supportive of a protected area in Mossy River Watershed
April 2016	FMP incorporates proposed caribou habitat zoning scheme - FMP approved
March 2016	Recommendations for protected area advanced to Government of Saskatchewan in tandem with strengthened Aboriginal community support

APPENDICES

APPENDIX A: PASQUIA-BOG CARIBOU CONSERVATION PLAN SUMMARY

The Canadian Boreal Forest Agreement (CBFA) contracted Al Arsenault of to conduct an assessment of the Pasquia-Bog area to characterize the caribou range using best available science and information. The process of developing a caribou conservation plan involves many steps. Initially, several guidance documents were reviewed to inform the development and structure of the caribou conservation plan. The next foundational step involved compiling relevant science literature and acquiring jurisdictional data and geobases. These data and information were then reviewed to assess utility of Best Available Information, and included a gap analysis. The next stage involved assessing and consolidating the current state of knowledge of the Pasquia-Bog Caribou Range. Using this information, a three zone land management system was applied to the planning area, which was systematically tested and assessed though an iterative process to optimize the best configuration of zones to ensure a balance of sustainable habitat supply for long-term caribou persistence and land use, by manipulation of allowable disturbance levels by zone type and configuration.

Planning Area Defined

The Pasquia-Bog boreal caribou (Rangifer tarandus caribou) population range straddles the Saskatchewan-Manitoba provincial border. Although the National Boreal Caribou Recovery Strategy portrays the Pasquia-Bog range as two separate caribou ranges: a portion of the Boreal Plain Range (SK2) and The Bog (MB1) – they are in fact the same caribou population based on genetics and distribution. Defining the planning area involved delineating the range boundary in an ecological context (using the ecodistricts described by the Ecological Framework for Canada), a population context (using jurisdictional range plans, caribou range occupancy data and published local studies, including genetic relatedness), and a habitat context (using landscape configuration and caribou habitat preference). Within the Saskatchewan portion of the caribou range, the Area of Implementation (AOI) is the Pasquia Porcupine FMA.

Caribou Habitat Preference Model

A caribou habitat preference model was constructed using the Ducks Unlimited Enhanced Wetland Coverage (EWC). This 30m resolution geobase coverage is derived from LandSat imagery that is analyst interpreted and extensively ground-truthed to ensure accuracy. Two ecosite classifications (Beckingham et al. 1996, McLaughlan et al. 2010) were assessed for caribou habitat preference based on value as forage, mortality-risk and refuge. The ecosite habitat preference assessment was then compared to results from jurisdictional workshops that undertook a similar exercise yielding identical results. The ecosite preference ratings were then reconciled with the covertypes in the EWC. The resulting fine scale EWC habitat preference model was then compared with results from a federal pan-boreal habitat assessment coarse scale resource selection function model. There was significant correspondence between both models, and therefore provided validation of the EWC habitat preference model. Population range occupancy data was then overlaid on the EWC habitat preference model, which provided further validation of model accuracy.

Current Population Status

The Pasquia-Bog local population status was determined using population abundance estimates and minimum viable population analysis from guidance documents and jurisdictional data sources, including the relationship with adjacent populations from recent genetic study. The Pasquia-Bog population was estimated to be 225-275 caribou (0.030 – 0.037 caribou/km2), which is below the federal recommended minimum viable population (MVP) threshold of 300. However, there is a close genetic relationship with the North Interlake population (180 caribou; also below a MVP level). The combined population of both ranges collectively is above the MVP.

Disturbance – Existing and Future

Landscape disturbance data (natural and anthropogenic) was acquired from Environment Canada. The data set was supplemented with recent natural disturbance data from the National Fire Database, and local disturbance data from the forest industry operating in the Pasquia-Porcupine FMA, to determine current extent and distribution of both natural and human disturbance across the planning area (AOA) relative to preferred caribou habitat and occupied range. Current land use and potential future disturbance within the planning area were determined from several provincial geobases

that provide information on protected areas and the distribution of principle land use occupants and interests (i.e. forest industry, peat mining, mineral exploration claims and dispositions, First Nations communities, recreational cabin leases, local communities, and utility and transportation corridors).

The Pasquia-Bog Caribou Range (AOA) totals 12,640 km² in spatial extent. Based on the known existing disturbance level (as of 2014), there are 3,342 km² of anthropogenic disturbance (i.e. includes a 500 m buffer around linear disturbance) overlapping with 1,088 km² of natural disturbance (i.e. wildfires) resulting in a cumulative total disturbance of 3,514 km² (27.8% disturbed). Based on the Environment Canada (2012) disturbance threshold model, this level of current disturbance equates to a 70% probability of caribou persistence.

Land Management System

Collectively, the resulting Best Available Data, the analysis of Current State of Knowledge for the planning area, and the caribou habitat preference model were used to inform delineation of a land management system using a disturbance threshold approach. A land management system consisting of three zone types was proposed, with varying levels of recommended maximum allowable disturbance (zone management strategies):

1. Caribou Conservation Zones (CZ) have a caribou conservation emphasis. This zone type represents the "minimum functional" habitat area required. It is characterized by an effective configuration and connectivity of high quality preferred habitat patches, with minimal disturbance, to sustain the caribou population at its current abundance and distribution within the Pasquia-Bog Caribou Range (AOA). Recommended disturbance levels are minimized to <15% for this land base, with no individual CZ exceeding 35% disturbance.

2. Development Zones (DZ) have an ecologically sustainable economic emphasis. Overall, each DZ would be managed in an environmentally sustainable way, with caribou conservation considerations applied through BMPs only in larger caribou habitat patches contiguous with the other zone types. The disturbance threshold within this zone type would not exceed 40% disturbance.

3. Special Management Zones (SM) are restricted development buffers intended to spatially buffer core caribou habitat (CZs) from development zone (DZ) areas, or function as movement corridors between CZs, ensuring landscape connectivity. They have a relatively higher proportion of preferred caribou habitat relative to DZs but have relatively lower use by caribou as a consequence of proximity to anthropogenic disturbance occurring within the SM and adjacent DZ. Disturbance thresholds for this zone type would not exceed 35% (all disturbance types pooled), with no human disturbance exceeding 25% (all SMs pooled), with no human disturbance to exceed 30% within any individual SM (exception is SM3), and avoidance of large patches of preferred caribou habitat types in SM3 (including a 250m disturbance buffer).

Test and Assess

Caribou conservation requires land management strategies that maintain caribou habitat, favour structural and functional habitat connectivity, and support sustainable caribou populations. Analyses were conducted based on relative disturbance threshold levels within each zone type to test and assess the effect of manipulating disturbance levels by zone type on the probability of persistence of caribou, using the federal disturbance threshold model. Through an iterative process, scenarios of low disturbance, current state, and high disturbance were tested each time zone boundaries were altered, until the optimal zonation boundaries were achieved to maximize probability of caribou persistence and minimize effects on timber supply. This provided an understanding of how altering disturbance levels within a particular zone or combination of zones would affect caribou population status, viability and habitat supply relative to the current state of the caribou range, as well as timber supply. This ensured that the resulting recommended zonation would provide sufficient functional habitat supply over the long term, to support a viable caribou population at a natural level of abundance and distribution across preferred habitat types, with retention of critical caribou habitat functions at appropriate spatial and temporal scales of habitat and resource selection.

Lastly, this caribou conservation plan provides additional detail and management recommendations by zone type, including forestry best management practices. Best management practices (BMPs) were provided at a high level and are specific to forestry; other land use BMPs should also be incorporated for comprehensive range planning and management.

APPENDIX B: PASQUIA-PORCUPINE WOOD SUPPLY ANALYSIS

The purpose of the wood supply analysis component was to assess the impact that the proposed protected area measures might have on wood supply and intact forest in the future. Impact assessment is always a comparison between two or more forecasts of what the future might be like, given that different courses of action may be followed. In this case the impacts to be measured were between a future where the current status-quo management policies were followed and several other forecasts where protective area strategies were applied. The primary indicators used to assess impact were wood supply (the long-term sustainable rate of harvest) and the amount and arrangement of intact forest.

Wood supply analysis is carried out using computerized simulation models. In general, these models start with a depiction of current forest conditions (taken from the provincial forest vegetation inventory), and sequentially apply rules of change to step forward in time, simulating growth, harvest, and renewal. In order to assess long-term sustainability of actions, the simulations were carried out to forecast potential growth, harvest and renewal over a 200-year future planning horizon.

Conceptually, wood supply modeling is very simple. The state of the simulation is initialized with current forest conditions, typically derived from a map that delineates forest stands into homogeneous polygons by age and species. These maps in turn are derived from aerial photography and ground survey data. The condition of each polygon is linked to yield curves that estimate the amount of wood volume that would be present at each age for a given composition of species. The yield curves are derived from a statistical analysis of ground survey data. In order to forecast stand conditions in the future, the age of the polygon is incremented, and the estimated amount of volume present is looked up at an older location on the yield curve. To simulate a future harvest, the yield curve volume at that future time is added to the estimate. Renewal is simulated by setting the future age of the polygon to zero, and assigning a new yield curve that reflects the likely growth and development of the post-harvest condition for the original forest type. There are a few more details involved, but wood supply modeling is basically the aggregation of these simple steps across all of the polygons in the forest, over all of the time periods in the planning horizon.

