ALCES Group

Protected Area Needs for Maintaining Ecological Integrity in the Moose Lake Region

Energy Resources Conservation Board
DOVER COMMERCIAL PROJECT; Dover OPCO
ERCB Application No. 1673682

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Executive Summary

Fort McKay is a Cree, Dene and Métis community, located in the centre of the Athabasca Oil Sands area in northeastern Alberta. Much of Fort McKay's traditional lands have been leased for oil sands developments and many projects have been developed or planned, which has significant adverse impacts on Fort McKay's Aboriginal and Treaty rights and cultural heritage.

Of particular concern to community members are projects and activities that might affect the Moose Lake area. The "Moose Lake area" is the area on and surrounding Fort McKay First Nation Reserves IR174A (located on the southeast side of Moose Lake, also known as Gardiner Lake) and IR174B (located on the southeast side of Buffalo Lake, also known as Namur Lake).

The Moose Lake area is considered a peaceful and spiritual place where members of Fort McKay can get away from the development surrounding the hamlet of Fort McKay and practice their traditional land use activities (hunting, trapping, fishing, harvesting of traditional foods and medicines). It is also a place where community members feel that ecosystems are still healthy, the air and water are still clean, and that the traditional foods and medicines are safe to consume.

Community members and Leadership have determined that a buffer area is required around Reserves 174A and 174B (hereafter referred to as Moose Lake Reserves) to protect the ecological integrity and cultural significance and function of this area. To inform Fort McKay's process of establishing a buffer in the Moose Lake area, this report considers protected area requirements for achieving four ecological integrity principles:

1. protect examples of all native ecosystem types;
2. maintain populations of all native species in natural patterns of abundance;
3. maintain ecological process that support species and ecosystem services; and
4. maintain ecosystem resilience to changing conditions.

Land use typical of the region, most notably in situ and mineable bitumen development, is intensive in Fort McKay's Traditional Territory. A precautionary approach to maintaining ecological integrity in the presence of these developments is to assume that ecological value provided by developed areas will be limited. Given this and the large spatial scale at which populations (e.g., woodland caribou) and processes (e.g., fire, hydrology and potential species migrations) operate in the region, the ecological integrity principles are likely to require the protection of a large landscape. As the area protected increases, risk to ecological integrity declines because more populations and processes are secure from activities occurring beyond the protected area's border.

Table 1 summarizes strategies referred to in the report. Lower risk strategies require the protection of larger areas. Although a precise estimate of protected area size is beyond the scope of the report, a low risk strategy for maintaining ecological integrity calls for the protection of an area that is thousands of square kilometres in size.

Table 1: High and Low Risk Strategies for Maintaining Ecological Integrity Discussed In This Report

Ecological Integrity Principle	Higher Risk Strategy	Lower Risk Strategy
Maintain examples of all ecosystem types	Represent 17% of each natural sub-region in the Traditional Territory. This would require protection of 758 km² of Lower Boreal Highlands and 2358 km² of Central Mixedwood.	Protect an area capable of maintaining the full range of forest age classes. This likely requires protection of at least 7000 km², which is three times the size of the largest fire expected in the region.
Maintain populations of all species	Protect an area covering at least 3,000 km², which has been proposed as the minimum size requirement for protected areas in northern Canada based on minimum reserve area estimates for mammals in southern Canada.	Protect the extent of nearby caribou herds (Red Earth and a West Side of Athabasca River (WSAR) that overlap with the Traditional Territory. Herd area within the Traditional Territory is 4988 km² for Red Earth and 5964 km² for WSAR.
Maintain ecological processes	Protect buffers around lakes and streams in the Moose Lake area. The area required to protect buffers has not been assessed.	Protect effective drainage areas that overlap the Moose Lake Reserves. Effective drainage areas that overlap the Moose Lake Reserves cover 1257 km².
Maintain resilience to changing conditions	Protect an elevational gradient between the Moose Lake area and surrounding areas. The area required to protect an elevational gradient has not been assessed.	Protect a latitudinal gradient across the western portion of the Traditional Territory. The area required to protect a latitudinal gradient has not been assessed.

An opportunity exists to achieve this level of protection, without significantly sacrificing opportunity for economic growth in the territory. Protecting the western portion of Fort McKay's Traditional Territory would address the ecological integrity principles, build upon the existing protected areas of Birch Mountains Wildland Park and Wood Buffalo National Park, incorporate an important cultural anchor in the Moose Lake area and Moose Lake Reserves, and incorporate areas that have been prioritized for caribou conservation.

In this area, bitumen reserves are low relative to the central portion of the territory, and protection of the western portion of the territory could offset some of the impacts from development that is likely to expand elsewhere in the territory. Further analysis is required to establish more detailed protected area recommendations for the Traditional Territory in order to design a specific protected areas network.

Introduction

Fort McKay is a Cree, Dene and Métis community, located in the centre of the Athabasca Oil Sands area in northeastern Alberta. The term "Fort McKay" in this report refers to the Community of Fort McKay and includes both the Fort McKay First Nation and the Fort McKay Métis Community.

Much of Fort McKay's traditional lands have been leased for oil sands developments and many projects have been developed or planned, having significant adverse impacts on Fort McKay's Aboriginal and Treaty rights and cultural heritage.

Of particular concern to community members are projects and activities that might affect the Moose Lake area. The "Moose Lake area" is the area on and surrounding Fort McKay First Nation Reserves IR174A (located on the southeast side of Moose Lake, also known as Gardiner Lake) and IR174B (located on the southeast side of Buffalo Lake, also known as Namur Lake). The term "Moose Lake" in general usage by the community of Fort McKay, includes both of the Reserves, the surrounding area, and the lakes themselves (i.e., Moose and Buffalo lakes; Figure 2: Effective Watersheds Overlapping with the Moose Lake Reserves (Figure 1). The term Moose Lake Reserves is hereafter used to refer to Reserves IR174A and IR174B. The term Moose Lake area is hereafter used to refer to the Moose Lake Reserves, the surrounding area, and Moose and Buffalo Lakes.

Fort McKay community members are highly sensitive to the integrity of the Moose Lake area due to historical and cultural connections to this area, and because the Moose Lake Reserves were chosen because of the richness of their resources for traditional land and were expanded in 2006 for the purpose of providing a sanctuary for Fort McKay's traditional way of life. The Moose Lake area is considered a peaceful and spiritual place where members of Fort McKay can get away from the development surrounding the hamlet of Fort McKay and practice their traditional way of life (hunting, trapping, fishing, and harvesting of traditional foods and medicines). It is also a place where community members feel that ecosystems are still healthy, the air and water are still clean, and that the traditional foods and medicines are safe to consume. Essentially, it is the nearest and best remaining undeveloped area for community members to continue to practice their Aboriginal and Treaty rights within their Traditional Territory.

During the Fort McKay-led consultations of the fall of 2011, Fort McKay community members indicated that the Moose Lake area is of utmost cultural importance, and that it is their view that it is essential that this area is protected as a means to preserve the cultural heritage of Fort McKay.

