INTEGRAL ECOLOGY GROUP LTD.

A Community Approach for Landscape Planning

Prepared for: The Fort McKay Sustainability Department

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EXECUTIVE SUMMARY

Northeast Alberta is experiencing substantial and rapid development associated with both mining and in-situ extraction of oil sands deposits. The closest indigenous community to the centre of oil sands development is the hamlet of Fort McKay, with a population of approximately 778 Cree, Dene and Métis residents (Aboriginal Affairs and Northern Development Canada (AANDC), 2013). The territory traditionally occupied by Fort McKay supported sustained aboriginal traditional land uses and subsistence in the pre-industrial period (pre-1960s), but at present is under increasing pressure from industrial development and associated human activity. There are currently 19 surface-mining or in-situ oil sands projects within Fort McKay's traditional territory that are operating or have regulatory approval to start construction, and tenured leases for oil sands projects occupy 70% of Fort McKay's traditional territory and 98% of Fort McKay's registered traplines ((Lagimodiere, 2013); lease data current to November 2012). The two largest and longest-standing mines in the region are located within approximately 10-20 km of Fort McKay, with two other mines operating within 5-10 km of the town for the last decade. Associated with this industrial development, the number of people living in Fort McKay's traditional territory has grown to over 100,000 (Regional Municipality of Wood Buffalo (RMWB), 2012).

Fort McKay's culture and traditional lands have been and continue to be affected by industrial development, with these effects linked to changes in air quality, loss of wildlife habitat, and other aspects of land disturbance (Fort McKay Industry Relations Corporation (IRC), 2010). A comprehensive, multi-stakeholder analysis of regional (including Fort McKay's traditional lands) environmental effects of oil sands development conducted in 2008 indicated that some ecological indicators are already below their pre-disturbance levels (moose, fisher, fish), with their decline projected to continue with future industrial activity. This analysis supports the experience expressed by Fort McKay community members of substantial adverse environmental effects of industrial development in their territory.

In order to better understand current and probable future effects of industrial development, in 2011 Fort McKay commissioned a comprehensive cumulative-effects study focused on the community and its traditional territory. The intent of this study was to assess the environmental impacts of current oil sands development and future development scenarios, and to identify management tools that can be implemented to meet Fort McKay's objectives for maintaining ecological integrity and traditional land-use opportunities on their reserves and within their traditional territory. The study used ecosystem simulation modelling to evaluate the performance of selected environmental indicators on the current and projected future landscape, and to compare this performance to pre-industrial baseline conditions.

The project included extensive community engagement, to ensure that the ecological indicators and mitigation strategies established in the modelling reflected Fort McKay's interests and were culturally relevant.

Results from this project reinforce the experience of community members and the findings of similar previous studies that some environmental indicators are already in decline in the region. Fort McKay's traditional territory has undergone a significant transformation over the past 50 years, with a current industrial footprint of almost 100,000 ha, the majority located in direct proximity to Fort McKay. Our modelling shows that, as a result of this development, studied biotic indicators have declined by an average of 24% from median pre-disturbance conditions.

Although surface mining accounts for the majority of industrial disturbance at present, in-situ development activity is in its initial stages in the region, and is beginning to expand into areas of the traditional territory that have been otherwise relatively remote and undisturbed. This study indicates that, as a result of this expansion, the future effects of industrial development on environmental indicators will be greater in scale and pace than those that have occurred to date, with over 800,000 ha of projected land disturbance over the next 100 years. This disturbance is predicted by this study to lead to continued decline in environmental indicators unless rapid mitigation actions are taken, with a projected average decline in biotic indicators of 62% from median pre-industrial conditions.

In order to mitigate these projected effects, through this study a suite of mitigation options, supported by the community, were developed that if adopted and implemented, would substantially reduce the adverse effects of industrial development on the future health and integrity of ecosystems in the Fort McKay traditional territory. These mitigation options include:

- expanding areas protected from industrial development and locating them with reference to Fort McKay's environmental and cultural objectives;
- developing a coordinated access management plan for the traditional territory that is enforced by the Government of Alberta, in order to reduce motorized access to the landscape and corresponding overharvest of fish and wildlife resources; and
- including regulatory requirements for industry Best Management Practices that seek to reduce growth of overall cumulative disturbance footprint.

Collective implementation of these community-supported mitigation options is projected to reduce the future decline of biotic indicators in Fort McKay's traditional territory to 34% from median pre-industrial conditions - which represents a substantial improvement from predicted declines under business-as-usual management, and only 10% further decline from current conditions - while still allowing significant continued bitumen extraction and related industrial activities in the traditional territory.

GLOSSARY OF TERMS

Aboriginal rights - Unique rights that First Nation, Metis and Inuit people of Canada hold by reason of having been independent, self-governing societies prior to the establishment of Canadian sovereignty. These rights are recognized and protected under Section 35 of the Constitution Act, 1982 and are part of the Common law in Canada. Aboriginal rights include the harvesting rights of the Métis, and the right to site specific cultural practices and features;

access management - A land use management tool that is directed to engage the public and stakeholders in consideration of future road development and management of use (motor vehicle and off-road-vehicle traffic) on existing roads and linear features. Effective access management is implemented as a systematic and regional coordinated plan to reduce access across the regional landbase, and would require government enforcement.

ALCES® - A Landscape Cumulative Effects Simulator - a landscape model which can simulate environmental and human-related changes and track a wide variety of environmental, biological, and socio-economic indicators as landscape change unfolds. ALCES is designed to explore and represent changes in land base composition caused by land uses and ecological processes.

Anthropogenic footprint – human-made permanent or temporary disturbance features that occupy space on the landscape such as roads, well-sites, transmission lines, towns, cities, mines, industrial plants.

BMP - Best Management Practices (BMP). A best practice is a method or technique that has consistently shown results superior to those achieved with other means, and that is used as a benchmark. In addition, a "best" management practice can evolve to become better as improvements are discovered. Best management practices are used to maintain quality as an alternative to mandatory legislated standards and can be based on self-assessment or benchmarking.

CEMA - Cumulative Environmental Management Association (www.cemaonline.ca), a multi-stakeholder group operating in the Regional Municipality of Wood Buffalo, Alberta. CEMA is a key advisor to the provincial and federal governments committed to respectful, inclusive dialogue to make recommendations to manage the cumulative environmental effects of regional development on air, land, water and biodiversity.

Community - The entire Community of Fort McKay includes First Nations members, Metis members and non-status members.

EIA - Environmental Impact Assessment. An assessment of the possible positive or negative impacts that a proposed project may have on the environment, together consisting of the environmental, social and economic aspects.

Enhanced Approval Process (EAP) - To aid the Integrated Operational Guidelines task team with project management support, and to assess and consolidate current guidelines, identify gaps, develop land use standards where required, and assemble a Consolidated Standards and Guidelines document to become a part of the development of a enhanced AOA.

FMSD - Fort McKay Sustainability Department

Focus Group - a selected group of Fort McKay Community members to participate in the Fort McKay Cumulative Effects Project

FMFN – Fort McKay First Nation

FMTA – Fort McKay Tribal Administration

Footprint type (FT) – an anthropogenic disturbance type (anthropogenic or human-made) classifications in ALCES

Industrial Study Area - The intensive oil sands industrial zone in and around the hamlet of Fort McKay, set as the Industrial Study Area for the Fort McKay Cumulative Effects Study, See Figure 5.

in situ operation - (i) a scheme or operation ordinarily involving the use of well production operations for the recovery of crude bitumen from oil sands

Integrated Land Management (ILM) - A strategic, planned approach to manage and reduce human footprint on the landscape.

Integrated Resource Management (IRM) - A coordinated approach to land and resource management, which encourages multiple-use practices.

Landscape type (LT) – discrete ecosystem (or broad habitat) classes used by the ALCES model that are not disturbed by development.

LARP - Lower Athabasca Regional Plan (Government of Alberta 2012), or pertaining to the land use plan for the Lower Athabasca Region.

MOSA - mineable oil sands area in northeastern Alberta (see Figure 5).

RMWB - Regional Municipality of Wood Buffalo. A specialized municipality located in northeastern Alberta, home to vast oil sand deposits, also known as the Athabasca Oil Sands, helping to make the region one of the fastest growing industrial areas in Canada. (http://www.woodbuffalo.ab.ca/).

RNV - Range of Natural Variation. The normal variation of a specific ecological indicator that occurs in response to the full suite of natural and episodic disturbances that characterize an ecological system.

Fort McKay Study Area – The main study area for the Fort McKay Cumulative Effects Project, including most of the Fort McKay traditional territory, with the exception of the northern portions located in Wood Buffalo National Park.

SAGD - steam assisted gravity drainage - an in situ production process using two closely spaced horizontal wells: one for steam injection and the other for production of the bitumen/water emulsion

SEWG – Sustainable Ecosystems Working Group, previously a working group in the Cumulative Environmental Management Association, now the Land Working Group

Simulation – the imitation of the operation of a real-world process or system over time. Computer models such as ALCES are designed to simulate real-world landscape changes due to natural fires and industrial activities.

Stochastic – A stochastic process is one whose behavior is non-deterministic; it can be thought of as a sequence of random variables.

TEMF - Terrestrial Ecosystem Management Framework (CEMA-SEWG 2008), a framework provided to the Government of Alberta that documented cumulative effects in the Regional Municipality of Wood Buffalo and recommended management actions to improve indicator performance following a triad land management approach.

traditional land use study (TLUS) – Also known as "Traditional Use Studies"(TUS) and "Use and Occupancy Map Surveys" (UOM), TLUS are a form of social science investigation that brings together community knowledge with ethnographic, archival and sometimes archaeological information to provide clarity on places and values of cultural, economic, heritage or community importance. This is usually accomplished through the recording of oral history and map biographies in interviews with community elders and sometimes a larger representative sample of the community.

Treaty rights - Treaty 8) are the rights embodied by Treaty 8 as interpreted by the Courts and include the adherents' right to hunt, trap and harvest natural resources within their Traditional Territory, the right to pursue their way of life; and the right to the use, enjoyment and control of lands reserved for them.

Traditional Territory is the area of land upon which a First Nation is entitled to exercise its Treaty Rights

1 INTRODUCTION

1.1 CONTEXT

Northern Alberta's oil sands resource is the second largest petroleum reserve world-wide. Large-scale industrial extraction of this resource began in the 1960s, and continues to increase in pace and scale. To date, the majority of oil extraction has occurred through surface mining methods, but in-situ extraction is expected to account for a growing proportion of production in the future[1]. The Regional Municipality of Wood Buffalo (RMWB), in which the majority of current oil sands activity is located, is a large (approximately 140,200 km^2) area of boreal forest (Government of Alberta 2010). Human population estimates in this area were as low as 2,600 in the mid-1960s (Fort McMurray Historical Society, from year 1966), with the majority of these being indigenous peoples (Fort McMurray, 2010). Industrial oil sands expansion has brought an influx of resident and transient workers centred on the city of Fort McMurray with a current regional population of about 119,000 (RMWB 2012).