For this study the Patchworks spatial forest simulation model was used. Patchworks has a comprehensive set of features to support basic wood supply modeling, and also integrates geographic information system capabilities to keep track of the location of forest conditions as features are forecast to change conditions over time. The integrated GIS enables some very powerful capabilities to implement the types of controls required to simulate the protected areas strategies, and to explicitly forecast the on-the-ground footprint of the actions required at each step of the hypothetical management program. Important outputs from the Patchworks model are GIS-based maps of disturbance locations and future forest conditions at selected time steps throughout each 200-year planning horizon, including locations of harvests and the active forest road access network required to support the harvest program. These digital map outputs are then processed with GIS operations to assess the Environment Canada disturbance footprint standard.

The various inputs describing initial forest conditions and rules for change are assembled into a base model. The Patchworks software is used to run simulations on the base model, including variations on parameters that simulate different policies, strategies and protective measures. The collection of inputs, parameter settings and outputs from a single simulation produces what is referred to as a scenario. A baseline scenario forecasts the conditions that would result with parameters set to most closely reflect the current business as usual policies. Other scenarios that express alternate protected area strategies are compared to the baseline, in order to measure the impact of the alternative.

It is important to note that the simulation modeling process did not seek to identify a single 'optimal' solution to satisfy all parties. The modeling process was used to describe future outcomes from the baseline and other protective measures strategy scenarios that were proposed by the RWG. The wood supply and disturbance footprint indicators, and more importantly the difference between indicators from different scenarios, were presented back to the RWG, so that along with other information they could make an informed recommendation of a best approach.

Modeling inputs

The modeling inputs used in this study for the most part had been prepared by Forsite Consultants Ltd. , for use in preparation of the "2015-2035 Twenty Year Forest Management Plan" for the Pasquia-Porcupine Forest Management Agreement Area. The following table summarizes some of the key inputs and parameters of the base model.

1. Digital inventory of the forest land base

Weyerhaeuser produced a high quality digital forest inventory from aerial photography and ground sampling. This inventory was updated to reflect fire and harvesting (actual and planned) up to the end April 2015. The inventory was reviewed and approved as meeting the Provincial standard for use in a Forest Management Planning process. This digital data set classified the land in to appropriate available and excluded management categories, and was used as input to the Patchworks modeling process.

2. Rules for change

The rules for change used to forecast stand-level conditions in to the future are described in the Forest Estate Modeling Assumptions1[1] report. 12 sets of yield curves were developed for groupings of similar forest development types, fitting predictions of change over time to a large collection of sample plot data.

Slow late-seral successional change, depending on forest development type, is typically manifest in the boreal forest as the gradual senescence of upper-canopy dominant trees, increased light through to the lower levels, and the emergence of shade tolerant mid-canopy as the new dominant cohort. Rules for this natural cycling were described in the modeling assumptions report.

Harvest eligibility was based on stands being in the available portion of the forest land base, and within an age range related to minimum harvest volumes and growth rates as determined for each forest development type. Harvested stands were eligible for one of several silvicultural treatments as appropriate for the ecological characteristics of the original development type. The post-treatment development type and age would be dependent on the original development type and silvicultural treatment type. For example, clearcut leave-for-natural treatment would result in a stand at age 0. An understory-protection treatment leaves the advanced-growth white spruce intact, and immediately results in a 25 year old hardwood/spruce development type.

3. Timber Harvest Objectives

The Pasquia-Porcupine FMA is being managed to provide hardwood for the Weyerhaeuser OSB mill in Hudson Bay, and softwood sawlogs for the Edgewood saw mill in Carrot River. In general, the timber harvest objective is provide a maximum long-term sustainable wood supply, subject to a predictable 20-year short-term supply, and allowing a maximum fluctuation of 10% in harvest between successive planning periods.

4. Non Timber Objectives and Targets

In addition to the timber objectives, the forest management planning guidelines in Saskatchewan require consideration of a number of other aspects of forest structure and arrangement, including minimum levels of retention of unharvested trees within cut blocks, maintenance of minimum areas of old and very old forest types, and the arrangement of harvest openings in a specific range of sizes. This later objective imposes a distinct spatial layout standard, requiring a fully explicit spatial model such as Patchworks to simulate its implementation and impact.

All of these objectives have the potential to reduce wood supply. Retention of unharvested trees within cutblocks has a direct and easily measurable reduction to harvest volumes: if 9% of trees are to be left unharvested, then the sustainable wood supply will be reduced by 9%. Old and very old forest area targets have a variable impact on wood supply, due to time between successive harvests on the same site being lengthened so that sufficient old forest persists in all time

1 Pasquia-Porcupine FMA, Forest Estate Modeling Assumptions. 2013. Forsite Consultants Ltd., Salmon Arm, BC. 21 pages. Unpublished report.

periods. Lengthening the rotation age in this way directly results in a lower long-term sustainable harvest rate. The arrangement of harvest patch sizes potentially reduces wood supply because it is possible that large harvest openings might only be able to be composed by selecting heterogeneous areas made up of some younger and some older stands. The timing of harvest for these stands may be off the age that is optimal to achieve maximum sustainable wood supply. The potential impact depends on a large number of factors (initial spatial layout of the forest in terms of development types and ages, the characteristics of the yield curves, the required size and number of openings), and it is only through simulation that these impacts can be assessed.

5. Road Access

A transportation sub-model was included in the Pasquia-Porcupine Patchworks base model. This model provided an explicit connection between harvested stands and the processing facility to where the wood was to be transported. The transportation model included existing roads and candidate road locations to be used by the model to access areas in the future. Two mill locations were included in the transportation model: Carrot River and Hudson Bay. For each simulated harvest, the transportation model identifies the sequence of roads required to deliver the hardwood and softwood products to the correct mill. Costs were associated with construction of new roads, maintenance of previously constructed roads, and trucking costs to move product, and were accumulated for each harvest in each planning period. Budget level were assigned in the model to limit capital road-building expenditures to realistic levels (incremental road development to sequentially access remote areas), limit the amount spent on road maintenance per year (must selectively retire and decommission old roads as new ones are built), and to balance hauling costs over all planning periods (ensure intergenerational equity by not harvesting all of the least expensive wood first).

The road model provided several important benefits to the analysis. First, considering the logistic and costs of moving wood from stump to mill provided additional operational realism to the strategic analysis. In selecting harvest locations to reduce costs, the simulation model also grouped stands in a way that concentrated the management footprint and reduced fragmentation, achieving ecological and economic gains. Secondly, the sub-model provides additional economic indicators that can be used to compare performance and costs between scenarios. Finally, the active road network in each future planning period forecasts an important part of the anthropogenic disturbance footprint, which significantly improves comprehensiveness of the disturbance assessment.

The road model was used in the baseline and all protected area scenarios.

Indicators

A broad number of indicators were generated by the simulation model and subsequent GIS processing, however only a small set were used in the impact analysis. The following describes the basis for the most important indicators.

1. Wood supply

Wood supply is simply the volume of wood (m3) harvested in each planning period of the simulation. The total number is partitioned by conifer and deciduous volume, since different industries use these two products, and is most conveniently presented in an annualized format (average m3 per year). These two products may come from relatively pure conifer or hardwoods stands, but a large area of the boreal forest is composed of mixedwood stands, containing both conifer and hardwood species. These species grow at different rates, in some cases with the fast establishing but short-lived hardwoods dominating during the early successional stages, and the slower growing, shade tolerant and longer lived conifers persisting and dominating the stand during the later successional stages. As a result, wood supply becomes a choice of the types and timings of management actions to achieve specific objectives. The balance of supply between conifer and hardwood is linked in complex ways, with simulation being a useful tool to explore options.

The intent of management is to achieve a long-term predictable and sustainable supply of wood, but it is rarely that an exactly even and unchanging level of annual harvest is the best case. The initial composition of the forest in terms of forest types and age classes is the most important factor in determining the production possibilities, and this is typically determined by historical large scale natural process of disturbance, such as fire, weather events (wind and ice damage),

and insect damage. For example, a predominantly young forest composed of mostly juvenile stands would have few harvest options, and the best sustainable harvest rates would initially be much lower than the long-term average. As this hypothetical forest aged until most stands reached a culmination volume, many harvest opportunities would be available and harvest rates could become higher than the long-term average. One of the goals of sustainable forest management planning is to identify a sequence of harvest events that will smooth out the highs and the lows, and provide a relatively steady, although not necessarily even, flow of wood products to provide for a sustainable local economy. While the long-term goal may be to reach a steady state harvest, this will likely never be achievable due to other external factors (such as market fluctuations causing changes in industrial demand, or catastrophic natural disturbances such as large fire events).

The policy for the Pasquia-Porcupine forest is to allow the harvest level to fluctuate by up to 10% per decade, independently for both conifer and deciduous volume. The harvest objectives were set up to try to achieve the maximum sustainable harvest over the entire planning horizon, with a reduced emphasis on the 150-200 year period due to the distant timing and the large uncertainties involved in forecasts that far in to the future. While it is clearly desirable to ensure an economically viable immediate supply, no specific emphasis was applied in the simulation model to cause this to occur.