At 77.5 km^2, the area of the Moose Lake Reserves is of insufficient scale to ensure viability of ecosystem goods and services vital to traditional land use. As described in the report, values such as wildlife populations and water operate over spatial scales that exceed the size of the Moose Lake Reserves, and therefore are sensitive to activities occurring outside of the Moose Lake Reserve boundaries.

Community members and Leadership agreed that a buffer area is required around the Moose Lake Reserves to protect the ecological integrity and cultural significance and function of the Moose Lake area. Fort McKay First Nation Chief and Council requested that the Fort McKay Sustainability Department (SD) and Fort McKay's technical consultants develop a scientific rationale to define this buffer. This report does not address cultural or traditional land use as part of the rationale for developing a buffer in the Moose Lake area; this is a component of the project that will be addressed in a separate report so that the buffer can ultimately meet both environmental and cultural values for the community. However, the Community of Fort McKay has clearly indicated that the Moose Lake area has high cultural significance and that the buffer should be anchored in and around the lakes and Moose Lake Reserves for this reason.

Objectives of the buffer are to:

1. ensure that Community members cannot see, hear or smell industrial development in and around the Moose Lake area; and
2. maintain ecological integrity so that the ecosystem can support resources required for Fort McKay's traditional land use activities and that these resources are healthy (e.g., free of contaminants) and support traditional harvesting in perpetuity.

To inform Fort McKay's process of establishing buffers at Moose Lake, this report addresses objective #2 by discussing requirements for maintaining ecological integrity of boreal landscapes.

Dover Project

This report was initially commissioned by Fort McKay First Nation as part of a larger study to assess strategies to protect the community's interests and rights in the face of the cumulative effects of development. The focus of the assessment was the Moose Lake Reserves and Moose Lake area because of its cultural significance and high ecological integrity. It later became apparent that the Dover Project was proceeding and would impact conservation options in the Moose Lake area. A section of this report ("Impacts of Adjacent Land Use on the Integrity of Protected Areas") summarizes relevant literature to discuss implications of land use, such as the Dover Project, occurring in the vicinity of the Moose Lake Reserves.

Principles for Protecting Ecological Integrity

The field of conservation biology establishes that the long-term viability of an ecosystem requires maintenance of the following principles (Noss and Cooperrider 1994):

1. examples of all native ecosystem types;
2. populations of all native species in natural patterns of abundance;
3. ecological processes that support species and ecosystem services; and
4. resilience to changing conditions.

These requirements provide a set of principles to guide the design of protected area networks, and are consistent with Fort McKay's views on the role of protected areas, presented as advice to the Government of Alberta regarding a vision for the Lower Athabasca Region (Table 2). The principles therefore reflect western scientific and Aboriginal perspectives on requirements for ecological integrity, and are applied here to structure an assessment of protected area needs in Fort McKay's Traditional Territory.

Table 2: Relationship between Conservation Biology-Based Ecological Integrity Principles and Fort McKay Protected Area Objectives

Ecological Integrity Principle	Fort McKay Protected Area Objectives
Represent examples of all ecosystem types	Protect natural features commensurate with a pre-disturbance landscape
Maintain populations of all native species	Maintain wildlife populations within their natural range of variation
	Maintain plant communities with natural abundance and vigor levels
	Protect a network of areas that encompass all different ecotypes
Maintain ecological processes	Air quality and water quality and quantity that is not significantly impacted by direct or indirect impacts of industrial development
Resilience to changing conditions	Movement of wildlife into and out of the protected area

Principle 1: Represent all Ecosystem Types

Protecting a representative suite of ecosystems is a coarse-filter approach that assumes conservation of the full range of ecological communities will also conserve the full range of species (Noss and Cooperrider 1994). Individually considering each species' needs is impossible, so protecting examples of all natural communities is assumed to be sufficient to conserve the majority of species. Although the assumption is largely untested, it is the only practical strategy for considering the needs of the full complement of species native to a region.

Conservation planning is sensitive to representation targets (Warman, et al. 2004) and the classification system used to define ecological variation requires careful consideration.

Species respond to a range of attributes, and selecting an ecological classification system that reflects the distribution of species is an inexact science. The classification system, in part, is dictated by what information is available. For example, species and rare community data are either not available or not dependable in northern Alberta (Timoney 2003), in large part because survey effort is limited to accessible areas (e.g., along roads).

A common information source when assessing representation during large-scale planning exercises is ecological land classification, such as the provincial ecological land classification (ELC) framework (Downing and Pettapiece 2006). The ELC framework consists of a nested hierarchy of ecosystem classifications based on the distribution of abiotic factors (geology, soil, climate, water) and vegetation types across spatial scales. The finest spatial scale is ecodistricts, followed by natural sub-regions and natural regions. Natural sub-region is an appropriate level of the hierarchy when seeking to represent broad-scale ecological variation (Schneider 2002), and has been used by the Government of Alberta when setting representation targets (e.g., Special Places 2000).

Fort McKay's Traditional Territory is ecologically diverse, encompassing five natural sub-regions:

- Lower Boreal Highlands
- Upper Boreal Highlands
- Central Mixedwood
- Athabasca Plain, and
- Kazan Uplands[1].

Although the Upper Boreal Highlands, Athabasca Plain and Kazan Uplands are well represented by existing protected areas (i.e., provincial or federal parks), the remaining natural sub-regions are not (Table 3). The Convention on Biological Diversity's strategic plan for biodiversity for 2011-2020 sets as a target that at least 17% of terrestrial and inland water is conserved through an ecologically representative system of protected areas[2]. If this target is applied to Fort McKay's Traditional Territory to set natural sub-region representation goals, an additional 2358 km^2 of the Central Mixedwood and 758 km^2 of the Lower Boreal Highlands natural sub-regions would require protection.

The Moose Lake area is in proximity to the under-represented natural sub-regions (Lower Boreal Highlands and Central Mixedwood), such that protected area expansion in the area could increase protected representation of Fort McKay's Traditional Territory's ecological diversity. Of the two natural sub-regions, the Lower Boreal Highlands should be prioritized for protection given than the Central Mixedwood natural sub-region is well protected by neighbouring Wood Buffalo National Park.

[1] Fort McKay's Traditional Territory also contains a small amount of the Peace-Athabasca Delta natural sub-region. The Peace-Athabasca Delta natural sub-region is not discussed in this report because it comprises a very small portion of the Traditional Territory.
[2] http://www.cbd.int/sp/targets/

Table 3: Representation of Natural Sub-regions within Protected Areas in Fort McKay's Traditional Territory

Natural Subregion	Area within the Traditional Territory	Percent Protected
Kazan Uplands	252 km^2 (0.7% of the Territory)	96.4%
Upper Boreal Highlands	5100 km^2 (14.1% of the Territory)	25.5%
Athabasca Plain	6183 km^2 (17.1% of the Territory)	19.1%
Central Mixedwood	19,340 km^2 (53.4% of the Territory)	4.8%
Lower Boreal Highlands	5318 km^2 (14.7% of the Territory)	2.7%

Species respond to variation in physical and biotic factors across a range of spatial scales, and representation targets that span multiple spatial scales are more likely to be effective (Rouget 2003). Natural sub-regions are useful for assessing the capacity of a protected areas network to represent coarse ecological variation; however, at the local scale, protected areas must encompass suitable vegetation communities to maintain the local suite of species.