The closest indigenous community to the centre of oil sands development is the hamlet of Fort McKay, with a population of approximately 778 Cree, Dene, and Métis residents (Aboriginal Affairs and Northern Development Canada (AANDC), 2013). Although this population now lives primarily in Fort McKay, prior to the advent of industrial oil sands extraction activities, aboriginal people in the region made use of large expanses of land patterned after availability of animal, fish and fish population. The land base people occupied included the currently defined traditional territory of the Fort McKay community more than 3.6 million hectares in size (Figure 1). Living off the land, including subsistence activities such as hunting, is central to the Fort McKay culture: "Our hunting and harvesting of meat is at the very centre of the Fort McKay way of life" (Fort McKay Tribal Administration, 1983). As hunters, trappers, fishers and gatherers, harvesting is important economically, culturally and socially. Time spent on the land is crucial to the passing of skills, knowledge and traditions among the Fort McKay people (Fort McKay Industry Relations Corporation (IRC), 2010). Hunting, processing of animals, trapping, gathering and other harvesting activities may involve the entire family while supporting the

[1] Energy Resources Conservation Board [ERCB] (2011; http://www.ercb.ca/learn-about-energy/energy-in-alberta/production-reserves) currently estimates established bitumen reserves at 26.8 Billion m^3; the vast majority of which will be extracted from the Athabasca Oil sand Reserves during the next century.

sharing of cultural teachings. Fort McKay's traditional harvesting activities provides food, reaffirms the continuing vitality of their culture and strengthens the kinship links through which harvesting is organized and wild food distributed (Fort McKay Tribal Administration, 1983) and (Fort McKay First Nation, 1994).

Fort McKay's hamlet and the traditional territory are centrally located within a landscape that is experiencing unprecedented industrial development in both geographic scale and intensity (**Figure 2**). There are currently 19 surface-mining or in-situ oil sands projects within Fort McKay's traditional territory that are operating or have regulatory approval to start construction (Lagimodiere, Disturbance and access - Implications for traditional use land disturbance update, 2013). Tenured leases for oil sands projects are on 70% of Fort McKay's traditional territory (Lagimodiere, Disturbance and access - Implications for traditional use land disturbance update, 2013) and 98% of Fort McKay's registered traplines (lease data current to November 2012). The two largest and longest-standing mines in the region are located within approximately 10-20 km of Fort McKay, with a two other mines operating within 5-10 km of the town for the last decade. Associated with this industrial development, the number of people living in Fort McKay's traditional territory has grown to over 100,000 (Regional Municipality of Wood Buffalo (RMWB), 2012).

Fort McKay's culture and traditional lands have been and continue to be affected by industrial development, with these effects linked to changes in air quality, loss of wildlife habitat, and other aspects of land disturbance (Fort McKay Industry Relations Corporation (IRC), 2010). A comprehensive, multi-stakeholder analysis of regional (including Fort McKay's traditional lands) environmental effects of oil sands development conducted in 2008[2] indicated that some ecological indicators are already below their pre-disturbance levels (moose, fisher, fish). This analysis revealed a major discrepancy in conclusions between rigorous and regional cumulative-effects assessment (like that performed in the TEMF, CEMA-SEWG 2008), and project-related Environmental Impact Assessments (EIAs), which generally conclude that individual projects do not significantly affect environmental or cultural values (Cumulative Effects Management Association (CEMA), 2008). This discrepancy stems from the fact that EIAs are designed to focus on the incremental contribution of a

[2] The Terrestrial Ecosystems Management Framework (TEMF), developed by the Cumulative Environmental Management Association (CEMA) Sustainable Ecosystems Working Group (SEWG)

single project to cumulative impacts in a defined region, rather than assisting in the understanding of impacts to overall ecological sustainability. The key differences between EIAs and comprehensive regional cumulative effects assessments are:

- EIAs employ a "shifting" baseline where projected cumulative effects are compared to current environmental states, which are constantly updated with progressing development, whereas regional cumulative-effects assessments compare current and projected future states to a pre-industrial landscape; and
- EIAs typically utilize a corporate focus in defining probable future impacts, and thus only include assessment of publicly disclosed projects, whereas regional cumulative-effects assessments utilize broader information such as regulatory projections and land-tenure information in estimating probable upcoming activities. As a result of this difference, EIAs, in hindsight, tend to substantially underestimate future activities.[3]

In addition, because methods and data sets differ between individual EIAs, and because these assessments tend to be poorly informed with respect to Fort McKay's interests, Fort McKay is not able to develop through collective review of EIAs an accurate understanding of overall changes to the landscape and the resources it supports, and believes that EIAs under-represent impacts to the Community. Consequently, project-specific EIAs do not provide sufficient and appropriate information to determine project-development effects on Fort McKay's traditional land-use opportunities, as well as effects to the environmental, traditional and cultural resources in areas of importance to the Community.

The work by CEMA to prepare the TEMF (Cumulative Effects Management Association (CEMA), 2008) and associated work by Fort McKay (Fort McKay Industry Relations Corporation (IRC), 2010) led Fort McKay to the conclusion that the current project-specific EIA process does not validly capture current and potential future cumulative impacts on aboriginal traditional land use and resources in the region, and also does not provide an adequate information base to assess proposed mitigation measures. It became apparent to Fort McKay that only by undertaking a proper regional cumulative-effects

[3] See, for instance, the *Submission of OSEC on adequacy of environmental impact statement before the Panel* to the Joint Review Panel on the Shell Jackpine Mine Expansion Project, CEAR Ref. No. 10-05059540, available at http://www.ceaa.gc.ca/050/documents/53358/53358E.pdf

assessment was it possible to understand both the benefits and risks of development of the bitumen sector on Fort McKay's traditional territory.

In 2011, the Fort McKay Sustainability Department (FMSD), on behalf of both First Nation and Métis members residing in the hamlet of Fort McKay, commissioned its own cumulative-effects study for the Fort McKay traditional territory: the "Fort McKay Cumulative Effects Project" (Nishi, Berryman, Stelfox, Garibaldi, & Straker, 2013). This Project assesses the impact of current oil sands development and future development scenarios, and identifies management tools (e.g., access restrictions, specific industry best management practices, and extended protected areas) that can be implemented to meet Fort McKay's objectives for maintaining ecological integrity and traditional land-use opportunities on their reserves and within their traditional territory.

1.2 Rationale

Today, many residents of Fort McKay benefit from participation in the industrial economy in the region, but also still greatly value their ability to conduct traditional land-use activities. Fort McKay's members continue to hold fur management licenses to many trapping areas within the traditional territory (Appendix A, Figure A1), and continue traditional uses within their traditional territory. Not only are these uses valued and important to maintain the cultural heritage of Fort McKay, their continued viability is protected by aboriginal and treaty rights.

As a result of oil sands development in northeast Alberta, there are current and likely future effects to both the ecological integrity of Fort McKay's traditional territory and to the capacity of this area to support healthy resources for traditional land uses that support Fort McKay's culture. These effects are both direct (e.g., from the removal by industrial footprint of land available for traditional uses) and indirect (e.g., as a result of increased access and use of the land around Fort McKay by non-residents).

Examples of indirect effects are related to linear features and the primary concerns include, but are not limited to:

- potential effects of linear disturbance on selected species and their habitat (e.g., moose);
- pressures on resources by increased hunting/trapping/fishing pressures as a function of new public access to areas that were previously remote (e.g., increased hunting pressures); and,
- limitations to people's ability to access the land for cultural practices.

This cumulative effects Project examines the implications of both direct and indirect effects from industrial development on the landscape, with a focus on vegetation habitat, fish and wildlife resources within Fort McKay's traditional territory (i.e., air quality and water quality/quantity were not addressed), compared to a pre-industrial development baseline (i.e., pre-1960).

Fort McKay plays an active role in multi-stakeholder initiatives regarding regional land management, and has an explicit interest in protecting the ecological integrity and function of their traditional territory, and mitigating degradation that has already occurred. As industrial activities continue to increase and affect Fort McKay's traditional territory, there is a need for the community to establish a clear understanding of the benefits and impacts associated with land-use decisions in its territory, and to develop an approach to setting community objectives for sustainable ecological and socio-economic conditions. Fort McKay completed this cumulative effects modeling Project (i.e., the Fort McKay Cumulative Effects Project, or hereafter referred to as the "Project"), directed by the Community and its technical representatives, to assess the status of environmental and cultural indicators in the Community's traditional territory.

1.2.1 The Dover Project

This study was initially commissioned by Fort McKay to evaluate current and probable future effects of land use on a regional basis (i.e., in the Fort McKay traditional territory), and to identify community-supported mitigation options for these effects. The study was not commissioned to focus on effects of specific industrial projects or proposals. However, during the course of study completion, two things became apparent:

1. The best options for protection of land for maintenance of ecological integrity and culturally meaningful traditional land-use opportunities are in the lands surrounding the Moose and Buffalo Lake area and Fort McKay First Nation's reserves (174 a and 174 b), as this portion of the regional landscape is relatively undeveloped, and already viewed as a refuge by Fort McKay community members;

2. There are a number of current industrial activities, including the Dover project, which are proposed for the area adjacent to Moose and Buffalo Lakes, and hence that threaten the ecological integrity and traditional land-use opportunities in this area.

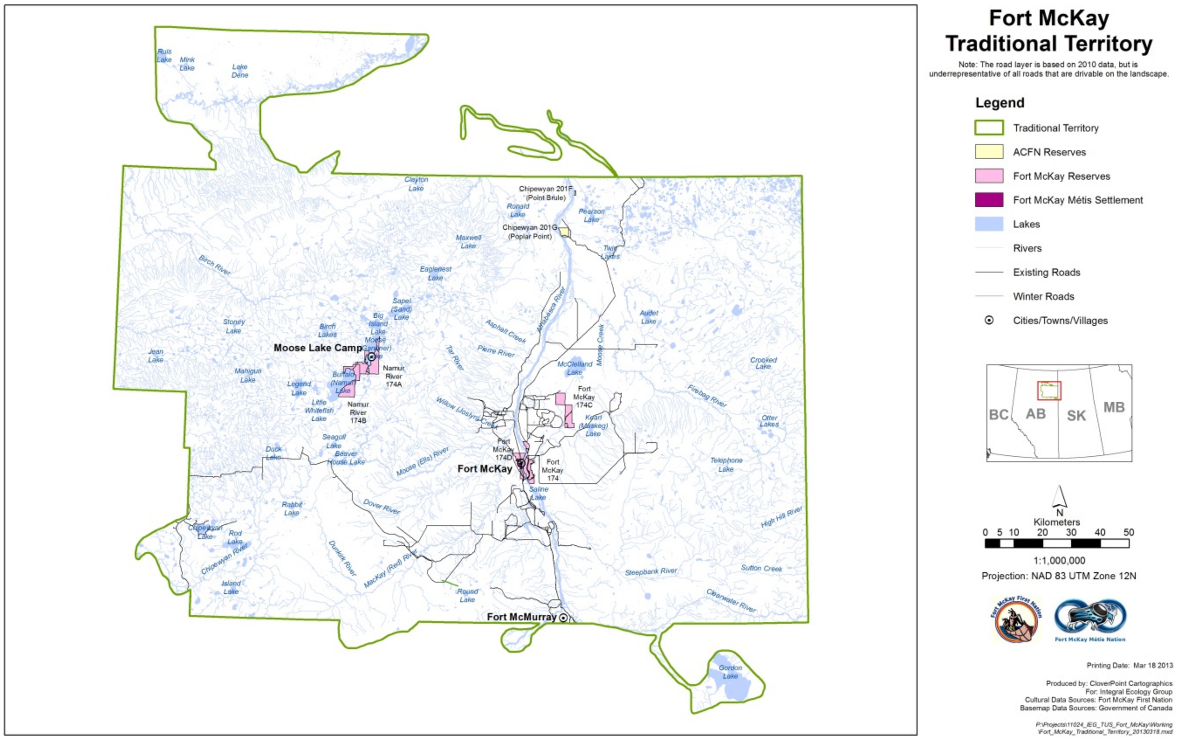


Figure 1: Location of the Community of Fort McKay in Alberta, Canada, showing the traditional territory boundary