Due to the fluctuating harvest level policy it is difficult to fully describe the results of a simulation scenario with a single number. An average harvest value provides some indication, but does not characterize the degree and timing of the fluctuation. For this reason the wood supply indicator was show in several different formats. The first was simply as a histogram or line chart showing the average level of conifer or deciduous harvest at each decade of the simulation. This format is visually intuitive, and suitable for comparing multiple scenarios (see Figure 1). Numeric quantities are best for ranking, and several were reported for each scenario describing the short-, mid- and long-term averages, as well as the minimum and maximum periodic average harvest. (see link to table ”Figure 2” in the recommendations report).

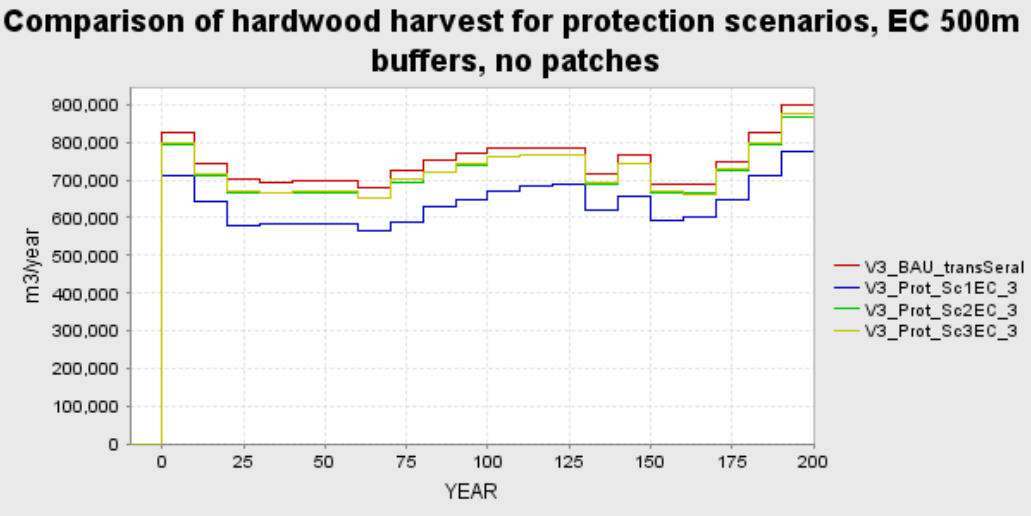


Figure 1. Example of the deciduous wood supply indicator, comparing the results of several scenarios.

2. Intact/Disturbed Forest

Intact forest is the symmetrical opposite of disturbed forest. Disturbed forest was defined using the assessment protocols described in the Environment Canada document “Recovery Strategy for the Woodland Caribou (Rangifer tarandus caribou), Boreal Population in Canada”. The criteria in this protocol is that the disturbance footprint consists of the area of disturbance, plus an additional 500 metre buffer around disturbances of anthropogenic origin. All structural anthropogenic features (highways, pipelines, communities, cottages, gravel pits, transmission corridors, etc) were considered to be static and unchanging through the entire planning horizon, for there was no information one way or the other to suggest further expansion or decommissioning.

The EC protocols acknowledge that forest disturbance has a finite duration, after which the forest regrows to a condition where it is no longer disturbed in terms of caribou habitat. The original EC study used a disturbance duration of 40 years.

In this study we used the 40 year EC value, and also a more refined variable width criteria that had the buffer distances reducing over time as the impact condition was gradually remediated. The initial disturbance footprint for recent harvest and fire (within the last 40 years) and currently used forest roads was captured in industry and government data sets. The legacy disturbance was 'grown out' as the forecasts advance through time, as the future disturbance footprint was 'grown in' (for example, the 10-year future disturbance footprint forecast only legacy fire and harvest from the past 30 years, plus the locations of the first 10-year of forecast harvest). There was no attempt to forecast the locations of future fires, essentially meaning that the forecasts ignored the potential for large catastrophic fires.

The locations of the forest access roads required to achieve the harvest were also forecast by the simulation model. These road locations were also buffered by 500 metres, and considered to actively contribute to the disturbance footprint for 40 years.

Depending on the configuration of the locations of harvest and road access, the 500m buffer around anthropogenic disturbance provides a significant increase to the overall disturbance footprint, in some cases being several times larger in area than the disturbance itself.

The disturbance calculations were carried out using raster GIS operators using a 10 metre sampling grid. These calculations were done post-facto after the simulations had completed, for the calculation were too complex and time consuming to perform during the running simulation.

Values for this indicator were calculated for selected scenarios, at forecast times 0, 20, 40, 60, 80 and 100 years in to the future. The disturbance footprint was calculated for the entire FMA, and results were summarized by each individual caribou management zone. Results were presented as histograms (see Figure 2) and tables showing the cumulative impact of various disturbance categories (fire, harvest, roads, linear features, other anthropogenic disturbances). Maps were also produced to show the overall distribution of the disturbance footprint on the FMA and how the location and intensity changed through time.

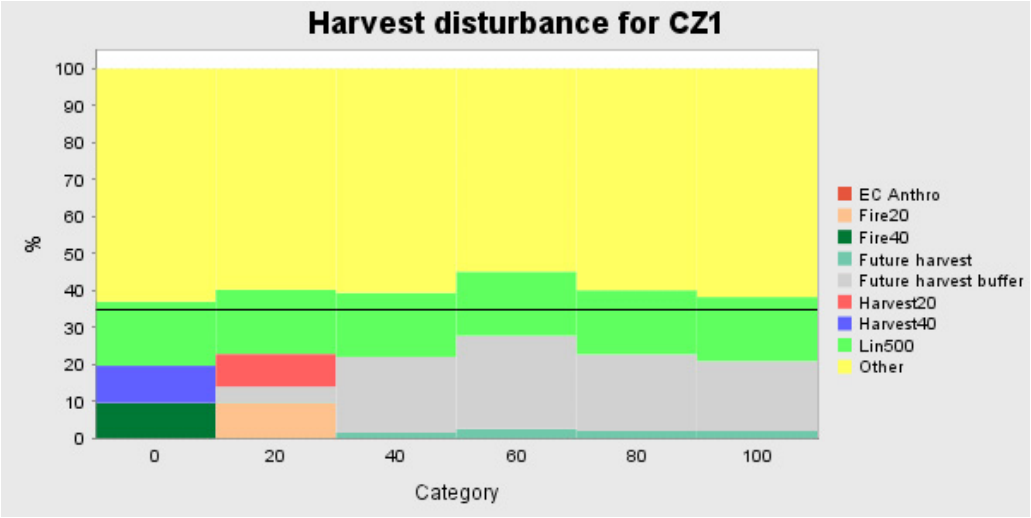


Figure 2. Example histogram showing the change in the disturbance footprint over time, by category of disturbance. The yellow category is not disturbed. The black line shows the 35% disturbance threshold.

Scenarios

The RWG used the wood supply modeling process to incrementally explore the production and conservation possibilities in both the baseline and a carefully thought out series of protected area scenarios. The analysis process was carried out over the later part or 2013 and the early part of 2014. The initial steps of the process were to calibrate the baseline 'business as usual' scenario, observe the upper limits of wood supply, and understand the location and levels of disturbance resulting from the status quo. Results were presented to the RWG, along with interpretations of the limiting factors and potential for mitigative actions.

The RWG, informed by the baseline results, the benchmark analysis carried out by the BEACONS project and the evolving Caribou Habitat Management Plan recommendations, then proposed to alter the baseline analysis. The alterations included a series of proposed protected area designs in various shapes and configurations, as well as a sensitivity analysis on various levels of permitted disturbance intensities within the Caribou Plan.

1. Baseline Calibration

The first simulations carried out in January 2014 were done to assess the current wood supply situation using 'business as usual' policies, prior to considering protective measures. This set systematically explored individual management policies and practices to gain understanding of the production possibilities of the forest and confidence that the simulation was performing reliably. Of note is that current 'best practices' forest management reduces the sustainable harvest level to 80% of the theoretical maximum harvest.

2. Second Round Baseline Calibration and Protected Area Design

The second round analysis made some changes and corrections to the baseline scenario, and tested the first tentative protected area designs. Among other small issues, the interpretation of old forest retention requirements was clarified with the government, and the objectives for landscape level patches were relaxed. A draft of the caribou conservation zones was applied to the simulation data set, and several different levels of disturbance thresholds were applied to the conservation, special management and development zones. Disturbance levels were tested with fixed and variable width buffers.

3. Third Round Baseline Calibration and Protected Area Design

The results of the second round analysis showed that there was still room for an improvement to the way that the models were set up, including corrections to interpretations of policies and steps to mitigate wood supply losses, resulting in a new refined baseline. This third round of analysis incorporates those lessons learned from the first two rounds. The protected area design was expanded to include a 100% exclusion in 'Network Configuration 3' obtained from the BEACONS analysis. The scenarios were evaluated with and landscape level patches, to gauge the impact of this management policy.