Although relatively simple in terms of vegetation types (e.g., dominant forest species), boreal ecosystems are diverse in age due to the influence of fire (Schneider 2002). Species have evolved to the patchwork of forest age created by a variable fire regime, such that seral stages differ with respect to the suite of species they support. For example, older forests in Alberta's boreal forest (Schieck and Song 2006) support more species (Stelfox 1995) and large tracts of undisturbed forest are needed to maintain woodland caribou (Environment Canada 2011).

Recently disturbed forests are also important for species that rely on associated attributes such as young vegetation (e.g., moose) and standing dead trees (e.g., woodpeckers and cavity-nesting mammals) (Lindenmayer, et al. 2004). In boreal ecosystems, maintenance of the full range of species in perpetuity is likely to require that all seral stages exist in appropriate frequencies through time.

A potential limitation of representation in conservation areas is that natural communities are not stable, with the implication that capacity of an area to represent ecological communities is likely to change through time (Noss and Cooperrider 1994). In boreal ecosystems, protecting an area based on its current age-class composition is risky because the age-class composition will be changed (potentially dramatically) by future fire events or other natural disturbances (insect outbreaks, storms). Instead, conservation should focus on protecting areas capable of maintaining the full range of age classes in the face of an ongoing fire regime.

The concept of minimum dynamic reserves (MDR) was developed to incorporate natural disturbance into protected area design (Leroux, et al. 2007). A MDR is defined as the minimum reserve area needed to maintain representation of vegetation communities through time while permitting internal fluctuations in their abundance (e.g., due to fire).

Leroux, et al. (2007) applied the concept to a boreal region in the Northwest Territories to assess the minimum reserve area needed to maintain at least 25 hectares (ha) of each of five vegetation communities that varied in age and species composition. The estimated minimum dynamic reserve area was three times larger than the maximum fire size. The three times maximum fire size multiplier is being used elsewhere in the boreal to identify candidate conservation areas that are sufficiently large (e.g., Canadian BEACONs Project) to provide examples of naturally functioning boreal ecosystems (Canadian BEACONs Project 2008).

The largest fire size in the neighbouring Alberta Pacific Forest Management Agreement (FMA) area between 1961 and 2003 was 236,448 ha (Smith and D'Eon 2006), suggesting that a MDR in the northeast Alberta region might require at least 7000 km^2.

This scale is dramatically larger than the Moose Lake Reserves; [22] however, an opportunity exists to incorporate the Moose Lake Reserves within an area of sufficient scale by creating a protective buffer directly around the Moose Lake Reserves, and then further linking this buffer to the neighbouring Birch Mountains Wildlands Park (1445 km^2) and with Wood Buffalo National Park (44,807 km^2) to the north. It is important to note, however, that much of the Birch Mountains Wildlands Park and all of the Wood Buffalo National Park are on the periphery of Fort McKay's Traditional Territory and are therefore more challenging for people to use for cultural pursuits, particularly as people are based in Fort McKay. As a result, these areas are currently most significant for their contribution to ecological integrity of the Moose Lake area.

Principle 2: Maintain Populations of Native Species

A limitation of representation is that the needs of all species mighty not be accommodated by maintaining examples of ecological communities. Although it is not possible to assess the needs of all species due to time and information constraints, planning should consider the capacity of protected areas to maintain viable populations of a subset of species, especially those sensitive to expected future changes in landscape composition, those already declining in population levels or those that are culturally important. For example, area-limited species (Lambeck 1997) are often used as a focal species during protected areas planning, the assumption being that protected areas of sufficient size to maintain populations with large area requirements will also be sufficient to maintain populations with lesser area requirements.

Woodland caribou is an area-limited species in the region. A meta-analysis of boreal caribou population data concluded that local populations' maintenance requires that no more than one-third of a range occurs within 500 m of an anthropogenic footprint or has burned within the last 40 years (Environment Canada 2011). Greater levels of disturbance increase mortality rates beyond sustainable levels due to the influx of predators (i.e., wolves) in response to increased presence of alternate prey (e.g., moose or deer). Given that the average caribou herd in the region[3] spans 15,000 km^2, the viability of local populations requires relatively intact landscapes spanning thousands of square kilometres.

Two caribou ranges occur in the vicinity of the Moose Lake Reserves: West Side of Athabasca River (WSAR) to the south and Red Earth within which the Moose Lake Reserves

[3] Herds in the region include Red Earth (24,737 km^2), Richardson (7074 km^2), West Side Athabasca River (15,727 km^2), and East Side Athabasca River (13,160 km^2). Range sizes are from Environment Canada (2011).

are located (Figure 1). Both populations are in decline and have a very low likelihood of being self-sustainable (Environment Canada 2011), implying that conservation effort is required to secure their persistence. Indeed, the WSAR herd was targeted for conservation attention by an assessment of caribou management options in the region (Athabasca Landscape Team (ALT) 2009), whereas the Red Earth range is prioritized for restoration in the national boreal woodland caribou recovery strategy (Environment Canada 2011).

The WSAR caribou population is estimated at less than 400 animals, substantially less than the estimated natural population (2500 to 6000 animals), and risk from future development is high (Athabasca Landscape Team (ALT) 2009). To maintain the population, ALT proposed a caribou conservation area spanning thousands of square kilometres in the northern portion of the herd range, immediately south of Birch Mountain Wildland Park.

To be effective, the conservation area would need to be free from future industrial development and receive coordinated reclamation of existing land-use footprint (Athabasca Landscape Team (ALT) 2009). The area was prioritized for protection because it contains suitable habitat and relatively low wolf density, and has areas with no currently economic bitumen reserves or plans for timber harvest in the next 15 years. Some economic bitumen reserves do occur in the proposed caribou conservation area, including the Dover lease.

In pursuit of the goal of achieving self-sustaining local populations across the boreal population's range, the federal recovery strategy prioritizes twelve herds for recovery. The prioritized herds are not currently self-sustaining and need to be recovered to ensure representivity of ecological conditions and connectivity across the broader boreal caribou population. The Red Earth herd, estimated to contain between 172 and 206 animals, is one of the prioritized local populations. Recovery requires that anthropogenic and natural disturbance is reduced to cover no more than 35% of a range.

Anthropogenic disturbance covers 44% of the Red Earth range, and total disturbance (i.e., including burned areas) covers 62%. As such, disturbance needs to be reduced by almost half to secure a stable population. A reduction in disturbance of this magnitude is unlikely to occur without protection of habitat and changes to the pace of development in the region.

The WSAR and Red Earth herds cover 5964 km^2 and 4988 km^2 of Fort McKay's Traditional Territory, respectively. Some of the Red Earth range within Fort McKay's Traditional Territory is proposed to be incorporated in protected areas through the Lower Athabasca Regional Plan. The WSAR range, on the other hand, receives no protection nor is any formally planned within Fort McKay's Traditional Territory. Dover's Project area overlaps with the WSAR and Red Earth ranges.