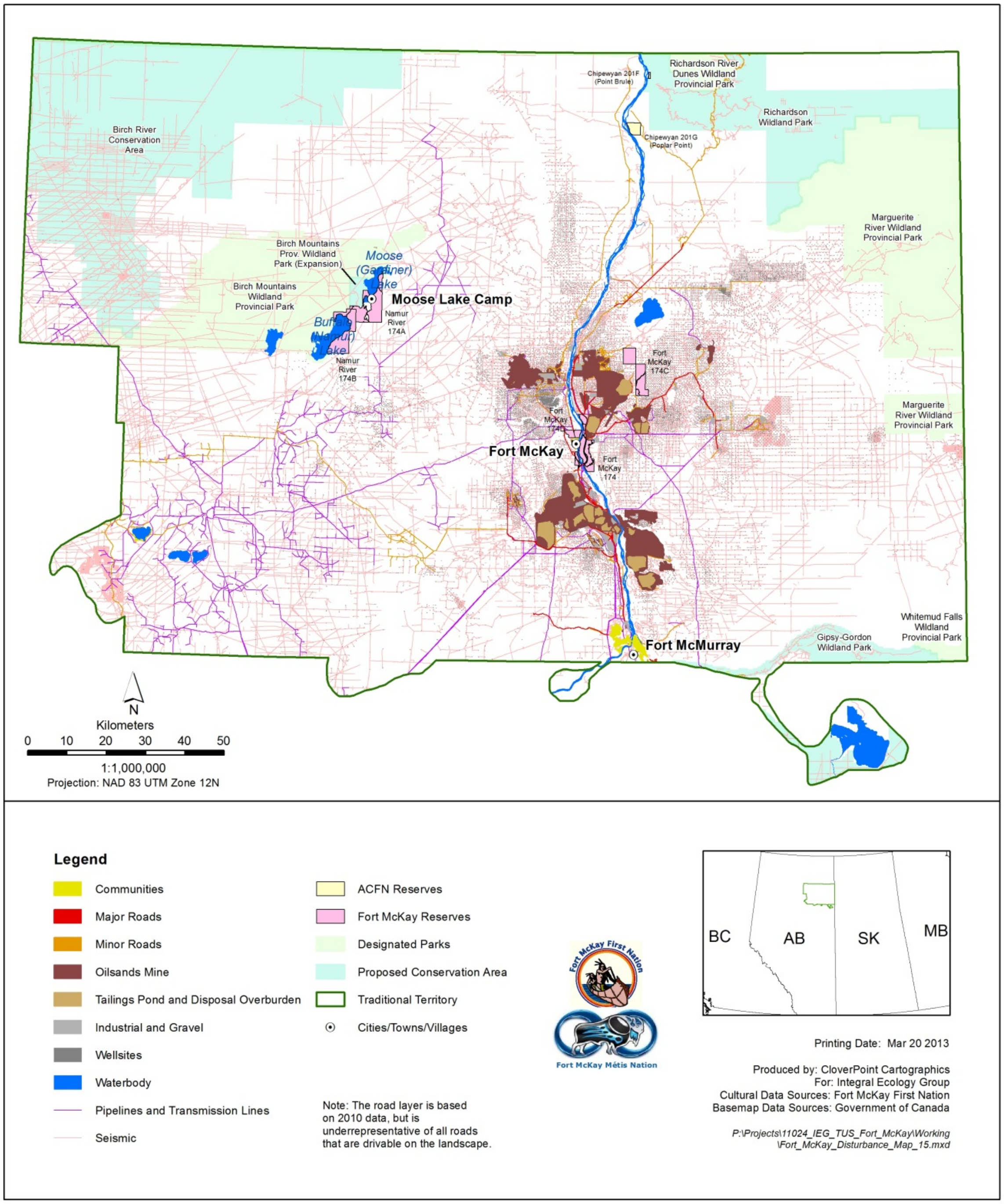


Figure 2: Current disturbance footprint (i.e., anthropogenic) in the Fort McKay Study Area, note that the study area is part of the Fort McKay traditional territory, but does not include the portions of the territory north in the Wood Buffalo National Park as these areas are already protected from industrial development. Existing provincial parks and LARP conservation areas are shown on the map.

Because of these competing objectives, and the shrinking options for Fort McKay to achieve a balance in their traditional territory of support for industrial resource extraction and protection of ecological integrity, traditional land-use opportunities, and aboriginal and treaty rights, we believe that the results from this regional study can usefully inform consideration of the Dover project, as the project will:

- contribute incrementally to already significant regional cumulative effects of industrial development; and
- reduce the viable options for mitigation of the adverse effects of this cumulative development.

1.3 Project Objectives

The Project is designed to document cumulative environmental effects on the landscape and key resources of interest within Fort McKay's traditional territory as a result of industrial development and associated pressures such as increased public access and hunting pressures. The Project's goal is to provide the Community of Fort McKay and its leadership with specific, reliable and relevant, science-based information on the current and future states of the environment in Fort McKay's traditional territory assessed against pre-disturbance values. There were four main objectives for the Project:

- facilitate community understanding and discussion about effects of regional and project-specific industrial development;
- identify and articulate detailed management and mitigation strategies that can be implemented in regional (and sub-regional) land-use planning to best maintain the ecological integrity of Fort McKay's traditional territory;
- support more informed and effective community engagement with industrial operators and government agencies on project-specific and cumulative regional effects and on proposed strategies to address these effects; and,
- support development of community-based monitoring of current environmental states, and the effectiveness of mitigation strategies.

2 OVERALL PROJECT APPROACH

Due to a desire to both participate in the industrial economy and protect some meaningful level of opportunity to practice traditional land uses, Community members in Fort McKay are faced with decisions that involve finding an appropriate balance between the benefits (largely economic) and liabilities (largely ecological and cultural) that industrial development brings. To inform these decisions, it is necessary to explore the amount of "risk" that Fort McKay is willing to accept with respect to eco-cultural liabilities to gain corresponding levels of benefits. The approach of this Project was to identify key indicators that are important to the Community (e.g., Cultural Keystone Species for Fort McKay; (Garibaldi, 2006), and (Garibaldi, 2009)).Through modelling, the performance of these indicators was assessed in the current landscape and projected future landscape as compared to a pre-industrial baseline. Mitigation strategies were then developed to evaluate their success in improving future ecological indicator performance, in a way that will meet Fort McKay's interests in maintaining ecological integrity in the traditional territory and opportunities for traditional land use for future generations. Community engagement was essential to this Project in order to ensure that the ecological indicators and mitigation strategies established in the modelling reflected Fort McKay's interests and were culturally relevant

3 ALCES ECOLOGICAL MODELING APPROACH

This study used the landscape-simulation model ALCES (A Landscape Cumulative Effects Simulator, www.alces.ca) to provide information on pre-industrial, current, and future conditions within the study area This model has been developed specifically for use in Alberta's ecosystems, and has a history of being been deployed in this setting by resource-industry, regulatory (ALCES Group, 2009), and multi-stakeholder groups (CEMA-SEWG 2008). The intent of this modelling work was to use the scenario modelling tool to learn and understand the implications of current and future land use, so that the results could be used to inform Community decisions and planning.

ALCES is a model designed to explore and represent changes in landscape composition (i.e., of a given study area) caused by human land uses and natural ecological processes. The model is populated with defined development rates, lifespans of development footprint, and reclamation rates for industrial footprints within the study area. The influence of natural disturbances (fire and insects) and plant succession on landscape composition, and associated wildlife and plant habitat, are also tracked.

The first-order effects tracked by ALCES are landscape composition and the anthropogenic footprint (i.e., land disturbance) associated with resource production/supply. Using an annual time-step the model modifies the area and length of up to 20 natural landscape types and 15 anthropogenic disturbance footprint types in response to natural disturbances (e.g., wildfire), ecological succession, landscape conversion, reclamation of footprints, and creation of new footprints associated with simulated land-use trajectories (e.g., mining, in situ, roads, forestry, etc.; see Appendix A, Table A-3 and Table A-4).

Coefficients are used to tie performance of key indicators (biological, environmental, and/or socio-economic) to the changes in abundance and composition of land-cover and footprint types.

Additional details on Project methodology, modelling assumptions, indicators, results and discussion can be found in Nishi et al. (2013) "Fort McKay Cumulative Effects Project – Technical Report of Scenario Modeling Analyses with ALCES" (Nishi, Berryman, Stelfox, Garibaldi, & Straker, 2013)

3.1 LANDSCAPE TYPES AND FOOTPRINT TYPES IN ALCES

Landscape types are ecosystem classes used by the ALCES model that are not disturbed by development. Land-use footprints tracked in ALCES can be either permanent or transient, for example in this Project most roads (other than in-block forestry roads that are reclaimed) are considered permanent footprint type features on the landscape. If footprints types are not permanent (e.g., well pads), then over time, ALCES gradually re-converts these footprint types back to landscape types, to reflect reclamation activities. In order to do this, the model requires assumptions on two key factors:

- the timing of reversion from a Footprint Type feature to a Landscape Type (duration of that footprint on the landscape, e.g., it is assumed that in situ well pads will persist on the landscape for 40 yrs on average, and will then be reclaimed back to their original landscape type), and
- the "reclamation destination", i.e., the landscape type to which each area of footprint type is assigned on reclamation – that is either the pre-disturbance landscape type, or something else (e.g., for mine disturbances, like tailings ponds, it is assumed that many of these areas cannot be reclaimed back to pre-disturbance vegetation types).

Twenty landscape types and 14 footprint types were defined based on available geospatial data for the Fort McKay study area, as well as the Industrial Landscape Study Area (**Figure 2** and **Figure 3**). Among the landscape types described for the study area, open fens, bogs, and pine forests represented the cover types with the largest surface area (**Figure 3**). With respect to anthropogenic footprints, oil sands mines represented the largest polygonal features, whereas seismic lines represented the most extensive source of edge on the landscape today (**Figure 2**).

4 STUDY AREA

4.1 FORT MCKAY STUDY AREA

The main Project study area (3.62 million hectares), hereafter referred to as the "Fort McKay Study Area", is located within the boreal mixedwood forests of northeast Alberta (**Error! Reference source not found.** and **Figure 3**). The study area was established by the Fort McKay Community Focus Group, and included most of the Fort McKay traditional territory, with the exception of the upper northern sections of the territory that are located in the Wood Buffalo National Park. The Community Focus Group omitted this area from the Project mainly because Community members seldom use the park for traditional land use activities.

4.2 INDUSTRIAL LANDSCAPE STUDY AREA

The size of a study area influences how performance of indicators is measured and tracked, where a large study area may dilute the intensity and associated effects of land-use within sub-areas. Therefore, it is also useful to assess indicators at a more local level to better understand the potential effectiveness of land-use management strategies within area more focussed zone. The predominant industrial land use within the Fort McKay Study Area is associated with bitumen extraction through oil sands mining and in situ wells, much of which is currently located in and around the hamlet of Fort McKay (**Figure 2**). At the request of the Community, the effects of land use and potential benefits of management strategies was also evaluated on a smaller portion of the study area based upon the land around Fort McKay (hereafter referred to as the "Industrial Landscape Study Area").

This smaller study area was considered to more accurately reflect the pressures that the Community of Fort McKay experiences on the land in proximity to their main residential centre. The Industrial Landscape Study Area was defined by areas with bitumen pay thickness of high economic value, using two data sources (see **Figure 4**):

- the mineable oil sands area, which is already under active development, and,
- areas likely to be developed in the near future through in situ well technology where bitumen pay depth is greater than 6 m (Energy Resources Conservation Board (ERCB), 2012).

Areas with bitumen pay depth less than 6 m were not selected for the smaller study area, as the assumption was that thicker bitumen pay deposits were economically viable and more likely to be developed first. The Industrial Landscape Study Area is 1.2 M ha or 32% of the Fort McKay Study Area. The proportion of total industrial footprint area in the Industrial Landscape Study Area is much higher than in the larger Fort McKay Study Area.