4. Fourth Round Protected Area Design

This set of scenarios tested finer-scale variations to the protective measures: removing the disturbance limits within the development zones, removing the harvest restrictions for 'Network Configuration 3', and testing 30 and 60 year variations on the disturbance duration criteria. These scenarios were tested with the EC 500 metre anthropogenic buffer criteria.

5. Evaluation of Variable Width Buffers

This round tested a selected set of round 4 scenarios using the variable with buffer criteria.

6. Review and Validation of FMP run

Weyerhaeuser was in the process of developing a forest management plan, and was incorporating some of the designs developed through this process. This analysis was to compare the draft results of the FMP process preferred scenario with the preferred scenario chosen by the RWG. There were several differences in model formulations and objectives, with the FMP model having a slightly updated data set and including more specific management objectives refined after more thorough review and consideration by company planners. The comparison showed consistency between the primary wood supply and disturbance indicators for both scenarios.

APPENDIX C - TRADITIONAL KNOWLEDGE (TK)

Background: Cumberland House Cree Nation, Métis Nation of Saskatchewan Eastern Region I, Red Earth First Nation and Shoal Lake Cree Nation

The Prince Albert Model Forest (PAMF) was contracted in May 2013 to work with the Canadian Boreal Forest Agreement (CBFA) - Saskatchewan Regional Working Group (SK RWG) to assist in community engagement and Traditional Knowledge gathering in the Cumberland House Cree Nation, Métis Nation of Saskatchewan Eastern Region I, Red Earth First Nation and Shoal Lake Cree Nation.

The PAMF belongs to the Canadian Model Forest Network and the International Model Forest Network, which at time of writing boasted over 60 sites in 30 countries. The organization has a 20-year history in offering guidance and expertise in the area of natural resources.

The project was designed as a community based research initiative, which trained and engaged local community members in the interviews and research collected in their traditional use areas.

Through the discussions with community leaders and members, it was suggested that a holistic look at the landscape was important. As a result, the scope of the project was expanded to consider all aspects of traditional life in the environment – water, wildlife, culture and traditions - in addition to woodland caribou and protected areas topics of interest.

A total of 27 interviews were conducted. The local Swampy Cree language, N-dialect was prominent in each interview. Interviewers had strong language skills or had the assistance of a Cree translator. All audio clips were transcribed from Cree to English.

Background: James Smith Cree Nation, Kinistin Saulteaux Nation and Yellow Quill First Nation

Canada North Environmental Services (CanNorth) was contracted in March 2015 to complete Traditional Knowledge gathering and reporting on woodland caribou for the SK RWG. The study area consisted of the Pasquia Porcupine Forest Management Area within the Fur Block Conservation Area H-25 which includes the communities of James Smith Cree Nation, Kinistin Saulteaux Nation and Yellow Quill First Nation.

A total of 30 participants were interviewed from the three First Nations communities. Participants were asked a series of 29 questions regarding woodland caribou in the Pasquia Porcupine FMA and were provided with a map on which they were encouraged to provide locations for woodland caribou and any other wildlife species they thought were relevant. Participants were interviewed regarding woodland caribou traditional use and importance, habitat and movements, interspecific interactions, population stability, conservation and how these factors have changed over time.

Contributors

Participation by these six nations was requested due to their proximity to the Pasquia Porcupine FMA and the likelihood that each community would have individuals with relevant knowledge. Individuals were identified that had used the project area for traditional activities and who possessed traditional knowledge passed down from Elders or forebears previously residing in the region.

Confidentiality and Ownership

All information collected by participants, including hard copies of questionnaires, maps, and sound recordings have been treated as confidential. The TK data obtained from the interview participants will remain under their ownership. The two final reports, consisting of summaries of the TK provided, do not contain sensitive personal information and have been shared with participating communities, the Canadian Boreal Forest Agreement and the University of Saskatchewan's Indigenous Land Management Institute. TK for the SK RWG was undertaken as an independent research project and is unrelated to any consultation or proponent engagement process for any future wildlife or management plans.

APPENDIX D - PROTECTED AREAS

Signatories of the CBFA have committed to "the completion of a network of protected areas that, taken as a whole, represents the diversity of ecosystems within the boreal region and serves to provide ecological benchmarks" (Goals 2, CBFA 2010). To guide this commitment, the CBFA developed the Protected Areas Methodological Framework (PAMF; Strittholt and Leroux 2012) which draws from the principles of systematic conservation planning (Margules and Pressey 2000) to provide a suite of steps for protected areas design. These steps were followed by the Saskatchewan RWG and described below.

Area of Assessment (or Study Area)

The Area of Assessment (AoA) defines the area over which the protected areas network is designed and conservation objectives are applied. Following the guidance of the PAMF and CBFA Science Committee (SC 2013), the RWG identified an Area of Assessment based on an ecology-based hierarchical framework which allows for planning at multiple scales as well as integration across CBFA planning initiatives. In adherence to these objectives, the boundary of the AoA was identified using the boundary of Brandt's (2009) boreal and boreal alpine regions and refined using ecodistricts, the smallest unit of the National Ecological Framework for Canada (Marshall et al. 1999). Ecodistricts are characterized by relief, landforms, geology, soil, vegetation, water bodies and fauna. The Saskatchewan AoA is comprised of the 12 ecodistricts intersecting the Pasquia Porcupine Forest Management Area.

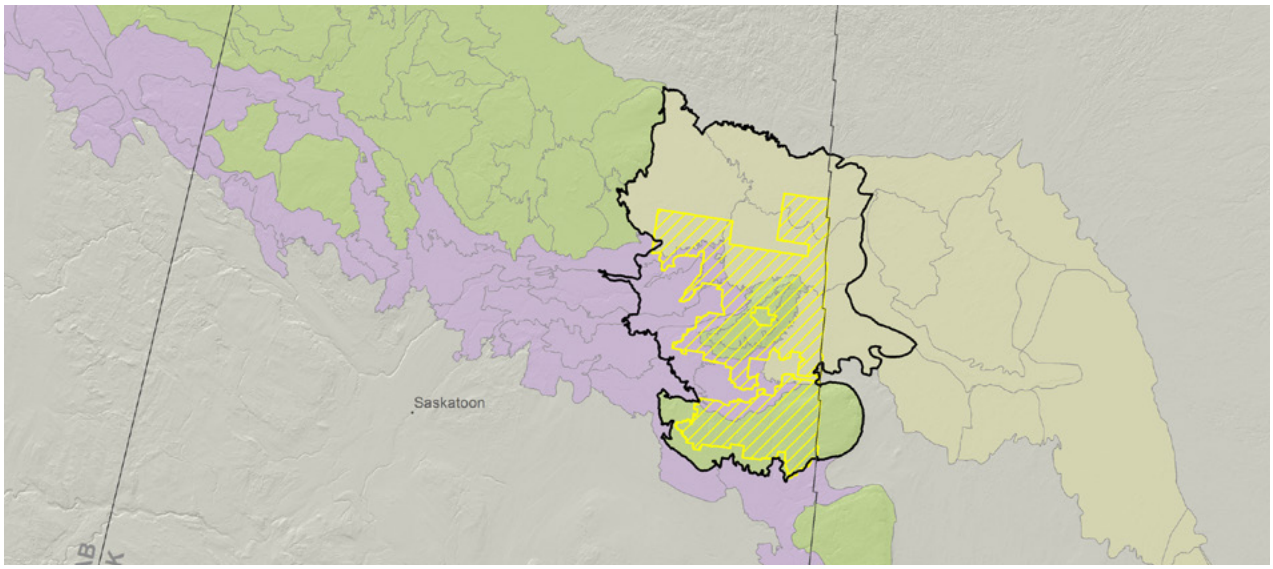


Figure 1. Area of Assessment is comprised of all ecodistricts from the National Ecological Framework for Canada (Marshall et al. 1999) intersecting the Pasquia Porcupine Forest Management Area.

Identification of Conservation Features of Interest

Once the planning region has been defined, systematic conservation planning starts with the identification of conservation features and associated goals and targets. Conservation features are elements of conservation interest (e.g., freshwater systems, woodland caribou, cultural sites). There are several opportunities for incorporating conservation features in protected areas design, so the identification of goals and targets for conservation features is important for determining when and where it is best to incorporate a particular feature and for measuring conservation success. A goal is “the desired conservation outcome or result from a conservation planning process,” while the target operationalizes the goal by defining a “specific biological attribute or area required for meeting conservation goals” (e.g., protect 25% of wetlands in the planning region; Strittholt and Leroux 2012). Ideally, targets are evidence-based, derived from an adequate understanding and mapping of the distribution and viability of the feature, rather than an arbitrary policy- or value-based target (e.g., 17% protection of terrestrial and inland waters advocated by the Convention on Biological Diversity).

Within CBFA Goal 2 (completion of a network of protected areas), there are four sub-goals for designing a protected areas network to represent and maintain native biodiversity in the boreal, which can be summarized as represent boreal ecosystems, maintain viable native populations (focal species), sustain ecological and evolutionary processes (e.g., natural disturbance), and represent special elements. Given that biodiversity is "the sum total of all life and the processes that govern it" (Strittholt and Leroux 2012), it is not possible to individually address every element of biodiversity within the context of the sub-goals above. Instead, conservation features are selected to serve as surrogates for other elements of biodiversity with the assumption that by focusing efforts on these features, the likelihood of conserving the majority of biodiversity elements will be high (Groves et al. 2002). When selecting conservation features as biodiversity surrogates, the PAMF recommends that features be selected to represent the three major components of biodiversity (composition, structure, and function) as well as coarse-, meso- and fine-scale features.