The boundary between the two adjacent herds is to the south and west of the Moose Lake Reserves. Herd protection would not only contribute to caribou conservation, but also create a landscape-scale movement corridor across the Traditional Territory, through Birch Mountains Wildland Provincial Park, and into the expansive Wood Buffalo National Park to the north (Athabasca Landscape Team (ALT) 2009).

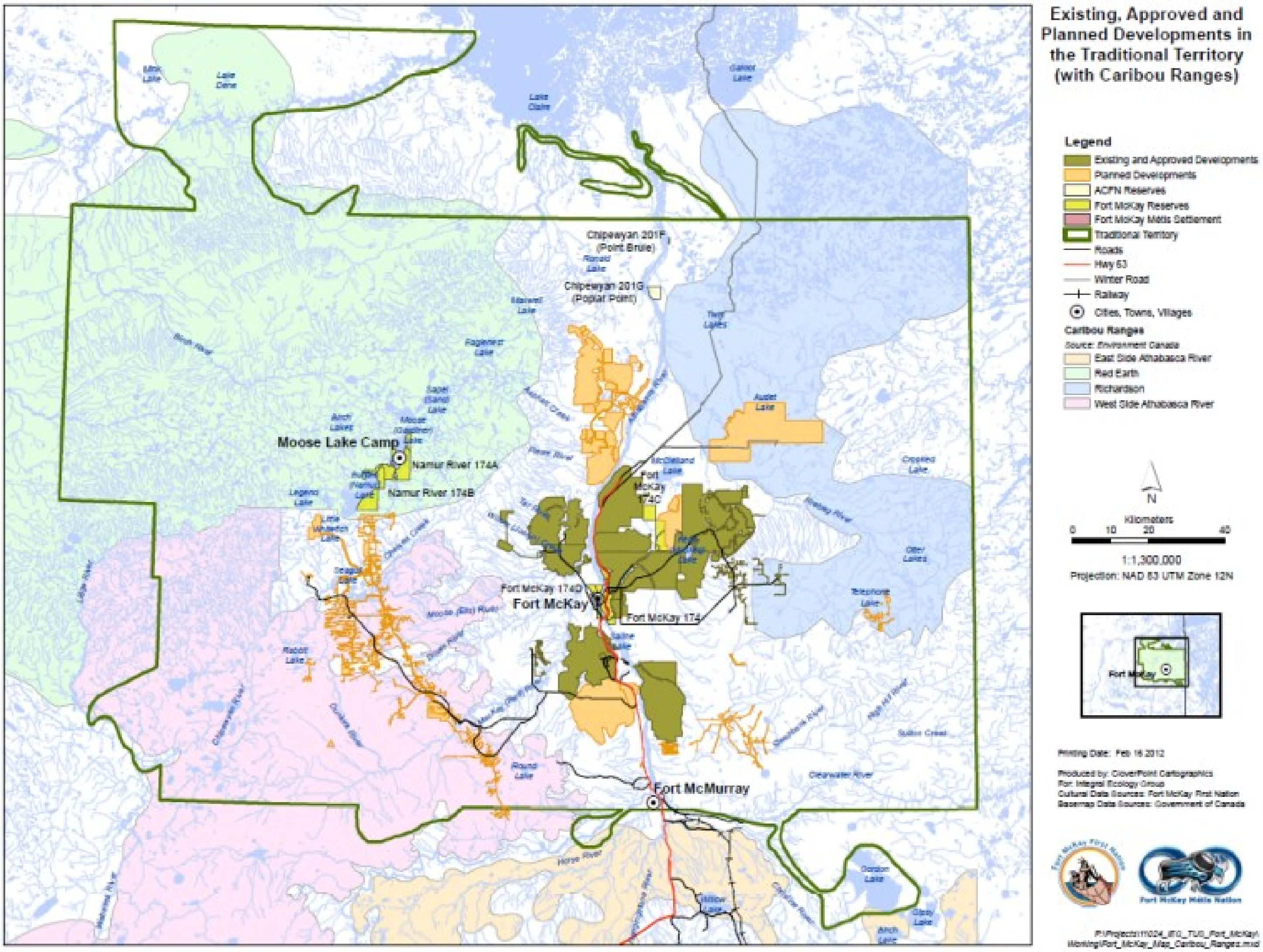

Figure 1: Existing, Approved and Planned Developments within Fort McKay's Traditional Territory including Woodland Caribou Ranges

It is important to note that there is little evidence that one species' habitat requirements can be used as a surrogate for the needs of multiple other species (Wiersma, Beechey, et al. 2005). However, woodland caribou is perhaps the most area-limited species in the region and considering their habitat requirements is a *precautionary* coarse filter approach when assessing how large protected areas should be to maintain integrity.

Another approach is to estimate the minimum reserve area (MRA), which refers to the minimum area required for a protected area to contain its historical suite of species. For example, an assessment of historical and current mammal distributions in relation to protected areas in eastern North America concluded that retention of the full complement of mammals requires protected areas that span approximately 5000 km^2, with a 95% confidence interval spanning from 2700 to 13,296 km^2 (Gurd, Nudds and Rivard 2001).

Based on the lower limit of the 95% confidence interval for MRAs in eastern North America, Wiersma, et al (2005) proposed 3000 km^2 as the minimum size requirement if a protected area in northern Canada is to maintain ecological integrity. Retention of a subset of less sensitive species in the Moose Lake area would require smaller expanses of protected habitat.

Phrased differently, the larger the protected area, the greater the proportion of species of plants and wildlife that will be maintained on the landscape. Deriving estimates of buffer sizes required to maintain viable populations of various species of interest (e.g., moose, fish and fisher) requires species-specific analysis, which has not been done yet. However, ensuring the long-term viability of the full complement of species is likely to require protection of areas that cover thousands of square kilometres.

Principle 3: Maintain Ecological Processes

Ecological processes such as hydrologic and nutrient cycles and natural disturbance regimes (fires, insect outbreaks) maintain conditions required to support boreal biodiversity. It is therefore necessary to consider ecological processes during protected area design (Noss and Cooperrider 1994). Maintaining the integrity of the fire regime's effect on landscape composition has already been discussed. This section will focus on water, due to its significance to Fort McKay and its importance to all life.

The status of aquatic systems is sensitive to the condition of upstream territory due to the movement of water across landscapes and through hydrologic networks. Examples of impacts to surface waters from upstream activities include eutrophication caused by increased nutrient runoff, contamination from upstream pollution, and altered water flows. Timber harvest causes soil saturation and increased runoff, and typically results in altered surface water quality when more than 30% of a boreal catchment is impacted (Prepas, Pinel-Allou, et al. 2003).

Groundwater can also be impacted by development such as steam-assisted gravity drainage (SAGD) bitumen extraction, which requires large amounts of groundwater for stream production and generates contaminated waste water (Ko and Donahue 2011). Roads associated with development are also problematic; stream crossings, particularly culverts, deliver sediment and nutrients to aquatic systems, fragment fish habitat (Park, et al. 2008), and deplete fish communities through increased angler access (Sullivan 2003).