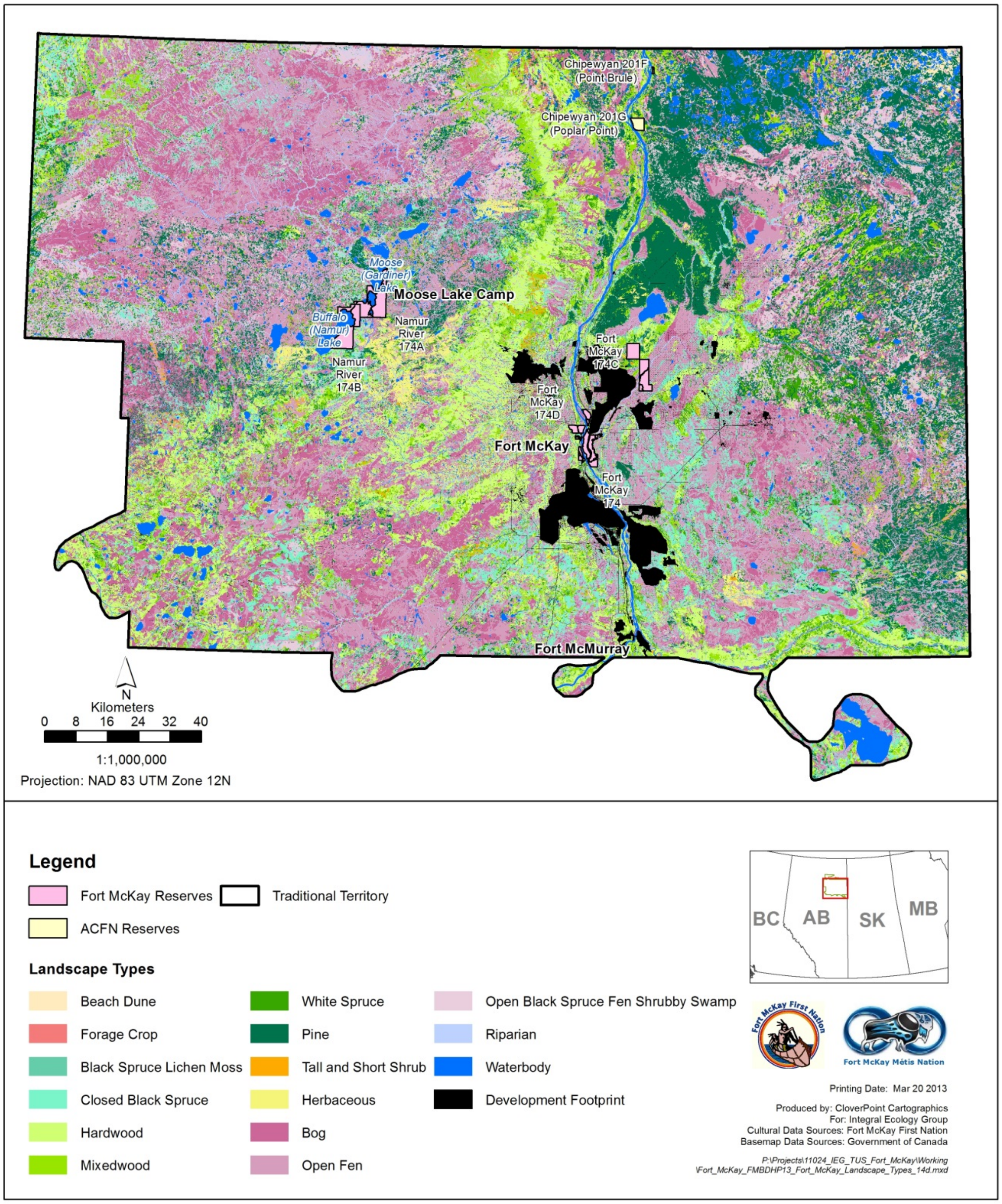
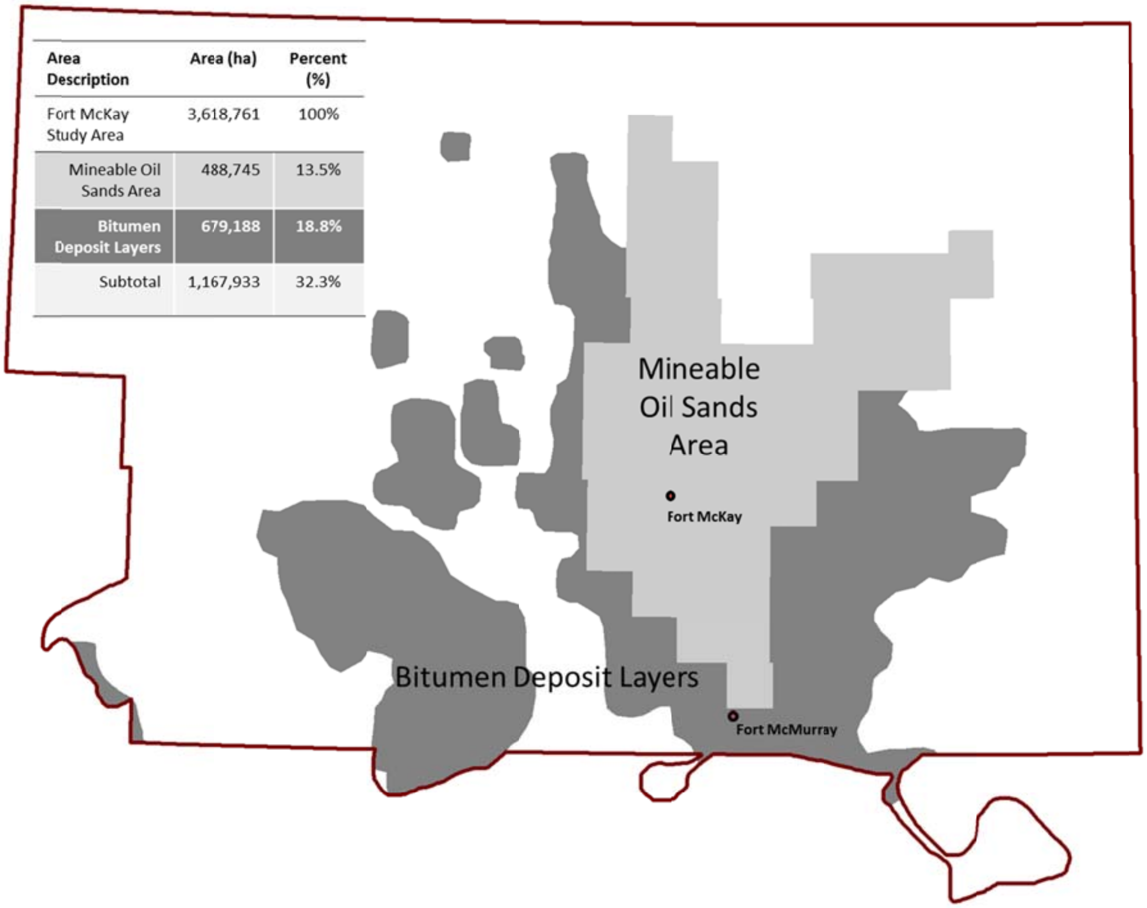


Figure 3: Landscape types including aquatic features (lakes, streams and rivers) in the Fort McKay Study Area



Area Description	Area (ha)	Percent (%)
Fort McKay Study Area	3,618,761	100%
Mineable Oil Sands Area	488,745	13.5%
Bitumen Deposit Layers	679,188	18.8%
Subtotal	1,167,933	32.3%

Figure 4: The Industrial Landscape Study Area (shown in the two shades of grey on the map) was selected within the larger Fort McKay Study Area, and is comprised of the area underlain by bitumen deposit layers > 6 m in pay thickness (bitumen in place for Athabasca SAGD area, (Department of Energy, 2008) and the mineable oil sands area as defined by the ERCB (2012) (Energy Resources Conservation Board (ERCB), 2012)

5 INDICATORS

Indicators are used to measure and monitor change in the landscape over time. Indicator selection for this Project was based on indicators with existing regional data and coefficients, primarily those developed through ecological modelling conducted for the CEMA and the Government of Alberta's Land Use Framework – Lower Athabasca Regional Plan (LARP). These indicators and their coefficients have been reviewed and accepted by a wide range of stakeholders, including Government of Alberta personnel. Many of these indicators represent key resources that are important to traditional activities such as hunting, trapping, and fishing while others are important to overall ecological integrity and health (**Figure 5**).

The following indicators were selected for modelling in this study, based on Community Focus Group input:

- Landscape Indicators
  - area of disturbed(anthropogenic footprint)
  - area of undisturbed land
  - edge density (km/km^2) - "Edge" refers to roads, seismic lines, pipelines and other linear features that are anthropogenic (human-made).
  - forest core area (proportion) – an area of forest that is at least 200 m from any anthropogenic feature (i.e., disturbance feature)
  - average forest age
  - watershed discontinuity - the degree of fragmentation in lotic ecosystems (i.e., rivers, streams, and creeks) that can adversely affect fish populations and fish communities.
- Biotic indicators
  - moose habitat Suitability Index (HSI)
  - fisher HSI
  - index of native fish integrity – a measure of fish composition
  - edible berry HSI (habitat area & habitat quality)

Figure 5: Culturally relevant indicators (on the outer part of the diagram) and their relationship to Fort McKay's traditional use values

5.1 Indicator Coefficients

Coefficients for wildlife indicators are based on HSI or population-dynamics models developed for northeastern Alberta. HSI models are primarily knowledge-based (as opposed to empirical) models that can incorporate information from both empirical studies and expert knowledge. The HSI models used in this study were based on a review of published literature as well as expert opinion; they were initially developed for application in CEMA's TEMF, and subsequently revised through the LARP process (with the exception of the edible berry HSI module that was developed by the Integral Ecology Group).

Coefficients for forest-production metrics are based on growth-and-yield data provided by Alberta Pacific Forest Industries Inc., and were used in modelling conducted for the CEMA's TEMF, which included involvement of both Fort McKay and Government of Alberta representatives.

The interpretation of potential changes in environmental indicators was aided by a standardized method for describing change that is both relevant and readily understood. For the biotic indicators such as moose, fisher and edible berries, HSI results were displayed against risk categories adopted from peer-reviewed criteria developed by the World Conservation Union (IUCN) and adopted by the international community, including Canada (Committee on the Status of Endangered Wildlife in Canada – COSEWIC), for evaluation of species at risk.

5.2 RISK CATEGORIES

Indicator risk categories were based on the relative departure from the RNV reference band (i.e., the space between upper and lower boundaries of the RNV). Colour-coded risk categories were ranked and illustrated along a scale declining from the best condition, scaled as 0% decline, to the most disturbed condition expected, scaled as 100% decline. When applying risk categories to simulation results, the lower 95% confidence interval of the estimated RNV was used as the undisturbed point of comparison.

Indicator risk categories were applied in the following manner, using four colour codes:

- **Green**: representing stable and equivalent to the COSEWIC / IUCN classification of "Stable". Defined as a decline of no more than 10% from the undisturbed (RNV) state.
- **Yellow:** representing low risk and equivalent to COSEWIC / IUCN classification of "Special Concern". Defined as a decline of 10% to 50% from the undisturbed (RNV) state.
- **Orange:** representing moderate risk and equivalent to the COSEWIC / IUCN classification of "Threatened" or "Vulnerable". Defined as a decline of 50% to 70% from the undisturbed (RNV) state.
- **Red:** representing high risk and equivalent to the COSEWIC / IUCN classification of "Endangered". Defined as a decline of more than 70% from the undisturbed (RNV) state.