Following the guidance above, the RWG identified a suite of conservation features (Table 1). The conservation features represent ecosystems, focal species, and special elements. While features were not selected in relation to sustaining ecological and evolutionary processes, protection of these processes are addressed in the design of ecological benchmarks which will be discussed later. Three target scenarios representing low, medium and high conservation objectives were identified for each feature. For features associated with ecosystems, the three target scenarios were 10%, 30% and 50%. High-value caribou habitat had targets of 65%, 75%, and 85% with the lowest target based on the minimum disturbance levels for a sustainable population recommended by Environment Canada (2012). No rationale was provided for the 50%, 70%, and 90% targets for Lake Sturgeon waters (GFWC 2013). In all cases, with the exception of caribou, the targets are value- rather than evidence-based. Protected areas design is not a linear process. Following the initial identification of conservation features, additional features were added (environmental domains, important bird areas, and songbirds). No targets were identified so the default target assigned was proportional representation.

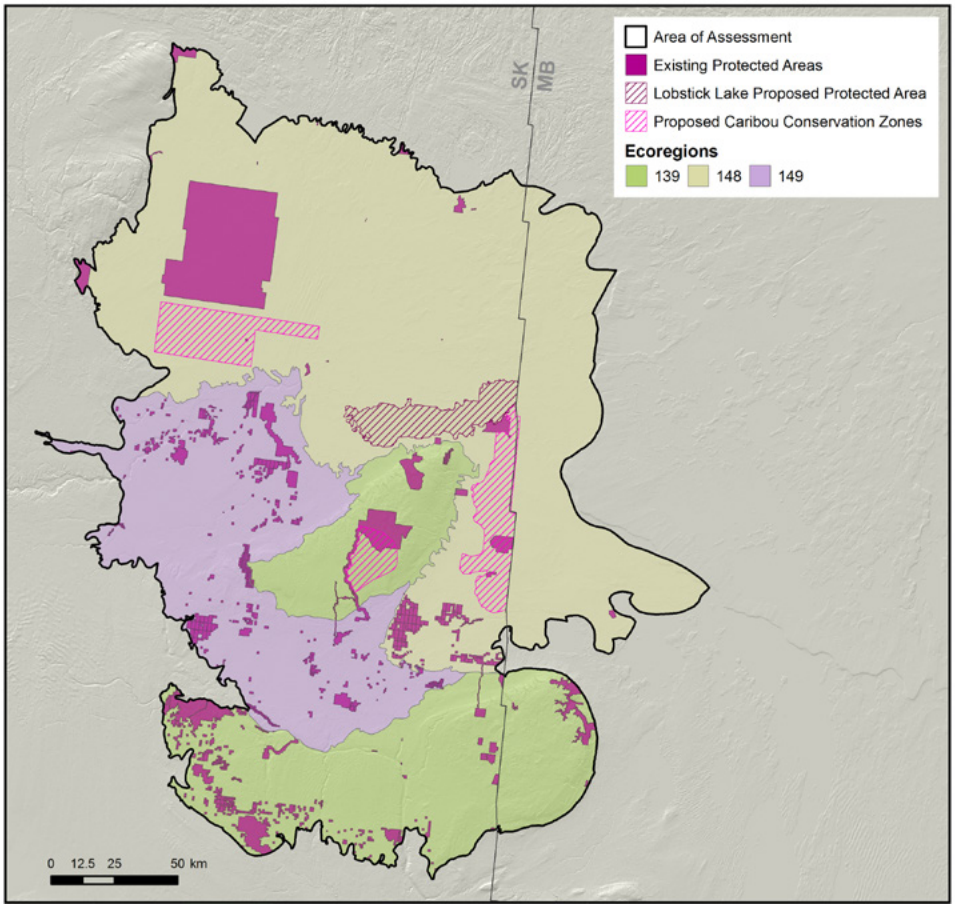
Table 1. Conservation features and associated targets selected by the RWG.

Conservation Feature	Goal	Biodiversity Component	Scale	Low Area Target (%)	Medium Area Target (%)	High Area Target (%)
WWF Enduring Features (Rep Scores A, B, C, D)	Ecosystem	Structure	Coarse	0, 5, 10, 10	5, 10, 10, 20	10, 20, 30, 40
Gross Primary Productivity	Ecosystem	Structure	Coarse	10	30	50
Topographic Diversity (ruggedness)	Ecosystem	Structure	Coarse	10	30	50
Elevation	Ecosystem	Structure	Coarse	10	30	50
Lake-Edge Density (measure of riparian areas)	Ecosystem	Structure	Coarse	10	30	50
Intact Forest Landscapes (GFWC and EC)	Special Element	Function	Coarse	10	30	50
Natural Land Cover Types	Ecosystem	Composition	Coarse	10	30	50
High-Value Caribou Habitat	Focal Species	Composition	Fine	65	75	85
Lake Sturgeon Waters	Focal Species	Composition	Fine	50	70	90
Other features added later:				Target		
Environmental Domains	Ecosystem	Composition	Coarse	Proportional representation		
Important Bird Areas	Focal Species	Composition	Fine	Proportional representation		
Five Boreal Songbird species representing a range of habitat types: Blackburnian Warbler, Black-Throated Green Warbler, Canada Warbler, Cape May Warbler, and Olive-sided Warbler	Focal Species	Composition	Fine	Proportional representation		

Evaluate Existing Protected Areas

Prior to identifying new protected areas, the existing protected areas network (**Figure 2**) was first evaluated with regards to the provision of ecological benchmarks. Ecological benchmarks are reference (or control) areas for detecting and understanding the response of boreal ecosystems to human activities and management decisions, and are essential for the implementation of active adaptive management. To align with Government of Saskatchewan protected areas planning and other CBFA conservation initiatives, new protected areas proposed under the Saskatchewan Representative Areas Network initiative (e.g., Lobstick Lake) and proposed caribou conservation zones identified by the RWG were also included.

Figure 2. Existing protected areas evaluated for their benchmark potential were provided by CARTS (CCEA 2013). Existing protected areas account for 8.4% of the Area of Assessment (4,270 km^2). The addition of Lobstick Lake Representative Area (864 km^2) and caribou conservation zones (2,226 km^2) would increase the area protected to 14.5% or 7,360 km^2.



As reference areas, ecological benchmarks are designed to:

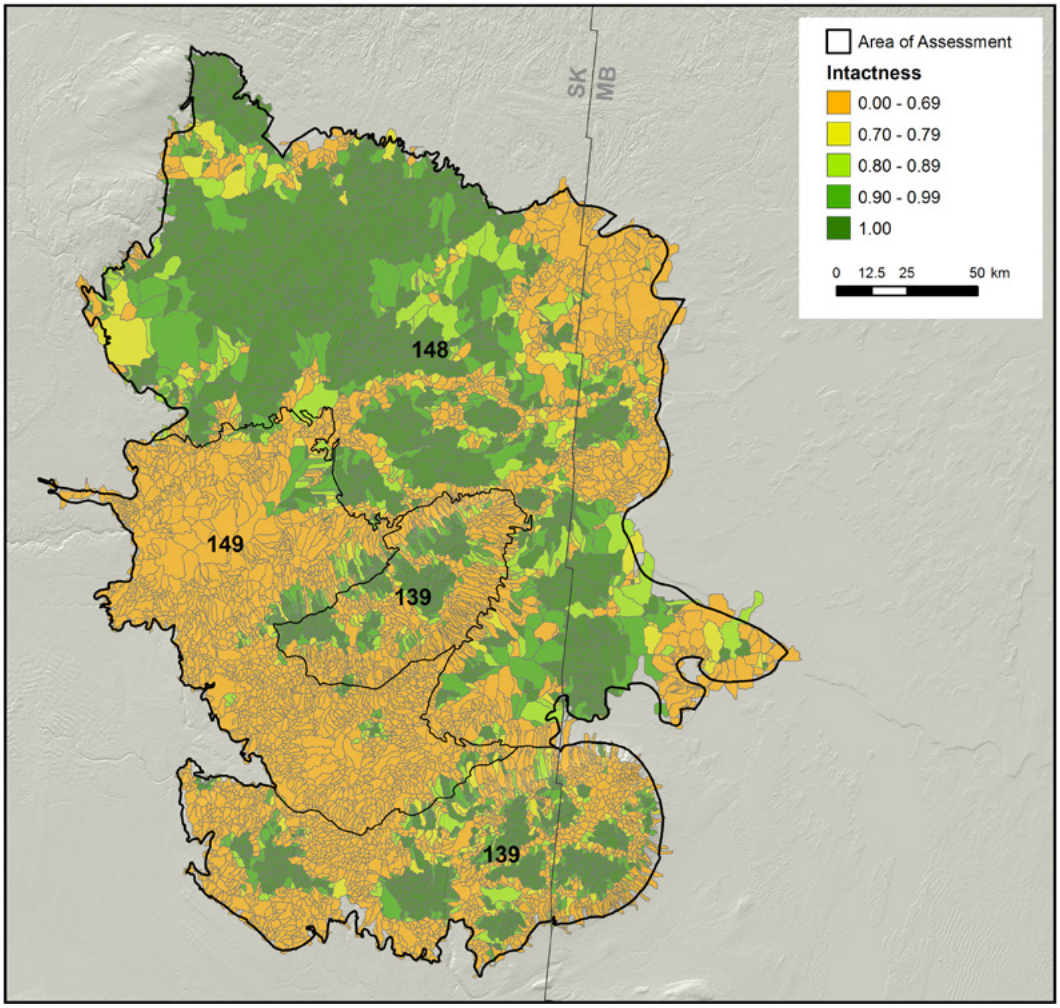
- Be **Intact**, with little or no human disturbance, so that ecological and evolutionary processes are operating within their natural range of variation;
- Support **terrestrial and aquatic connectivity** to facilitate the flow of nutrients and organisms that in turn support ecological and evolutionary processes;
- Be of **sufficient size** to maintain large-scale ecological processes and internal recolonization sources for habitat types that are vulnerable to natural disturbance. Internal recolonization sources are 'lifeboats' for species that rely on habitat types vulnerable to natural disturbance; and
- Be **representative** of environmental variation in the planning region.