These and other impacts (Sanders, Meeuwig and Vincent 2002) are such that maintenance of aquatic ecosystem integrity (Lowe and Likens 2005) requires the protection of headwaters (Meyers, et al. 2007). Protection of watershed catchments has multiple benefits including preserving aquatic biodiversity, maintaining freshwater supply and, when combined with catchment-scale monitoring of water and biogeochemical balances, early detection of ecosystem service degradation (Schindler and Lee 2006).

Maintenance of the integrity of the Moose Lake ecosystem will be supported by protection of the upstream landscape. Watersheds are hierarchical, ranging from very large (e.g., areas that drain into an ocean) to small (e.g., area that drain into a stream segment). A useful level of the hierarchy when considering impacts to water quality is effective drainage area, which refers to the portion of a drainage basin expected to contribute all runoff to the aquatic feature during a flood event with a return period of two years (Godwin and Martin 1975). Three effective drainage areas (or watersheds) overlap with the Moose Lake Reserves Figure 2. The largest is Upper Gardiner Lake's drainage watershed, which covers 884 km^2. Two smaller watersheds to the south of Upper Gardiner Lake cover 196 km^2 and 177 km^2.

Protecting these watersheds would secure aquatic features from contamination during moderate runoff events. A higher risk approach would be to protect buffers around aquatic features in the drainage areas; however, research suggests that buffers might have limited effectiveness for maintaining water quality in boreal ecosystems (Prepas, Pinel-Alloul, et al. 2001).

Principle 4: Resilience to Changing Conditions

If ecological integrity is to be maintained in the long-term, a protected area's ecosystems must be resilient to changing conditions. Boreal ecosystems are inherently dynamic, and an earlier section has discussed protected area requirements for maintaining the full range of forest types and seral stages in the presence of a stochastic fire regime. However, in addition to accommodating natural fluctuation in conditions, protected area design must consider the directional shift that is occurring with climate change. High latitude areas, such as northern Alberta, are expected to experience more rapid climate change than temperate and tropical biomes. By the 2080s, the temperature at Fort McMurray is expected to be similar to that currently observed at Lethbridge or Medicine Hat (Barrow and Yu 2005).

Such a pronounced climate shift has substantive ecological implications. For example, changes in air temperature and fuel moisture are expected to increase the fire rate in western Canada 3.5-fold to 5.5-fold (Balshi, et al. 2009). More prevalent fire would have severe consequences for woodland caribou habitat, and would likely increase the area required to accommodate the fire regime while also maintaining the full range of forest seral stages.

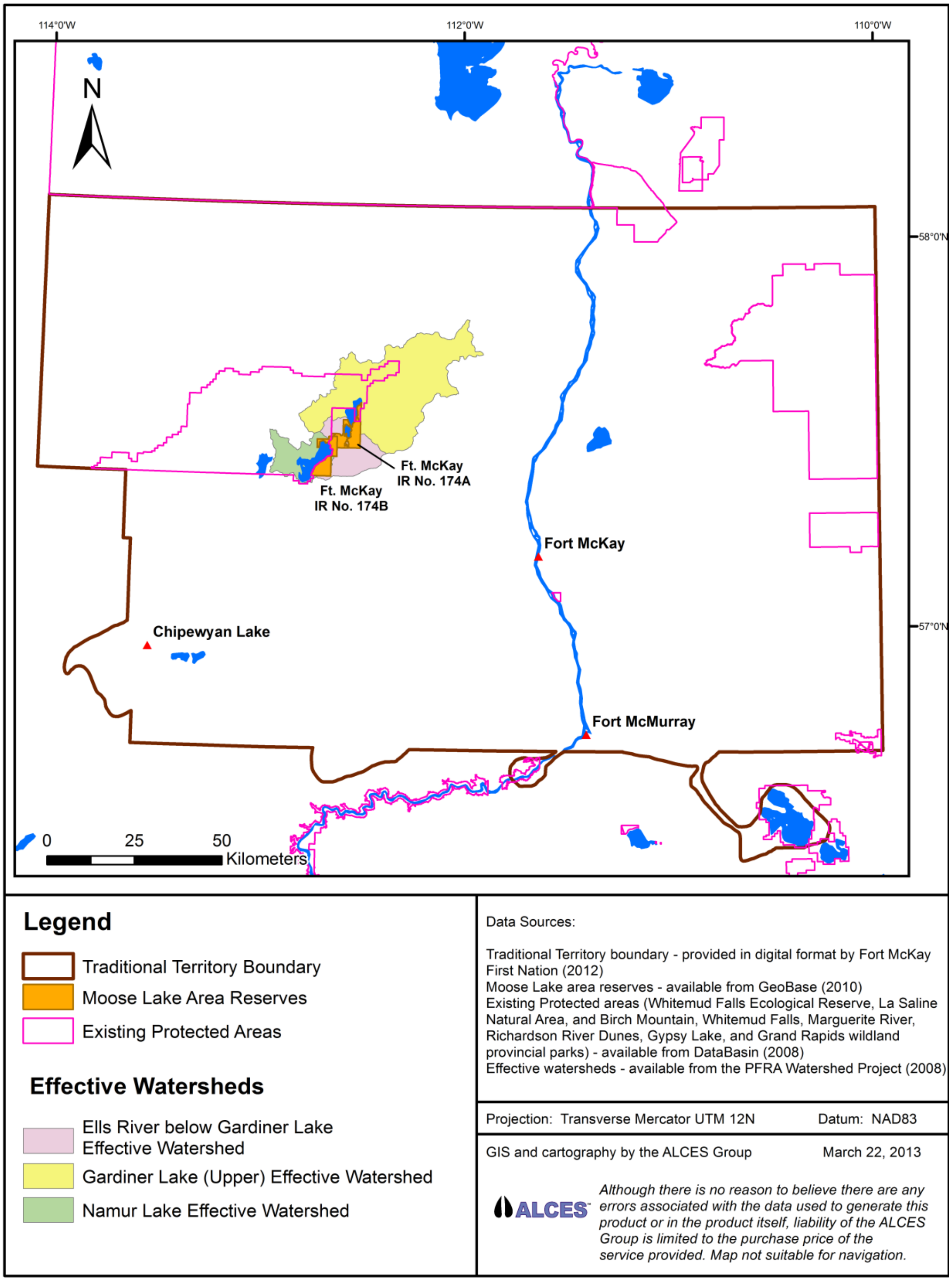

Figure 2: Effective Watersheds Overlapping with the Moose Lake Reserves

Another consequence of climate change is that the distribution of plants and wildlife will shift, necessitating migrations if populations are to persist. Globally, restricting migration might double the number of species extinctions by 2050 (Thomas, et al. 2004). Populations in northern areas such as the boreal region are expected to require the highest migration rates (Malcolm and Markham 2000), and northward shifts in population density are already being observed (Virkkala and Rajasarkka 2011). The terrestrial biome type of almost half of Canada's protected areas might change, emphasizing that isolated protected areas cannot be expected to retain their biodiversity (Lemieux and Scott 2005). Rather, protected areas must be linked to surrounding habitat to facilitate species shifts.