6 ALCES SIMULATION PERIODS

Simulation runs in ALCES were 250 years in length, and were comprised of three discrete time periods to provide a comparative baseline for exploring alternative scenarios, to show current conditions, and to illustrate projected relative landscape changes in response to different assumptions about future land-use decisions:

1. **Pre-industrial baseline (or Range of Natural Variability)** – the first 100 years (years 0-100) simulates dynamics of the pre-industrial landscape from 1860 – 1960;
2. **Backcast** – the next 50 years (years 101-150) reflect the period from the onset of industrial activities to current conditions, shown in figures as 1960 – 2010;
3. **Forecast** – a projected 100 years into the future from the "current" date of 2010 (years 151-250, or 2010-2110). Two forecast scenarios were run in this study
    - **Business as Usual**–assumptions are based upon industry and government development projections as defined by CEMA-SEWG (Cumulative Effects Management Association (CEMA), 2008) and LARP (Government of Alberta, 2012); and
    - **Fort McKay Scenario**– where assumptions developed by Fort McKay (with the support of Project consultants) related to industrial development, reclamation, best management practices, access management and protected areas are varied to achieve holistic resource management objectives that meet Fort McKay's interests for the future landscape.

More detail on these simulation periods is provided below.

6.1 Pre-industrial Baseline

The first modelling time period represents the "pre-disturbance case" or the pre-industrial baseline, describing the status of indicators in the traditional territory prior to the onset of industrial development in the mid-1960s. This simulation period provided information on a time period when Fort McKay Community members were able to subsist on traditional land use in their traditional territory. This pre-industrial baseline provides benchmark or reference conditions that define that landscape before industrial development. In previous work (Fort McKay Industry Relations Corporation (IRC), 2010), Fort McKay has established that this pre-industrial baseline is the reference point they wish to use to evaluate impacts of industrial development in their traditional territory. This reference point for comparison is reflective of the conceptual comparison that Fort McKay Community members, particularly elders, apply to their on-going observations of changes in their traditional territory.

In pre-industrial conditions, it is recognized that ecological indicators vary in space and time under natural (i.e., non-anthropogenic) disturbance regimes (e.g., wildfire). This "range of natural variability" (RNV) can be considered the normal variation of a specific ecological indicator that occurs in response to the full suite of natural and episodic disturbances that characterize an ecological system. This Project used RNV to estimate and quantify pre-industrial performance of key ecological indicators in Fort McKay's traditional territory, in order to provide a baseline reference for comparison to modelled current and future conditions.

Ecologists generally accept that the further land-use conditions move indicators away from RNV (either above or below), the greater the level of risk to integrity or resilience of an ecological indicator (Holling, 1973). The concept of RNV and risk to ecological indicators has been endorsed as a key measure by which to assess risk of ecological indicators examined in the Alberta Land-use Framework (https://www.landuse.alberta). RNV was also an accepted and appropriate tool use by CEMA in developing the TEMF (CEMA-SEWG 2008), where recommendations in the TEMF indicate that indicators should be maintained within 10% of the lower level of RNV. The RNV for wild animals, fish and plants provides a useful benchmark for understanding impacts to aboriginal and treaty rights because it was the basis for supporting traditional use of wildlife resources in the pre-development landscape.

6.2 Backcast

This backcast simulation period represents an approximation of the beginning of industrial development (~1960) in Fort McKay's traditional territory to present day (~2010). The backcast was used to describe the current effects of development on indicator status to date (to 2010), as best reflected by best available information (e.g., data sources on all indicators and on land-disturbance metrics such as industrial footprint). The backcast was compared to the pre-disturbance case to illustrate changes in the selected indicators in the traditional territory over the past four decades of development, and presents a quantitative assessment that corresponds to Community observations of ecological changes over this period of time. The backcast also provides a second type of benchmark information for impacts to Fort McKay's traditional land use opportunities, as it represents conditions that the Fort McKay Community members are currently experiencing on the land today.

6.3 Forecasts

Two forecast scenarios were run for 100 years (2010 to 2110). The "Business as Usual Scenario" (hereafter referred to as "BAU") is a baseline forecast scenario that examines the consequences of continuing with current trends in economic development, resource extraction (i.e., bitumen), and other associated land uses in the region. The business-as-usual scenario represents current industrial development and land-use activities if they continued as currently practiced and projected.

The "Fort McKay Scenario" (hereafter referred to as "FM Scenario") is a comparative forecast scenario that explores a combination of land-use management options that may improve long-term sustainability of ecological indicators, with the intent to maintain healthy ecosystems to support Fort McKay's traditional heritage. The Community Focus Group guided the development of this scenario.

7 LAND-USE MANAGEMENT STRATEGIES IN THE FORECAST SCENARIOS

The detailed assumptions regarding the respective management strategies for the BAU and FM Scenarios are described here. Both scenarios were based on a total bitumen-production trajectory with a peak production of 3.5 million barrels per day (Mbpd). This trajectory was based upon approved bitumen production within the Fort McKay Study Area as of January 2011 (Government of Alberta, 2011). This peak bitumen production value was also consistent with metrics adopted by both CEMA (CEMA-SEWG 2008) and the LARP initiatives (ALCES Group, 2009).

In addition to the baseline assumptions for bitumen development, the key management strategy assumptions that were modelled in the BAU simulation included: no access management, no additional industry best management practices and existing protected areas. The FM Scenario was based upon the same assumptions for pace of bitumen production and reclamation of surface mine footprints as the BAU Scenario, but "activated" three additional management strategies in the form of expanded protected areas, moderate access management, and aggressive industry best management practices (Table 1). The key management strategies that were considered in the two forecast scenarios are described in more detail below.

Table 1: Management strategy assumptions of the BAU and FM Scenarios, which were used to explore effects of alternative land use management strategies in the FM Study Area. Reclamation assumptions were the same for the two scenarios.

	Scenario	
MANAGEMENT STRATEGIES	**Business As Usual**	**Fort McKay**
Protected Areas	Existing	Expanded
Access Management	Current (none)	Moderate
Best Management Practices	Current (none)	High

7.1 PROTECTED AREAS

Protected areas were locations within the study area that were protected from current and future industrial development (i.e., forestry and bitumen development), and therefore model simulations excluded industrial footprint types from these areas.

The BAU Scenario was based on existing protected areas. It did not include the proposed LARP conservation areas (Government of Alberta, 2012) because these areas were not implemented at the time of modelling and uncertainty remains regarding how and when these LARP conservation areas will be implemented. Under the BAU Scenario, the current protected areas network was determined to be 378,000 ha or ~10.4% of the study area (**Figure 6**).

The FM Scenario included an expanded protected area which was designed to evaluate the significance and value of an expanded protected area within the study area. The expanded protected area location considered areas that are culturally important to Fort McKay because of historical, current and planned future use (e.g., the area around Moose and Buffalo Lakes). In addition, the expanded protected area included the proposed LARP conservation areas within the Fort McKay Study Area based on the same assumption used by the Government of Alberta: that areas with little bitumen are less likely to be developed, and they could contribute to overall ecological integrity. The LARP conservation areas are of modest cultural value to Fort McKay as they are located on the periphery of Fort McKay's territory. However, the existing Birch Mountain Wildland Park and LARP Birch Mountain Expansion conservation area, afford some protection to the Namur and Gardiner Lakes and Fort McKay First Nation reserves 174a and 174b, which are key traditional use areas for Fort McKay.

The expanded protected area resulted in a tripling of the existing protected area network (1.42 M ha or ~39.2%)[4] within the study area (**Figure 6**). The expanded protected area used in this study was designed as an exploratory scenario and was not intended as an actual proposed protected area network.

[4] Note that this proportion is within the range discussed in the CEMA's multi-stakeholder Terrestrial Ecosystem Management Framework (CEMA-SEWG 2008).

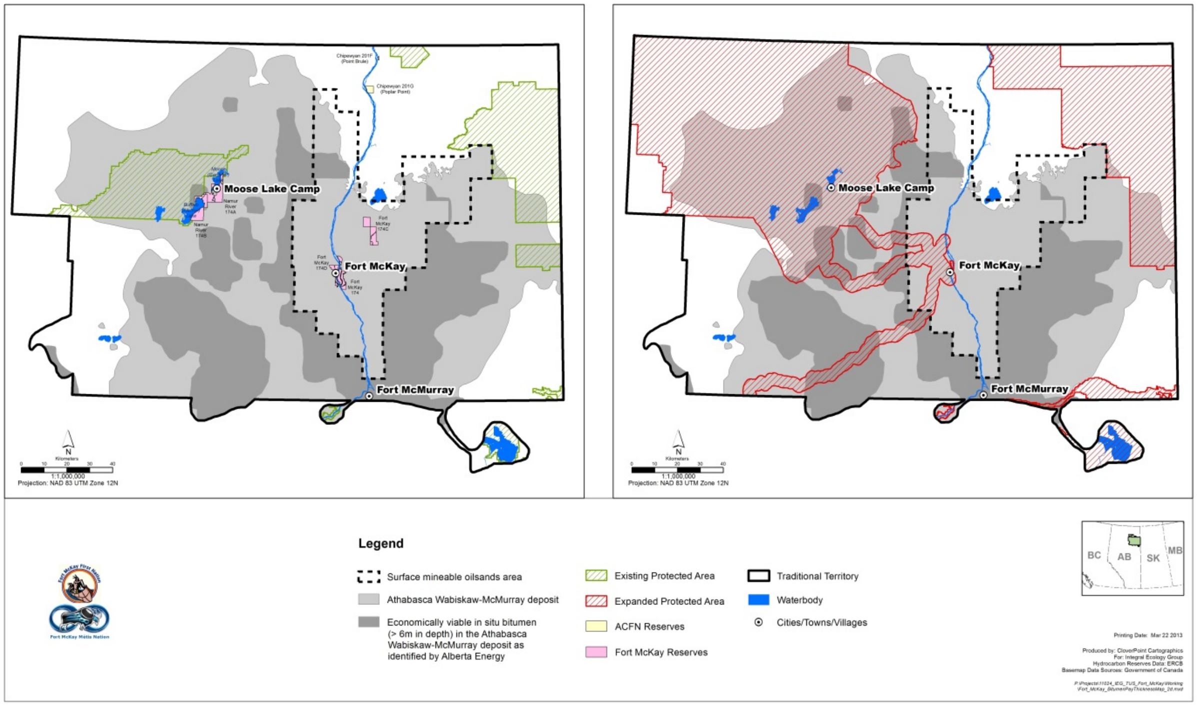


Figure 6: Two protected area scenarios are shown with bitumen reserves. On the left is the existing protected areas within the Fort McKay Study Area (protected area was 378,483 ha; 10.4% of study area). Note that existing protected areas were based on existing parks prior to the finalization of LARP. On the right is the expanded protected area network within the Fort McKay Study Area (1,420,579 ha; 39.2% of the study area).

7.2 Access Management

In recent decades, with the expansion of oil and gas exploration and timber harvesting in northeast Alberta, the construction of roads, seismic lines, pipelines, and transmission lines has vastly increased the ability for non-industrial users (e.g., recreationalists, hunters, fishermen, trappers, campers, etc.) with motorized off-highway vehicles (quads, trucks, motorcycles, snow machines) to access what were previously remote or largely inaccessible areas of the boreal forest. Impacts of unmanaged access include reductions in fish and wildlife populations and distribution, increases in disturbed and eroded lands, and loss of water quality (Sullivan, pers. comm., Edmonton).