Ecological benchmarks are first designed to satisfy criteria for intactness, size, and hydrologic connectivity.

Representation is an additional criterion for the evaluation and selection of benchmark areas for biodiversity objectives, rather than the goal itself. The methods described below for the design of ecological benchmarks were developed by the BEACONs Project, University of Alberta.

To address hydrologic connectivity, catchments are used as building blocks and assembled along stream networks to a user-defined intactness and size. Catchments are approximate drainage areas for stream networks (BEACONs 2013; **Figure 3**). Within the Saskatchewan AoA, catchments range in size from 1 to 326 km2 (mean 6.5 km2). Intactness is measured as the absence of human disturbance. For the Saskatchewan AoA, catchments were assigned a percent area intactness value using GFWC's (2010) Intact Forest Landscapes updated with Environment Canada's (2013) anthropogenic disturbance for woodland caribou local populations. Ideally, benchmarks would be constructed from catchments that were 100% intact; however, given the history of human activity in this region of the boreal, a minimum catchment intactness of 80% was permitted.

Figure 3. Area of Assessment coloured by catchment intactness. Ecological benchmarks were designed with catchments ≥80% intact (shades of green).



Benchmark size is defined based on the natural disturbance regime and estimates for Minimum Dynamic Reserves (MDR). MDRs are size estimates required for benchmarks to capture large-scale processes that shape the boreal at broad spatial extents and maintain habitat types vulnerable to natural disturbance within the benchmark at all times (MDR; Leroux et al. 2007). Natural disturbances such as fire are some of the largest and most influential processes in the boreal. As the primary driver of vegetation dynamics, natural disturbances influence the species composition and age structure of vegetation communities, and therefore play an important role in the creation and loss of habitat. Many species have adapted to the natural disturbance regime in their region, and therefore rely on these disturbances

for their long-term persistence. Capturing and maintaining these large-scale processes within benchmarks ensures not only the persistence of reliant species but that smaller processes are operating within their natural range of variation. MDRs were estimated for the ecoregions intersecting the AoA and range from 4,032 km^2 to 7,310 km^2 (**Table 2**).

Table 2. *Minimum Dynamic Reserve (MDR) estimates were identified for the ecoregions intersecting the Area of Assessment based on the methods of Leroux et al. (2007). MDR 1 is a conservative estimate for the ecoregion based on maintaining minimum amounts of five broad flammable vegetation types: conifer, deciduous, shrub . MDR 2 is an estimate based on discounting rare flammable vegetation classes (<5% of the ecoregion) which can drive up with the size of the MDR if widely dispersed in the ecoregion.*

Ecoregion	MDR 1 (km^2)	MDR 2 (km^2)
139	1,095	1,020
148	5,411	3,502
149	1,369	704

Based on size and intactness only, benchmarks are classified as either system or subsystem benchmarks. **System benchmarks** are the gold standard and satisfy the size requirements of a MDR and are highly intact (i.e., ≥80% catchment intactness). **Subsystem benchmarks** are smaller than a MDR and/or comprised of catchments with an intactness below that desired to ensure processes are operating within their natural range of variation (i.e., <80%). As such, depending on the benchmark characteristics compromised, subsystem benchmarks may not capture large-scale processes or those processes may not be operating within their natural range of variation. A subsystem benchmark is also unlikely to be resilient to natural disturbance. The utility of a subsystem benchmark will depend on the species/process to be monitored. For example, species have differing habitat and area requirements and differing levels of sensitivity to human disturbance. The subsystem benchmark must be sufficiently large to support an effective monitoring program for the species, and there should be some confidence that that the species' behaviour or probability of survival has not been altered by the level of disturbance in the region.

An ecological benchmark must be representative of the region for which they are to serve as reference areas. Environmental variation is characterized using the following four biophysical indicators:

- **Gross Primary Productivity (GPP)** - GPP quantifies the amount of carbon absorbed by living plants during photosynthesis. GPP units are in kilograms of carbon per square metre per year (kg C/m^2/yr). The GPP dataset was developed from MODIS GPP/NPP (MOD17) 1-km^2 resolution satellite imagery (Zhao et al. 2005, 2006, Zhao and Running 2010) and averaged from 2000-2012.

- **Climate Moisture Index (CMI)** - CMI quantifies the relationship between climate and vegetation and is a measure of soil moisture. It is a measure of water deficit (or surplus) in soil based on yearly average precipitation minus yearly potential evapotranspiration (Hogg 1994, 1997). CMI dataset is a 30-year normal (1980-2010) continuous indicator (10km X 10km raster) created by David Price and Marty Siltanen, Natural Resources Canada. CMI was selected as an indicator in part because of the ability to project CMI under climate change. Climate-projected CMI is quantified using 4-km^2 resolution datasets developed by Hamann et al. (2013) for four periods: 1961-1990,2011-2040, 2041-2070, 2071-2100.

- **Lake-Edge Density (LED)** - LED quantifies the linear density of terrestrial/aquatic edge and represents the abundance of habitat along large waterbodies (lakes and wide rivers). LED was calculated using the Lakes and Islands coverages from the National Scale Framework HYDROLOGY, Version 6.0 Drainage Network (BEACONs 2011). The units are km/km^2.

- **Land Cover** - Land cover classes describe fine-scale variation in vegetation which is an important component of biodiversity, and affects the distribution of other taxa within ranges determined by climatic factors. Land cover was measured using the EOSD Landsat-based dataset which reflects land cover around 2000 (Wulder et al. 2008). EOSD land cover classes include forests, shrublands, wetlands, water bodies, and other abiotic elements (e.g., rock).

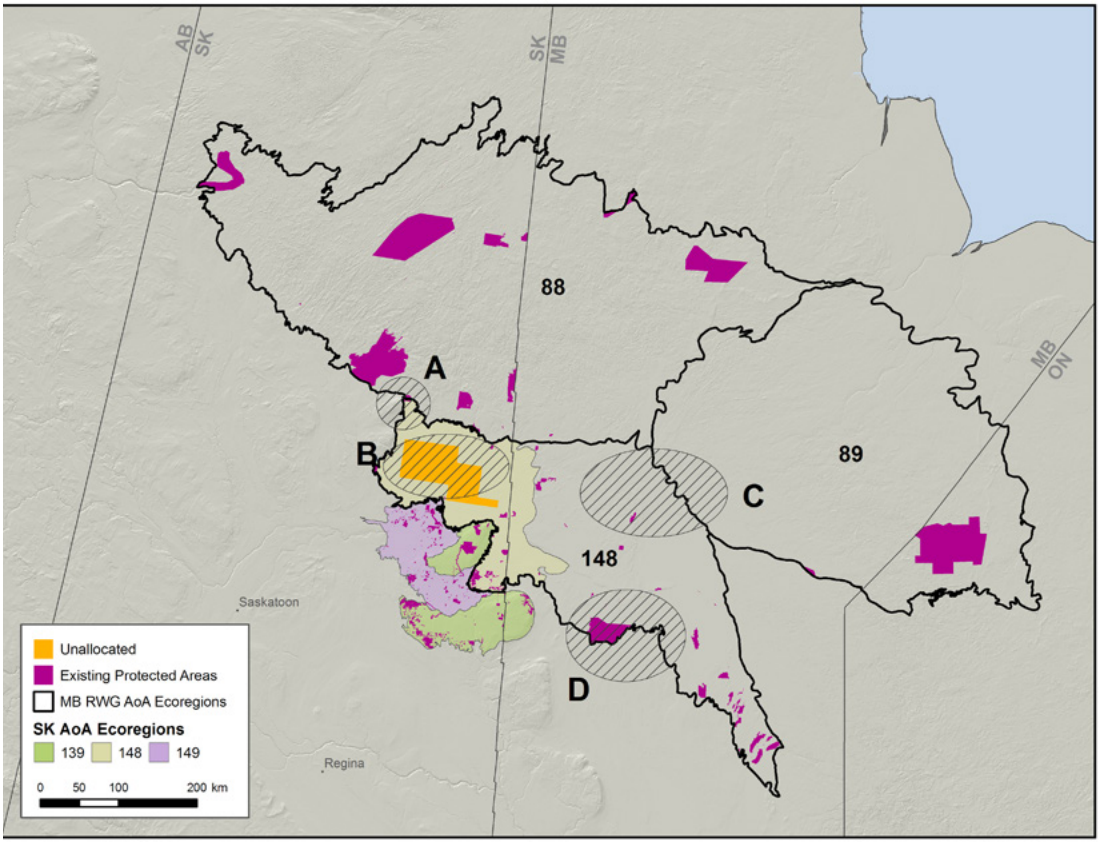
Representation is measured using Kolmogorov-Smirnoff and Bray-Curtis dissimilarity metrics (DM) for continuous and categorical indicators, respectively. DMs compare the distribution of indicator values within the ecoregion to the distribution within the benchmark or a network of benchmarks. The metrics range from 0 to 1 with 0 indicating high representation (i.e., distributions are identical) to 1 low representation (i.e., distributions are highly dissimilar), respectively.