Species distributions tend to respond to climatic gradients such as temperature (Szabo, Algar and Kerr 2009), and maintaining connectivity across climatic gradients is needed to accommodate future shifts in species distributions. Elevational gradients might aide species in adjusting to climate change, given that a 500 m increase in elevation will compensate for a 3°C increase in temperature. Ensuring that the Moose Lake area is contiguous with nearby elevational gradients (i.e., the transition from the Central Mixedwood to the Lower Boreal Highlands to the Upper Boreal Highlands Natural Sub-regions) is therefore beneficial to species undergoing a re-distribution. However, the respite provided by elevational gradients might be short-lived if populations become stranded in isolated highland areas that are of insufficient size to support viable populations (Krosby, et al. 2010). Long-term resilience to climate change is likely to require connectivity across latitudinal gradients.

Fortunately, the Moose Lake area is located approximately mid-way along a relatively intact south-north corridor that spans the western portion of Fort McKay's Traditional Territory (see Figure 3). Although energy and forest sector development has fragmented habitat to the south of the Moose Lake area, current development is low relative to other nearby regions (Athabasca Landscape Team (ALT) 2009) and substantial intact forest remains. To the north, there is a relatively uninterrupted intact forest landscape spanning to Wood Buffalo National Park.

Proposed development of in situ bitumen or timber within the relatively intact western portion of the Traditional Territory (i.e., approximately to the west of the CNRL Horizon project), could sacrifice connectivity for disturbance-sensitive species. Narrow corridors that link isolated patches of forest might have limited effectiveness (Hannon and Schmiegelow 2002). Connectivity would be best maintained by establishing a corridor of intact habitat that is sufficiently wide to avoid edge effects and satisfy habitat requirements for a range of species (Bennett 2003); further analysis is required to establish suitable corridor attributes, such as minimum width. Ideally, the integrity of the entire landscape would be maintained by:

- establishing the proposed caribou conservation area in the northern portion of the West Side Athabasca River caribou range, an area which incorporates Moose Lake and areas to the south, including the Dover lease area;
- conserving effective watersheds that overlap with the Moose Lake Reserves; and
- protecting the landscape between Moose Lake and Wood Buffalo National Park (which could be at least partially achieved by proposed conservation areas from the LARP process).

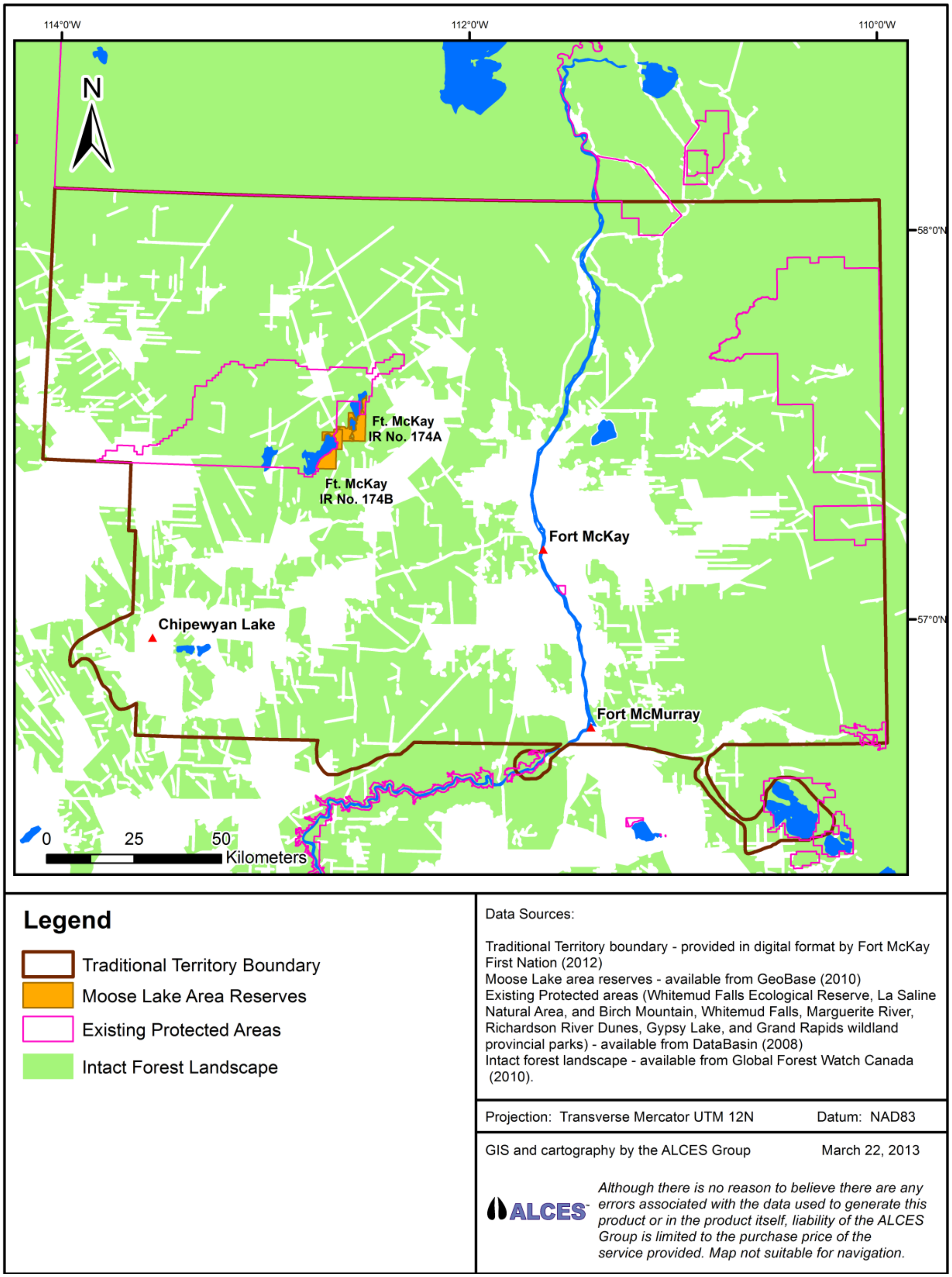

Figure 3: Intact Forest Landscapes within Fort McKay's Traditional Territory

Impacts of Adjacent Land Use on the Integrity of Protected Areas

Previous sections of this report have focused on strategies for maintaining the integrity of the regional ecosystem. It is important to note, however, that from a cultural perspective FMFN's greatest concern is maintaining ecological values in the vicinity of the Moose Lake Reserves because this is where their traditional land-use activities are focused. Maintaining viable wildlife populations at the regional scale, for example, will be of little benefit for FMFN traditional land use anchored by Moose Lake Reserves, if local wildlife populations in the landscape surrounding the Moose Lake area decline. Substantial anthropogenic footprint exists in unprotected landscapes in the vicinity, and is expected to increase in the future.

As part of an assessment of the naturalness of landscapes within 10 km of protected areas in Canada (Lee and Cheng 2011), the current landscape surrounding nearby Birch Mountain Provincial Park was assessed as being more than 25% "accessed" by anthropogenic footprint (the highest category of impact assigned by the study). Given the large bitumen reserves in the region, it can be expected that disturbance of the adjacent landscape will increase through time. In this section, the potential impact of adjacent land use on wildlife populations in the Moose Lake area is discussed.