Access management in this Project is a tool that is meant to be a systematic and regional coordinated access management plan to reduce access across the regional landscape, and would require enforcement by the Government of Alberta. Access management is a regional land-use management tool that attempts to reduce the impacts of road development and increased access to wildlife, fish and the overall environment. Access management is primarily focused on managing the use of motorized vehicles by non-industrial users. ALCES modelled access management at a conceptual level (e.g., no access management, moderate access management; Appendix A, **Table A-5**) in order to evaluate the benefit of reducing human access to linear features, such as roads and seismic lines.

The benefit of access management was simulated through the use of disturbance footprint buffers. Buffer widths are assigned to disturbance features, and represent the area directly adjacent to the disturbance where indicators are influenced by higher probability of mortality from harvest, and/or by visual, physical, chemical, noise, and vegetation changes associated with the direct footprint (i.e., indirect effects from these disturbances; **Figure 7**). The size of these disturbance buffers vary depending on the indicator (typically 100-300 m), particularly whether or not a specific indicator is harvested by humans, and how sensitive it is to humans, other predators, or other disturbances.

To simulate the benefits of access management, the buffer widths were reduced, resulting in an overall increase in habitat quality (or habitat suitability) for each indicator (i.e., moose, fisher and berry habitat suitability index. For the native fish indicator, implementation of access management was related to a reduction in fishing pressures. The assumptions for these changes in buffer widths for each indicator in the model were supported by expert knowledge and the scientific literature. In ALCES, buffer widths become incrementally smaller with moderate and high access management because of reduced levels of indicator disturbance and mortality associated with linear features (**Figure 7**).

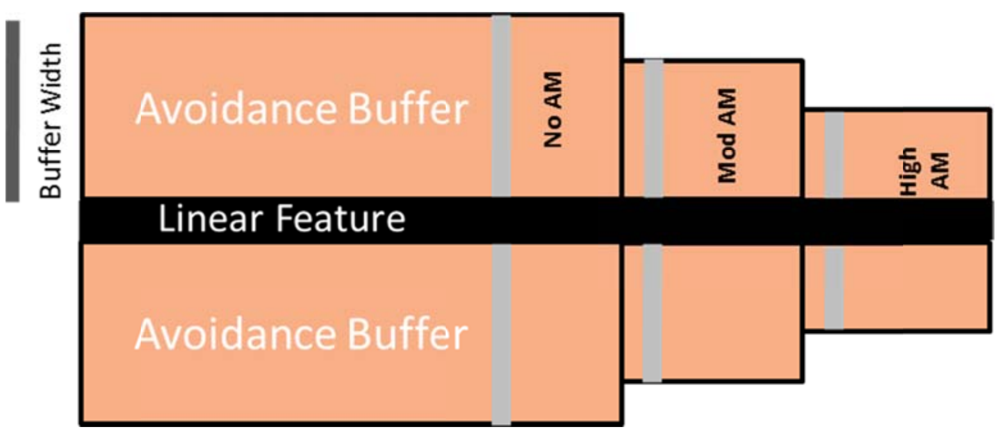


Figure 7: Conceptual diagram showing buffer widths associated with anthropogenic linear features. The effect of access management (AM) is shown as a sequential reduction in buffer width as efficiency increases from No AM = 0% reduction of access, Moderate AM = 50% reduction of access, and High AM= 100% reduction of access. No AM results in a larger area around linear features that is avoided by wildlife.

The assumption for the BAU Scenario was no access management, because coordinated regional access management planning has not been implemented for the study area. Some operators voluntarily implement access management plans on their project sites or leases, often to address safety and security concerns, but these plans are implemented at local scales, and are insufficient to meet regional access-management objectives (e.g., CEMA's TEMF recommended a coordinated regional motorized access reduction of at least 50% to be enforced by the government). In contrast, The FM Scenario included moderate access-management assumptions, conceptualized as a reduction to about 50% of current levels of public motorized access.

7.3 Industry Best Management Practices

The industry best management practices (BMP) modelled in both the BAU and FM Scenarios were considered to be realistic and feasible based on guidance from industry and government members provided during similar work done through CEMA-SEWG (2008) (Cumulative Effects Management Association (CEMA), 2008), LARP (Government of Alberta, 2012), and the Athabasca Landscape Team (2009) (Athabasca Landscape Team (ALT), 2009). A general description the industry BMPs is outlined below and is included in Appendix A, **Table A-6**:

1. Maintaining stream continuity
    - Increased replacement rate of hanging culverts[5], or
    - Installing clear span bridges instead of culverts
2. Reducing construction of disturbance that causes more "edge" in the landscape (e.g., seismic lines, roads, wellpads)
    - increased directional drilling for in situ well pads
    - increased spatial overlap of pipelines and roadways
    - construct narrower seismic lines, which would reclaim faster than wide lines
3. Increasing reclamation rate of disturbance footprints
    - more rapid reclamation for surface-mine (reduced from 30 year to 20 year lifespan) and in-situ (reduced from 40 year to 20 year lifespan) features
    - "pulse" reclamation of existing seismic lines, where a certain percentage of legacy seismic lines are actively reclaimed each year

[5] Park et al. (2008), define hanging culverts as "an outfall that is elevated above the stream surface, which can fragment fish communities in streams by creating upstream movement barriers. Culverts (typically of corrugated or smooth metal tubular construction) are commonly used to provide crossings of low-order streams and can be serious impediments to upstream movement of aquatic organisms, such as fish, when their outfalls are elevated above the water surface (i.e., hanging culverts)" (Park, Sullivan, Bayne, & Scrimgeour, 2008).

The BAU Scenario included currently utilized best management practices, while the FM Scenario included enhanced ("high") BMPs, which are intended to represent achievable, but not currently ubiquitous practices.

7.4 RECLAMATION

Simulation of reclamation of disturbance footprints is important for understanding the effects of human land uses and related mitigation practices to ecological indicators and the environment. Rapid reclamation of disturbance footprint is important to ecological indicators that are sensitive to landscape fragmentation (e.g., fisher, caribou). Reclamation assumptions were the same for the business-as-usual and Fort McKay scenarios, and assumptions were based on work done by CEMA-SEWG (2008), which used current industrial closure and reclamation plans to inform model approaches to reclamation.

In ALCES there were three aspects of reclamation that were considered:

1. the rate at which disturbance footprints were reclaimed (i.e., footprint lifespan),
2. the landscape or habitat type that a footprint reverts to on reclamation (reclamation destination), and
3. the quality of the reclaimed habitat (relative to quality of natural fire-origin habitats).

Disturbance footprints in ALCES can be either permanent or temporary. If footprints types were not permanent, then ALCES required input assumptions on the average footprint lifespan (See Appendix A, **Error! Reference source not found.**). For this Project, many disturbance footprints (major roads, minor roads, transmission lines, pipelines) were permanent and were never reclaimed in the model simulations. Disturbance footprints that were reclaimed included: forestry roads, seismic lines, well pads, and surface mining disturbances.

8 SENSITIVITY ANALYSES

In addition to the ALCES model scenarios described above, additional scenarios were run to test the sensitivity of model results to different management strategies, assumptions and uncertainties as described in more detail below. Sensitivity analyses were conducted for both study areas, the Fort McKay Study Area and the Industrial Landscape Study Area.

9 COMMUNITY ENGAGEMENT APPROACH

At the time the Project was initiated, the FMSD had recently completed their first community-wide consultation regarding proposed development taking place within Fort McKay's traditional territory. There were many concerns expressed by community members during the consultation, including changing access, competition for resources, declines in wildlife populations, and concerns over pollution. These are issues most effectively addressed within a cumulative effects lens. The significant negative impacts experienced by community members are the result of increasing industrial development modifying the landscape and its resources, where most of these impacts are not related to specific projects, but rather to the suite of impacts from all development in the region and associated land use. This Project was designed to consider these land uses collectively, and engage community members in determining a desired future for their traditional territory using culturally meaningful and scientifically robust indicators and mitigations options that were realistic and met Fort McKay's interests to maintain healthy functioning ecosystems and opportunities for traditional land use for future generations.

9.1 COMMUNITY FOCUS GROUP

The FMSD provided guidance on the design of a community engagement approach that would ensure a wide-range of community interests were addressed in the Project. The approach consisted of establishing a Project Community Focus Group (hereafter referred to as "Focus Group") whose members served as representatives of their larger Community as well as reflecting their own personal interests. Fifteen Community members were selected based on their age, gender, and interests (e.g., individuals active on the land) to be a part of the Project Focus Group. These members included active land users, young moms, and knowledgeable elders. The Focus Group format allowed for in-depth discussions regarding the current environmental state of Fort McKay's traditional territory as well as desired future states, and mitigation options to change the current trajectory of impacts to date. The Community of Fort McKay, through the focus Group, provided ultimate direction to guide the Project and validated Project outcomes. Fort McKay's technical experts and the Focus Group worked together to define key Project parameters and outcomes throughout the Project. . In addition to this, previous relevant project work that had been completed by Fort McKay was used in this Project where applicable (Garibaldi, 2006), (Garibaldi, 2009) and (Fort McKay Industry Relations Corporation (IRC), 2010).

9.2 COMMUNITY WORKSHOPS

Three Focus Group workshops were held in Fort McKay to:

- provide input into indicator selection and study area boundaries,
- review results from the model simulations; and,
- to develop management strategies for the FM Scenario that are in Fort McKay's interests.

Generally speaking, Focus Group members were not surprised by the decline in indicator performance into the future, as per the business as usual scenario. In fact, most Focus Group members mentioned that the current state of the indicators was worse than what the model results portrayed based on their personal experience. This perspective was a reflection of Community members' experience of the acute environmental situation adjacent to Fort McKay where development is most intensive, while the modelling was conducted for the entire Fort McKay Study Area scale, a much larger area, of which much of it is still yet to be intensively developed. In response to feedback from the Focus Group, the modelling was also run for a smaller study area focused around Fort McKay and in the area of current industrial development, the "Industrial Landscape Study Area". The intent of this additional modelling of the Industrial Landscape Study Area was to quantify the difference in impacts to ecological indicators in the current zone of heavy industrial development in Fort McKay's traditional territory, as this is more representative of the Community's "experience" of industrial impacts.

Focus group members provided their perspectives on the responses of indicators to the BAU Scenario. In general, Community members were not content with the current status of the environment based on the modelling results and their personal experience, and wished to see a different environmental future for their traditional territory. As a result, members identified mitigation options (e.g., access management strategies, protected areas) which informed the creation of the FM Scenario, an alternative option for the future trajectory of Fort McKay's traditional territory that was developed by the Community Focus Group and was considered a "reasonable" request for future land management in their traditional territory.

The overall sentiment from the Focus Group members was that the results from this Project were a useful means to communicate the Community's concerns of cumulative impacts in a manner that is understandable to industry and government (i.e., scientific language), but that still addresses important cultural values to Fort McKay. As one individual noted: "Why don't we start ….. using scientific terms for our cultural concerns, so the government and industry will actually look at it and value it?" (ID#63, Fort McKay Cumulative Effects Workshop 3, 2012).The Focus Group confirmed that the Project results "tell Fort McKay's story" of cumulative impacts of industrial development and provide viable options to change the trajectory of potential future environmental impacts.