The evaluation of the benchmark potential of existing protected areas started with an evaluation based on intactness and size (MDR). **No existing or proposed protected area was sufficiently large to serve as a system-level benchmark, so new protected areas were identified**.

Identification of New Protected Areas

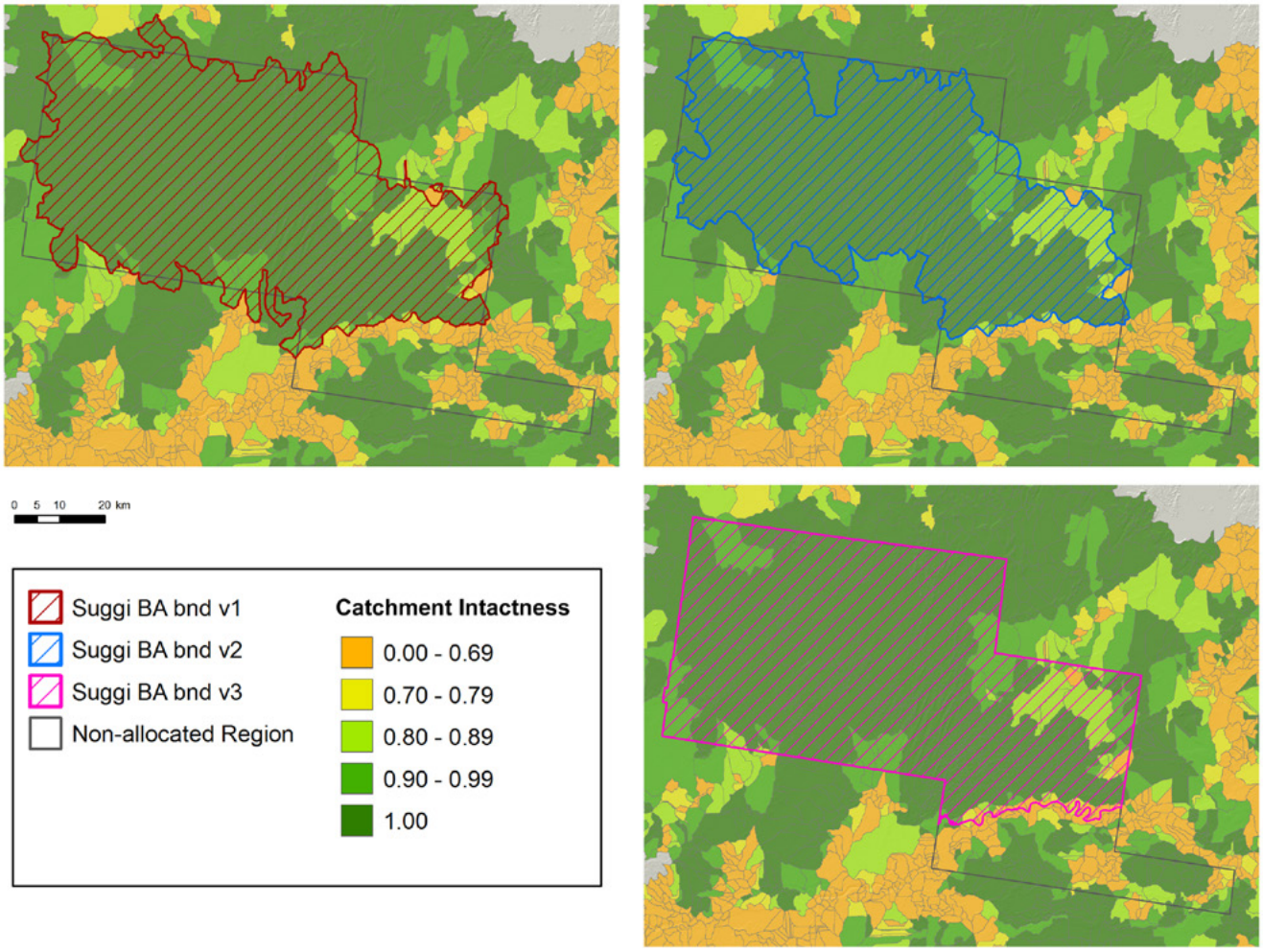
Benchmark design within the Saskatchewan AoA was a challenge given the long history of human development in this southern region of the boreal. Earlier work at the ecoregion scale highlighted the hashed areas (A-D) in **Figure 4** for the design of representative benchmark networks for ecoregion 148. Two to three benchmarks were needed per network with "B" appearing in most solutions. The RWG was inspired to focus on region "B" with regards to its benchmark potential because of its appearance in the top benchmark solutions, it's proximity to the FMA and area of influence and because this region was non-allocated and contained Seager Wheeler Lake Representative Area.

Figure 4. The identification of new protected areas was guided by previous work that identified regions A-D in the design of ecological benchmarks for ecoregion 148. Region B was of particular intersect because it included a region unallocated to forestry.



Building from the non-allocated region, the RWG explored a number of boundary options for an ecological benchmark, and settled on option 3 (4,697 km^2) in Figure 5, hereafter referred to as the Mossy River benchmark. The Mossy River benchmark (4,697 km^2) falls completely within ecoregion 148 and qualifies as a system-level benchmark based on the MDR 2 estimate for the ecoregion (3,502 km^2; **Table 2**).

Figure 5. Option 1 is defined by catchments ≥ 80% intact with the majority of their area within the non-allocated region. Option 2 is defined by catchments ≥ 80% intact and minimizes the area extending beyond the non-allocated region. Option 3 is defined by catchments ≥ 80% intact clipped to the non-allocated region.



Mossy River benchmark was evaluated based on its ability to represent environmental variation at three spatial extents: Area of Assessment (AoA), tenure only, and portion of ecoregion 148 within the AoA (Table 3 and Figure 6). The representation analysis revealed that:

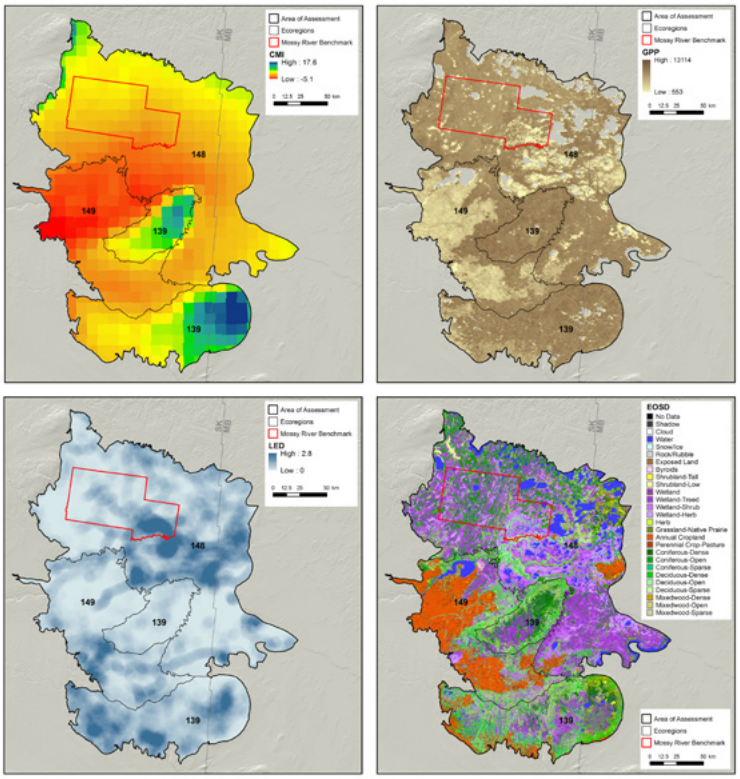
- The Mossy River benchmark is characterized by moderate soil moisture (CMI), low to moderate productivity (GPP), and is dominated by water and wetland land cover types with a mixture of forest cover types that is primarily open and dense conifer with smaller amounts of open broadleaf and mixedwood.
- Representation of environmental variation is best achieved for ecoregion 148 with southern regions of the AoA poorly represented.
- Representation of current and climate-projected CMI was low across all spatial extents with representation best achieved for ecoregion 148. High and low moisture values are most poorly represented.
- Representation of GPP is low to moderate with high-productivity areas under-represented. The representation of GPP is best achieved for ecoregion 148.
- Dense broadleaf and mixedwood land cover types are under-represented at both the AoA and ecoregion extents. Open broadleaf and mixedwood are also under-represented at the AoA extent.