The presence of land use adjacent to a protected area can impact wildlife both within and outside of the protected area. Land use can decrease habitat availability and increase mortality (e.g., hunting, trapping, vehicle collisions), such that population density is often depressed in landscapes adjacent to protected areas (Hansen, Contribution of source-sink theory to protected area science 2011). The negative impacts of land use can extend to wildlife residing within protected area boundaries, given the propensity for animals to disperse beyond park boundaries. Wildlife are unlikely to perceive that landscapes beyond protected area boundaries present higher risks of mortality because species have not evolved in the presence of modern levels of human-induced mortality.

Metapopulation theory is relevant here, whereby a regional population is comprised of subpopulations that are linked by dispersal of individuals. As landscapes are fragmented by land use, populations might also become fragmented into subpopulations (Hunter 2002). Two general types of subpopulations exist: sources that are capable of producing a surplus of individuals that might disperse; and sinks incapable of maintaining a viable population without immigration from source subpopulations. The concept of source-sink dynamics is relevant to protected areas and surrounding landscapes because:

1. wildlife is likely to move across protected area boundaries; and
2. a gradient in land-use intensity across protected area boundaries can create the differentiation in birth and death rates that cause subpopulations to exist as sources and sinks (Hansen, Contribution of source-sink theory to protected area science 2011).

High mortality rates can cause subpopulations within landscapes adjacent to protected areas to become sinks. This depresses population density in the unprotected landscape and can cause population density to decline in the protected area if mortality in the unprotected sink subpopulation surpasses surplus production of individuals from the protected source subpopulation.

Existing evidence suggests that source-sink dynamics at the boundary of protected areas apply to wildlife species that are relevant to the Community of Fort McKay. For example, a black bear population inhabiting a sanctuary in North Carolina where hunting was prohibited was assessed as being likely to decline due to high mortality rates suffered by bears dispersing into forest beyond the sanctuary boundary (Powell, et al. 1996). Bear detections were lower outside than within the sanctuary, and the majority of bears hunted in the adjacent forest had previously resided in the sanctuary. The ensuing mortality rate was too great to ensure long-term persistence of bears both within and adjacent to the sanctuary. The authors recommended a larger sanctuary and especially the elimination of roads and associated human access to secure a viable bear population.

Additional evidence of a black bear population sink adjacent to a protected area is Algonquin Provincial Park in Ontario, where all but two bears radio collared within the park dispersed beyond the park's boundary, and six of the eleven bears leaving the park were killed by hunters (Inglis and Wilton 1998). Moose from within Algonquin Provincial Park were also found to disperse beyond the park's boundary and subsequently suffer mortality primarily due to hunting (Wilton and Bisset 1988). Of 386 moose tagged within the park, at least 8% were killed outside of the park. The harvested moose were found to have dispersed substantial distances. The average distance between the locations of tagging and mortality was 15.9 km, 11 km of which was within the park. Population densities outside of the park were four to seven times lower than within the park. Based on these findings, the authors suggested that an 11 km buffer extending beyond the extent of the protected population might be needed to protect the majority of moose from hunting.

Population sinks in landscapes along the boundary of protected areas will have the greatest impact when species are wide ranging and when the protected area's perimeter-to-area ratio is high (Woodroffe and Ginsberg 1998). Both cases apply to the Moose Lake area and reserves. Large mammals typical of the region are wide ranging:

- Movements of up to 26.9 km (mean of 11.5 km) were observed in radio-collared moose in Swan Hills Alberta (Lynch 1976).
- Black bears near Cold Lake Alberta were found to disperse as far as 35 km, with an average long-range excursion distance of 23 km (Pelchat and Ruff 1986).
- Black bears in Algonquin Provincial Park in Ontario were found to disperse from 18.8 km to 73.8 km from breeding territories (Inglis and Wilton 1998).

These examples emphasize the potential for wildlife to disperse beyond the boundary of the Moose Lake Reserves (total area of 77.5 km^2) in the Moose Lake area and to be exposed to land use occurring in the unprotected landscape.

The Moose Lake Reserves' location adjacent to the substantially larger Birch Mountains Provincial Park might provide some respite from edge effects, but adjacent land use is still likely to impact wildlife populations within the Moose Lake Reserves and in the Moose Lake area where Fort McKay has and continues to actively practice traditional land use. The length of the boundary of the Moose Lake Reserves that straddles unprotected land is long relative to the area of the Moose Lake Reserves, increasing susceptibility to edge effects. Also increasing the susceptibility of the Moose Lake Reserves to edge effects is that the reserves themselves do not have protected status.

Further, the capacity of Birch Mountain Provincial Park to act as a source to offset edge effect related mortality within the Moose Lake Reserves is diminished by the Moose Lake Reserves' location at the periphery of the park. Wildlife movement within the park should not necessarily be expected to be directed toward the Moose Lake Reserves, and random movement would favour dispersal away from the Moose Lake Reserves given the Moose Lake Reserves' location at the park's periphery.

As an example, moose in Ontario did not exhibit a directional tendency from a protected to unprotected landscape, leading to the conclusion that sustained yield of moose within an unprotected landscape is likely to be more influenced by the productivity of resident survivors than on dispersal from adjacent protected landscapes (Goddard 1970). Also, dispersal is not necessarily positively related to population density and indeed was found to be negatively related to black bear population density in southwestern Quebec (Roy, et al. 2012).

Therefore , it cannot be assumed that wildlife will tend to disperse directionally from higher density subpopulations within protected areas towards lower density subpopulations along the boundary of protected areas. While Birch Mountain Provincial Park undoubtedly makes a positive contribution to the viability of regional wildlife populations, it is likely that land use adjacent to the Moose Lake Reserves would detrimentally affect wildlife in the Moose Lake area. Buffering the area of interest from industrial development and controlling adjacent land use is therefore a prudent strategy for managing risk to wildlife values in the Moose Lake area.

Recommended approaches for increasing the viability of populations within protected areas exposed to land use on their periphery focus on expanding the size of the protected area (Hansen, Contribution of source-sink theory to protected area science 2011)and other strategies to modify human behaviour in the adjacent landscape (Hansen and DeFries 2007). In general, risk of detrimental impacts to wildlife populations within protected areas should decline with increasing size of the buffer protecting the boundary of the protected areas from land use.

The fact that the Moose Lake Reserves are not protected from public access might increase their susceptibility to neighboring land use. While a precise prescription for buffer width based on the literature is difficult to establish, research indicates that biodiversity within protected areas is susceptible to land use tens of kilometres distant from the protected area boundary.

Wiersma and Simonson (2010) found anthropogenic footprint outside of Canadian national parks to be a significant predictor of extirpation of disturbance-sensitive mammals (Wiersma and Simonson 2010).

Effective habitat area outside of parks was a more important predictor than human population density. As such, disturbance-sensitive mammals were at greater risk of extirpation when the surrounding matrix was disturbed by land use, even if human population density in the region was low. Effective habitat area was assessed by subtracting anthropogenic footprint from total habitat area within buffers of 10 km, 25 km, 50 km and 100 km of park boundaries. Statistical analysis provided strong support for the negative influence of land use to mammals within each of the buffer widths, although the influence of land use within the 100 km buffer was less than the influence of land use within the other buffer widths. Based on this result, the authors recommended that total habitat was maximized (i.e., minimize detrimental land use) within 50 km of protected area boundaries to reduce the threat of species extirpations.