10 RESULTS AND DISCUSSION

10.1 CHANGES IN LANDSCAPE CHARACTERISTICS

The Fort McKay Study Area has undergone a significant transformation during the past 50 years due to industrial development (**Figure 8**), and due to this disturbance the overall age of forests in the study area have become slightly younger (**Table 2**). The greatest increase in disturbance is due to the mining of bitumen (~53,600 ha of mining related disturbance currently). The Community's experience of development effects are predominantly related to mining, as most of this development is located in close proximity to the hamlet of Fort McKay. In situ development also plays an important role in Fort McKay's traditional territory (~34,000 ha of current in situ disturbance), with smaller levels of disturbance from settlements (~3,000 ha), and transportation (~1,500 ha). Although bitumen surface mining disturbance is a key driver of landscape change in the Fort McKay Study Area today, the in situ development activity is just in its initial stages of growth and is beginning to expand into areas of the traditional territory that have been otherwise relatively remote and undisturbed (e.g., Dover OPCO project near the Fort McKay First Nation reserves at Moose and Buffalo Lakes; see maps in Lagimodiere (Lagimodiere, 2013). The patterns for in situ development in the region are predictable, once an access road is developed into a previously remote area, there will then be a sudden flurry of new in situ development proposed along the new road (See maps in Lagimodiere 2013 for existing and proposed development along the Dover multi-user access corridor road (Lagimodiere, 2013) in the west side of Fort McKay's traditional territory). In situ development will be the primary driver of ecological change in the Fort McKay traditional territory in the decades to come.

The model simulation results indicate that the future landscape changes to ecological function and indicators will be greater in scale and pace than those that have occurred over the past 50. In the BAU Scenario, by 2110 a total of ~803,500 ha of the Fort McKay Study Area would be directly disturbed (mostly related to bitumen development) and of that, ~428,500 ha of land will be reclaimed over the 100 year period from 2010-2110 years according to the model reclamation assumptions (**Figure 8** and **Figure 9**). If reclamation of these disturbances does not occur during this time, there could be an overall disturbance footprint of 803,500 ha in 2110. In comparison, the disturbance footprint for the FM scenario is much lower overall at ~332,400 ha in 2110, and without successful reclamation it could reach are ~718,300 ha (**Figure 9** and **Figure 10**).

Compared to disturbance from surface mining, in situ disturbance creates more overall "edge" in the landscape. Edge density (km/km^2) is the length of edge of all disturbances, such as seismic lines or well pads, and landscapes with high edge density are highly fragmented. 'Edge effects' are changes in structure and function of ecosystems that occur along the edges of disturbances due to indirect effects (e.g., increased mortality from hunting or increased nuisances that result in wildlife avoidance). The influence of edge effects ranges from at least 100 m to several km from the disturbance (Jordaan, Keith, & Stelfox, 2009). A highly fragmented landscape will result in a decline in ecological indicators (Fahrig, 2003). There is currently very little intact habitat left today due to edge density, for example, if a Fort McKay Community member was to be at any one place in the study area, they would likely be within 200 m of some type of disturbance footprint 81% of the time (See Forest core area indicator, **Table 2**). As two Focus Group members indicated in reference to decline in wildlife indicators: "The lines got a lot to do with it too. If we don't have the lines out there, we won't have those people out there." (ID#98 Fort McKay Cumulative Effects Workshop 2, 2012). "That's why they're not around, is because the habitat has changed. Because of the roads, because of the noise…" (ID99, Fort McKay Cumulative Effects Workshop 2, 2012).

Edge density in the BAU Scenario grows most rapidly when both surface mining and in situ bitumen production are increasing and this will result in a highly fragmented landscape (**Figure 10**, **Figure 11** and **Figure 12**). In 2040, surface mining for bitumen peaks and slows, however edge density will still continue to increase at a slower rate after 2040 due to continual in situ development, reaching 5-9 km/km^2 in 2110 (this assumes reclamation of non-permanent disturbances as per Appendix A, Table A-7 and **Table A-8**). In comparison, the timing of in situ development and its spatial extent is similar in the Fort McKay scenario, but the simulated edge densities increase to only half of that observed in the business as usual scenario (**Figure 10**, **Figure 11** and **Figure 12**). The main reason for this difference is the adoption of industrial BMPs which include narrow seismic lines (0.75 m wide) that reclaim faster and the implementation of pulse reclamation of seismic lines at a rate of 10% every 5 years (**Figure 12**). Both of these strategies significantly reduce the impact of seismic lines to landscape fragmentation over the 100 year period. Implementation of these BMP strategies in the Fort McKay Study Area is reasonable and possible if enforced by the regulators. Currently, some industry players have adopted these BMPs voluntarily, but to achieve this result of 50% reduction in edge density or fragmentation over the next 100 years it is critical that these BMPs are enforced and their effectiveness is monitored as a means to continually improve these practices over time.

Landscape fragmentation due to the increase of linear disturbance features results in watershed discontinuity, where stream, river and creek flow is disrupted as a result of hanging culverts that are not maintained (Lagimodiere & Eaton, 2009) and do not allow adequate water flow or fish movement (Park, Sullivan, Bayne, & Scrimgeour, 2008), (Stevens, Council, & Sullivan, 2010), and (MacPherson, Sullivan, Foote, & Stevens, 2012). This disruption of waterways in the landscape is further magnified by increased human access to the land, where the use of Off Highway Vehicles in particular can cause significant damage to stream crossings further impacting water flow, fish habitat and fish movement.

The application of aquatic BMPs in the FM scenario, (replacement of 10% of hung culverts annually as part of a culvert maintenance plan), is the main contributor to improved performance of watershed discontinuity under the FM scenario (Figure 13). Currently, companies are often required to have a culvert monitoring plan at the time of their approvals, and there are routine inspections made by the Government of Alberta to check on culvert maintenance. But, this is not a strictly enforced initiative at this time. In order to maximize the value of culvert maintenance to ecosystem function, it is essential that this become a requirement by the regulators and that in addition to an aggressive monitoring and maintenance culvert program, companies are encouraged to use clear span bridges when possible to avoid building culverts since they require high levels of maintenance to be effective.

Table 2: Ecological indicator status in three time periods: pre-industrial disturbance or range of natural variation (RNV, average); current (2010); future Business as Usual Scenario (BAU) at 2110; and, future Fort McKay (FM) Scenario at 2110. Units are shown for each indicator. Percent (%) change from the average RNV is also shown for indicators, except for those indicators that have a 0 value for RNV (edge density, percent area of disturbance, watershed discontinuity) because there was no industrial disturbance at the time of RNV.

	Average	Model Estimates			% Change from Average RNV		
Indicator	**RNV**	**Current – 2010**	**Future – 2110 BAU Scenario**	**Future – 2110 FM Scenario**	**Current – 2010**	**Future – 2110 BAU Scenario**	**Future – 2110 FM Scenario**
Percent (%) area of disturbed land	0	0.05	0.15	0.14	NA	NA	NA
Percent (%) of undisturbed land	1	0.95	0.85	0.86	-5%	-15%	-14%
Edge density (km/km^2)	0	1.27	4.35	1.96	NA	NA	NA
Forest core area (fraction)	1	0.19	0.09	0.35	-81%	-91%	-65%
Average forest age	69	62	48	49	-10%	-30%	-29%
Watershed discontinuity	0	0.01	0.46	0.10	NA	NA	NA
Moose Habitat Suitability Index (HSI)	0.35	0.3	0.17	0.3	-14%	-51%	-14%
Fisher Habitat Suitability Index (HSI)	0.153	0.127	0.057	0.084	-17%	-63%	-45%
Index of Native Fish Integrity	1	0.35	0.01	0.42	-65%	-99%	-58%
Edible Berry Habitat Suitability Index (HSI)	0.3	0.3	0.2	0.24	0%	-33%	-20%

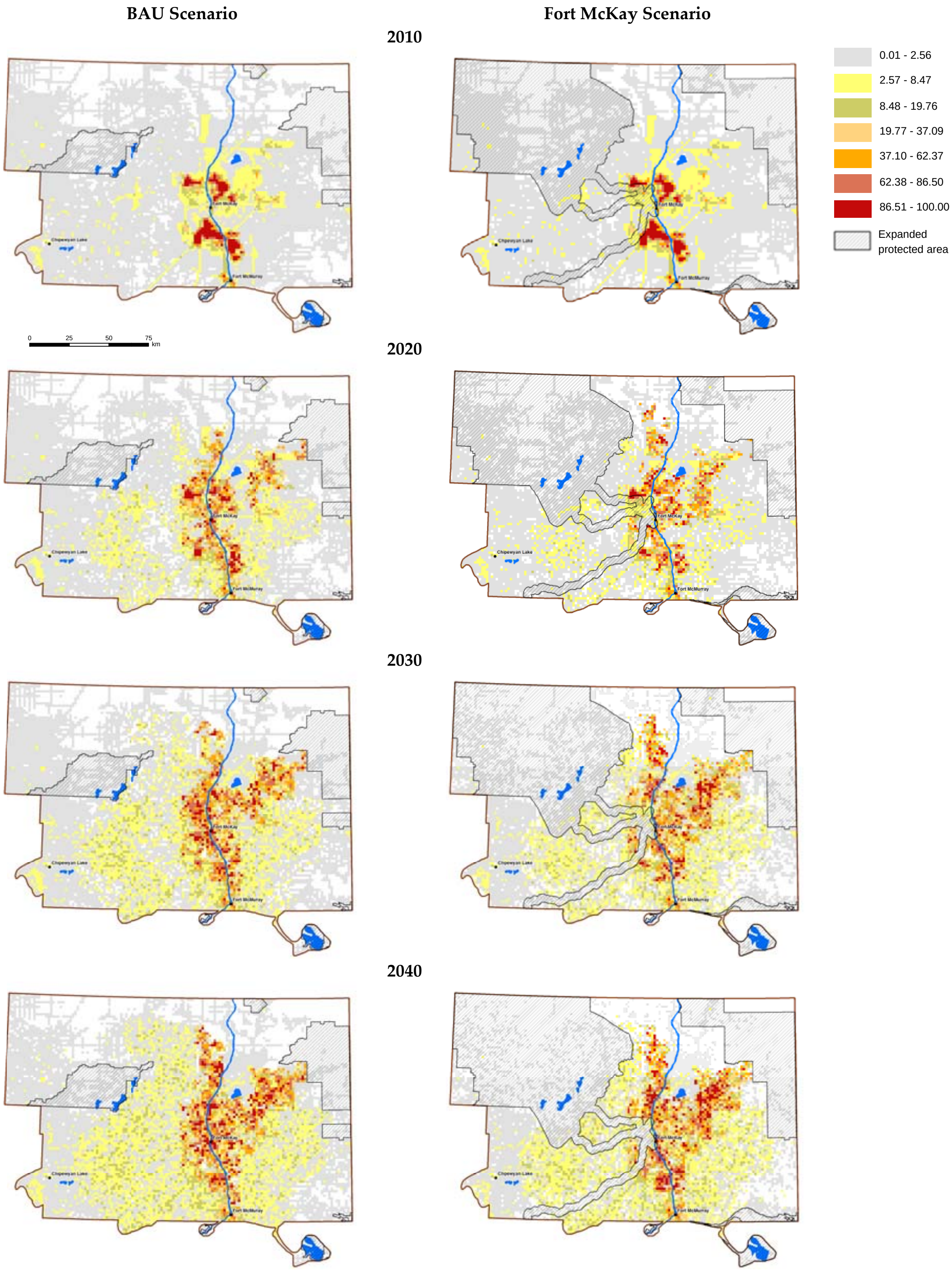


Figure 8: Projected future changes in percent (%) anthropogenic disturbance footprint for the Business as Usual (BAU) and Fort McKay Scenarios, year 2010-2040.