While not an exhaustive evaluation, the addition of subsystem benchmarks such as the proposed Lobstick Lake Representative Area and caribou conservation zones may improve representation of environmental variation.

Table 3. Dissimilarity metrics (DM) for the representation of biophysical indicators at three scales: area of assessment (AoA), tenure, and ecoregion 148. DM values range from 0 to 1 with values closer to 0 indicating increasingly higher (or better) representation.

Indicator	Dissimilarity Metrics		
	AoA	Tenure	Ecoregion 148
Climate Moisture Index	0.25	0.29	0.18
Gross Primary Productivity	0.28	0.49	0.18
Lake-Edge Density	0.12	0.14	0.11
Land cover	0.20	0.21	0.14

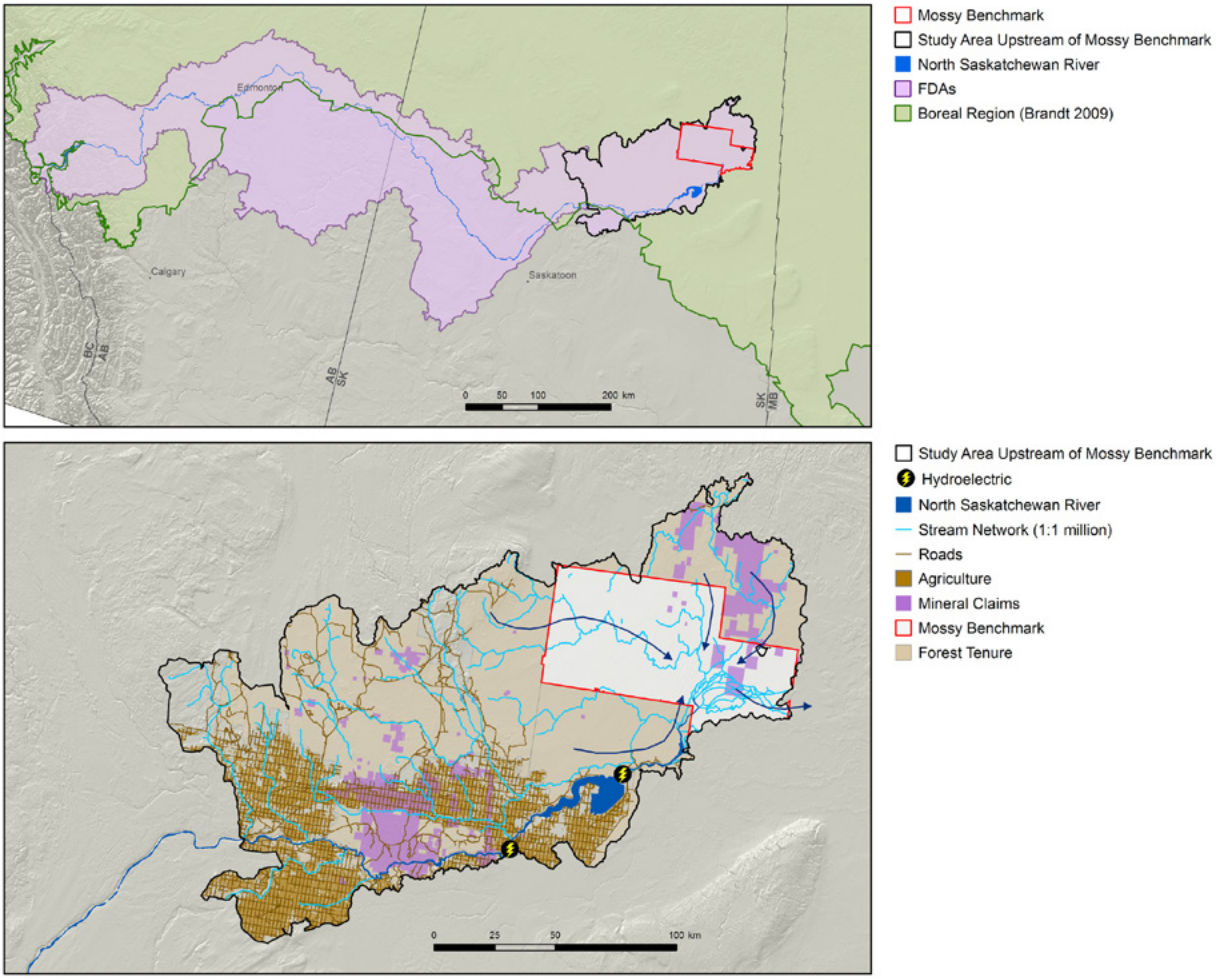
Figure 6. Four indicators of environmental variation and Mossy River Benchmarks.



Vulnerability to Upstream Disturbances

In addition to the characteristics described above, the Mossy River benchmark was also evaluated based on its vulnerability to upstream disturbances (Lisgo and Edwards 2014). Upstream disturbances have the potential to impact the ecological integrity of the benchmark, and thus its utility as a reference or control area. The area upstream of the Mossy Area extends to the north-east and west to the Rocky Mountains (Figure 7). For the purposes of reviewing upstream disturbances and potential threats, the review of upstream disturbances was restricted to a 22,250 km2 area upstream of the proposed benchmark. The upstream area to the south-west is highly disturbed and existing disturbances include roads, human settlements, existing hydroelectric development, agriculture, and forestry (Figure 7). These disturbances have the potential to influence the south-east portion of the Mossy benchmark, which makes up 14% of the benchmark. The remaining 86% of the benchmark has headwaters with considerably less disturbance, with the primary anthropogenic disturbance being forestry. Potential future threats also exist such as mineral claims located upstream to the north-east and in the south-west. Given the vulnerability of the proposed Mossy River benchmark to upstream influences, regional planning should ideally strive to minimize the risk that land use practices upstream may have on the integrity of the benchmark. When designing a monitoring program, careful consideration should be given as to whether or not those species and/or processes monitored have been influenced by upstream disturbances such as pollutants from agricultural run-off and alterations to water flow by hydro projects on the North Saskatchewan River.

Figure 7. Headwaters of the Mossy River benchmark and anthropogenic disturbances located upstream. Black arrows indicate the flow of water into and out of the benchmark



Gap Analysis of Conservation Features

Existing protected areas were combined with the proposed Mossy River benchmark, proposed Lobstick Lake Representative Area, and the proposed Torch Bog caribou conservation zone bordering the Mossy River benchmark, and evaluated with regards to their ability to represent the conservation features of interest and associated targets identified in Table 1. For conservation features with low to high targets, low targets were achieved for all conservation features, with medium and high targets met for a subset of classes for Lake-edge density and WWF enduring features (Table 4). For features with proportional representation targets, proportional representation was met for Important bird areas, 3 of 11 environmental domains, and 2 of 5 boreal songbirds (Canada and Cape May Warblers). Gaps exist and additional protected areas are required to complete the representation of all features. Only a portion of the caribou conservation zones were included in this analysis. The remaining caribou conservation zones may fill some of the representation gaps, but further analysis is required.

Table 4. Gap analysis results for conservation features selected by the RWG.

Conservation Feature	Low Target	Medium Target	High Target
Gross primary productivity 2000-2012 (Zhao et al. 2010; 5 equal-interval classes)	X		
Lake-edge density (BEACONs 2011; 5 equal-interval classes)	X	X* (1 of 5)	X* (1 of 5)
Elevation (Jarvis et al. 2008; 5 equal-interval classes)	X* (4 of 5)		
Terrain ruggedness index (Riley et al. 1999; 5 equal-interval classes)	X		
Natural land cover types (Wulder et al. 2008)	X		
WWF enduring features (2003; Representation Scores A-D)	X	X* (D only)	
High value caribou habitat[1]	X		
Lake sturgeon habitat[2]	X		
Intact forest landscapes (GFWC 2010 and EC 2013)	X		
	Proportional Representation		
Important bird areas (BSC 2013)	Yes		
Environmental domains (N=11; Coops et al. 2011)	Yes (3 of 11 domains)		
Blackburnian Warbler high-quality habitat (BAM 2012)	No		
Black-Throated Green Warbler high-quality habitat (BAM 2012)	No		
Canada Warbler high-quality habitat (BAM 2012)	Yes		
Cape May Warbler high-quality habitat (BAM 2012)	Yes		
Olive-sided Flycatcher high-quality habitat (BAM 2012)	No		

** A subset of classes met the targets.*

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1 Undisturbed (based on EC 2013) wetland and conifer land cover types (Wulder et al. 2008 and DU 2011) within caribou local populations.

2 Large two line water bodies connected to the Saskatchewan river system and buffered by 90m (GeoBase 2007).

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