Other studies have also found biodiversity within protected areas to be detrimentally affected by land use occurring in the adjacent landscape. Rivard, et al. (2000) found extirpation of mammals from Canadian national parks was positively related to the extent of human-dominated land cover within a 100-km buffer and concluded that management of areas surrounding parks is likely to be as important to mammal populations within parks as management of the parks themselves (Rivard, et al. 2000).

Extirpated species tended to be hunted fauna suggesting that extirpations are not necessarily solely related to habitat loss or fragmentation but rather to human activity (e.g., hunting pressure). Using human density as an index of the intensity of human impact, Parks and Harcourt (2002) found extinction rates of large mammals within protected areas in the United States to be significantly correlated with human impact within 50 km to 100 km of protected area boundaries (Parks and Harcourt 2002). In contrast, extinction rates were not significantly correlated with the size of the protected areas. The authors concluded that land use occurring outside of protected areas can have a strong influence on wildlife residing within protected areas.

Woodroffe and Ginsberg (1998) evaluated the relative contribution of edge effects and small population size to species extinction from protected areas by assessing home range size and population density of extirpated large carnivore species (Woodroffe and Ginsberg 1998). Species with large home range sizes are more likely to travel beyond protected area boundaries, thereby being exposed to human-induced mortality. Species with low population density, on the other hand, are more likely to be affected by stochastic processes that can detrimentally affect small populations within protected areas. Home range size was found to be a stronger predictor of extinction, indicating that edge effects rather than low population size is the more important factor contributing to species loss from protected areas.

The authors concluded that border areas of protected areas can be population sinks and that conservation efforts should be focused on maximizing protected area size or mitigating human-induced mortality in landscapes surrounding protected areas.

In conclusion, land to the east, south, and north of the Moose Lake Reserves is unprotected making it likely that industrial development will modify ecosystems and increase human access along much of the Moose Lake Reserves' boundary. Should this occur, wildlife within the Moose Lake area will likely be affected by edge effects. Examples exist of wildlife populations within protected areas being detrimentally impacted by land use tens of kilometres distant from the protected area boundary.

Implementing a buffer around the Moose Lake Reserves that limits industrial activity and human access along the exposed boundaries of the Moose Lake Reserves would reduce the risk of edge effects negatively affecting wildlife within the Moose Lake area.

Conclusion

This report has drawn from the principles of the conservation biology arena and relevant literature to provide a first-order approximation of protection requirements for maintaining the ecological integrity of the Moose Lake area.

Land use typical for the region, most notably in situ and mineable bitumen development, is intensive in Fort McKay's Traditional Territory. A precautionary approach to maintaining ecological integrity in the presence of these developments is to assume that ecological value provided by developed areas will be limited. Given this and the large spatial scale at which populations (e.g., woodland caribou) and processes (e.g., fire, hydrology, potential species migrations) operate in the region, maintaining ecological integrity of the Moose Lake area is likely to require the protection of a large landscape. As the area protected increases, risk to ecological integrity declines because more populations and processes are secure from activities occurring beyond the protected area's border.

Table 4 summarizes strategies referred to in this report. Lower risk strategies require the protection of larger areas. Although a precise estimate of protected area size is beyond the scope of this report, a low-risk strategy for maintaining ecological integrity calls for the protection of an area that is thousands of square kilometres in size. Further analysis is required to establish more detailed protected area recommendations for the Fort McKay's Traditional Territory.

Table 4: High and Low Risk Strategies for Maintaining Ecological Integrity Discussed in This Report

Ecological Integrity Principle	Higher risk strategy	Lower risk strategy
Maintain examples of all ecosystem types	Represent 17% of each natural sub-region in the Traditional Territory. This would require protection of 758 km² of Lower Boreal Highlands and 2358 km² of Central Mixedwood.	Protect an area capable of maintaining the full range of forest age classes. This likely requires protection of at least 7000 km², which is three times the size of the largest fire expected in the region.
Maintain populations of all species	Protect an area covering at least 3000 km², which has been proposed as the minimum size requirement for protected areas in northern Canada based on minimum reserve area estimates for mammals in southern Canada.	Protect the extent of nearby caribou herds (Red Earth and WSAR) that overlap with the Traditional Territory. Herd area within the Traditional Territory is 4988 km² for Red Earth and 5964 km² for WSAR.
Maintain ecological processes	Protect buffers around lakes and streams in the Moose Lake area. The area required to protect buffers has not been assessed.	Protect effective drainage areas that overlap with the Moose Lake Reserves. Effective drainage areas that overlap with the Moose Lake Reserves cover 1257 km².

Ecological Integrity Principle	Higher risk strategy	Lower risk strategy
Maintain resilience to changing conditions	Protect an elevational gradient between the Moose Lake area and surrounding areas. The area required to protect an elevational gradient has not been assessed.	Protect a latitudinal gradient across the western portion of the Traditional Territory. The area required to protect a latitudinal gradient has not been assessed.

Protecting the western portion of Fort McKay's Traditional Territory (i.e., approximately the area to the west of the CNRL Horizon project) would build upon the existing protected areas of Birch Mountains Wildland Park and Wood Buffalo National Park and the Moose Lake Reserves. It would also be consistent with the recommendation from a multi-stakeholder woodland caribou planning team to protect the northern portion of the West Side Athabasca River caribou range (Athabasca Landscape Team (ALT) 2009) and would provide a buffer to oil sands development that is proposed to the south of Moose and Buffalo lakes.

Relative to the central portion of Fort McKay's Traditional Territory, protection of western portion is economically efficient because resource potential is lower. For example, protection of the northern portion of the West Side Athabasca River caribou range was recommended by ALT (2009), in part, because it contained areas with no currently economic bitumen reserves or plans for timber harvest in the next 15 years.

When expanding the protected areas network in the western portion of Fort McKay's Traditional Territory, it would be important to ensure that sufficient area is protected to the east of Moose Lake Reserves to maintain ecological integrity from development outside of the protected area boundary. Protecting effective drainage areas of overlapping with the Moose Lake region would contribute to this. The cultural significance of the Moose Lake area and Moose Lake Reserves are also important considerations for developing a buffer for the Moose Lake area. As discussed in the section "Impacts of Adjacent Land Use on the Integrity of Protected Areas", land use tens of kilometres distant has been shown to detrimentally impact wildlife within protected areas. Implementing a buffer that limits industrial activity along the exposed southern and eastern boundaries of the Moose Lake Reserves would reduce the risk of edge effects negatively affecting wildlife within the Moose Lake area.

In contrast to the western portion of the Traditional Territory, bitumen reserves are high in the central portion of the territory. Bitumen reserves development will generate substantial economic growth at the cost of diminished ecological integrity. Protecting the western portion of the territory provides an opportunity to offset ecological degradation caused by development elsewhere, at a scale sufficient to maintain ecological integrity in the Moose Lake area and surrounding region.

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