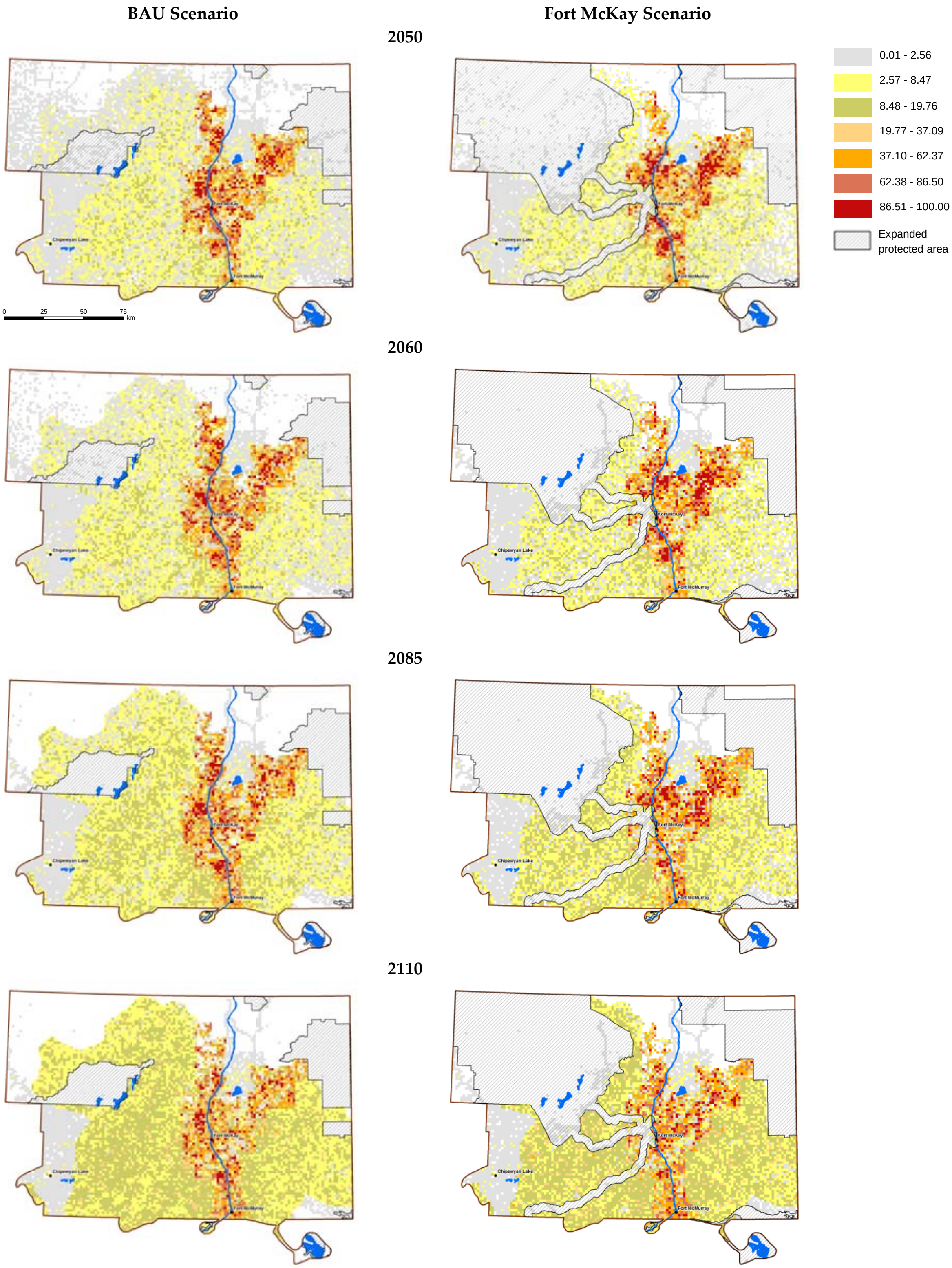


Figure 9: Projected future changes in percent (%) anthropogenic disturbance footprint for the Business as Usual (BAU) and Fort McKay Scenarios, year 2050-2110.

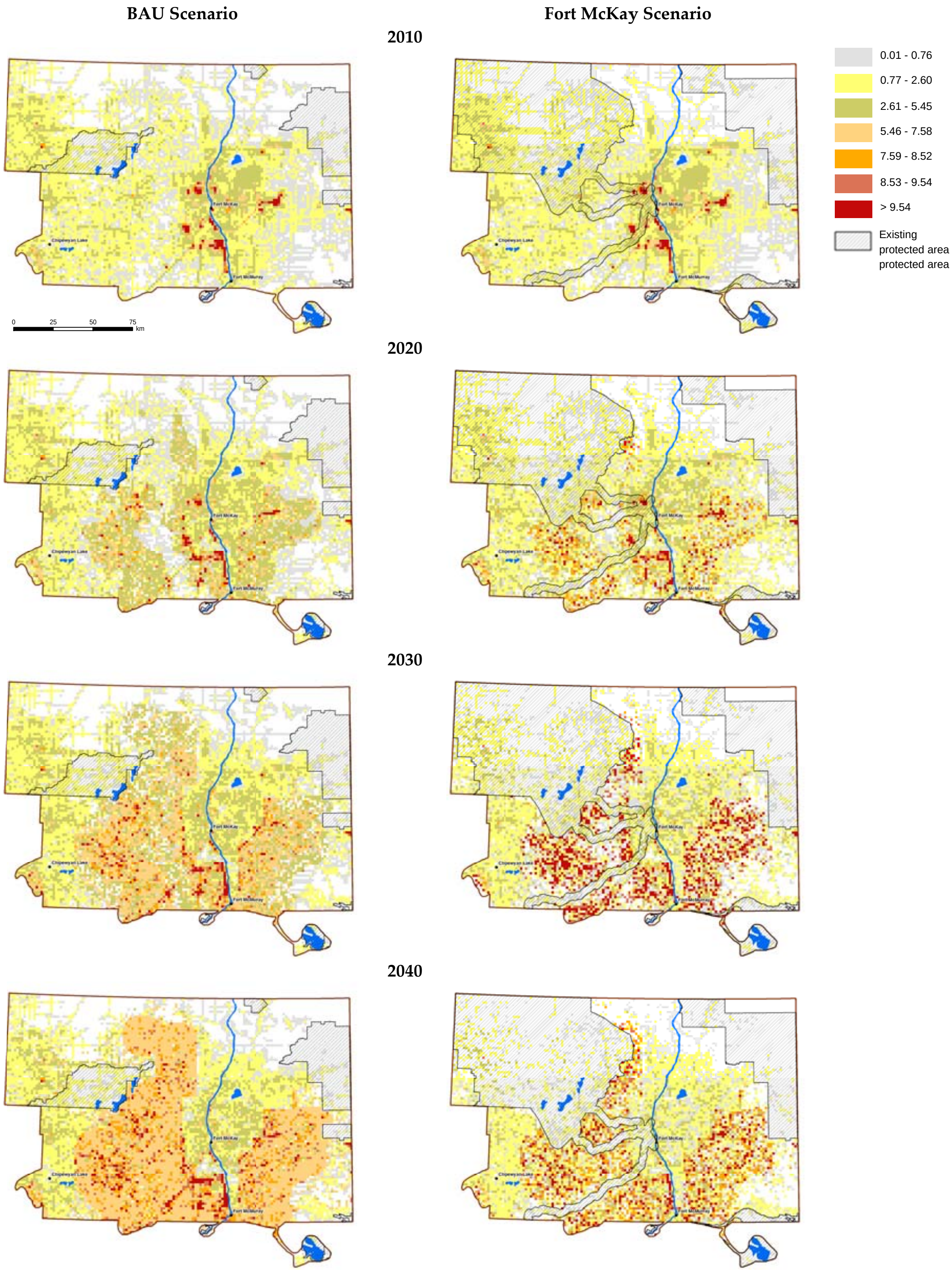


Figure 10: Projected future changes in footprint edge density (km/km²) in the Business as Usual (BAU) and Fort McKay Scenarios, years 2010-2040.

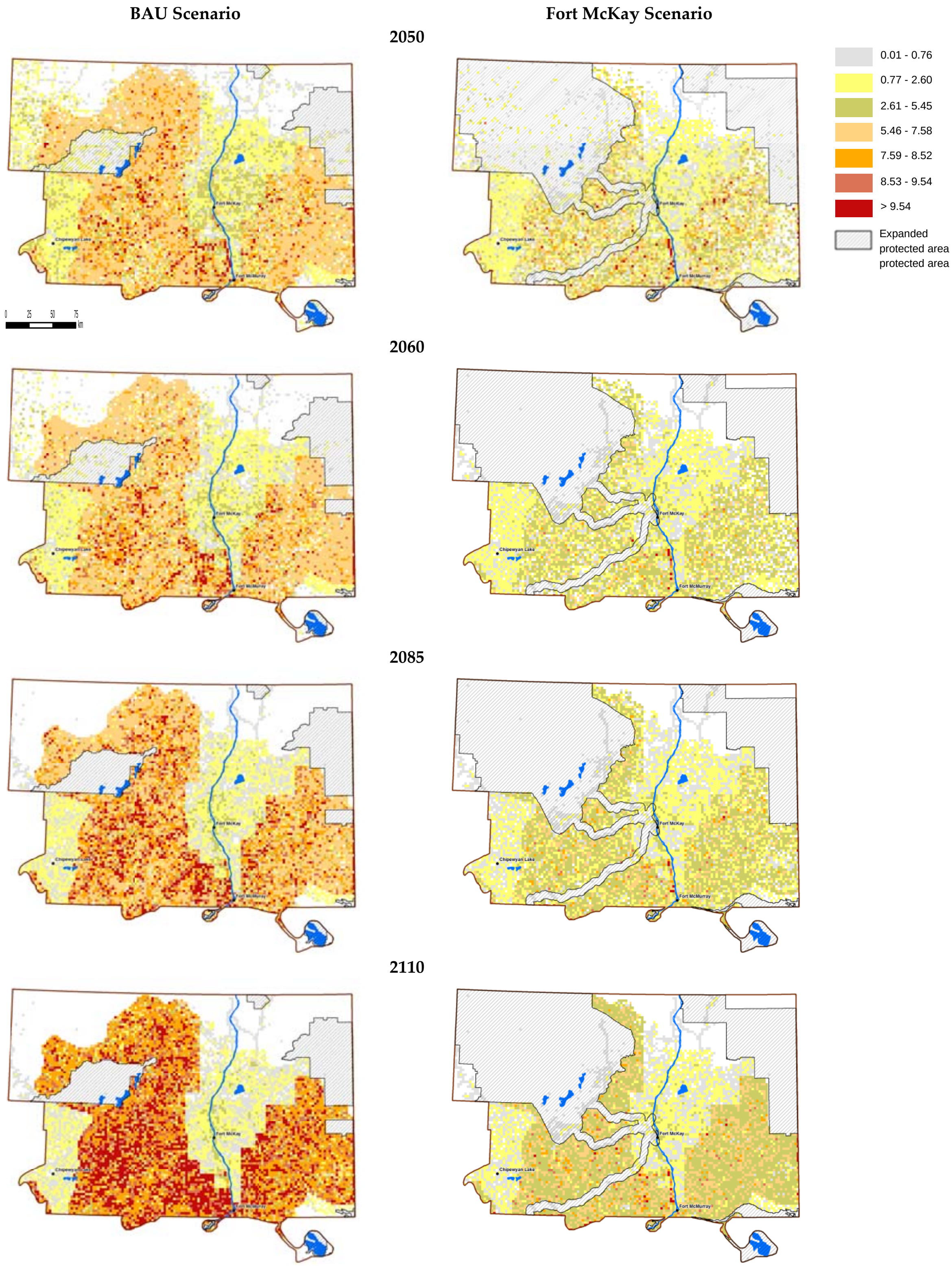


Figure 11: Projected future changes in footprint edge density (km/km²) in the Business as Usual (BAU) and Fort McKay Scenarios, years 2050-2110.

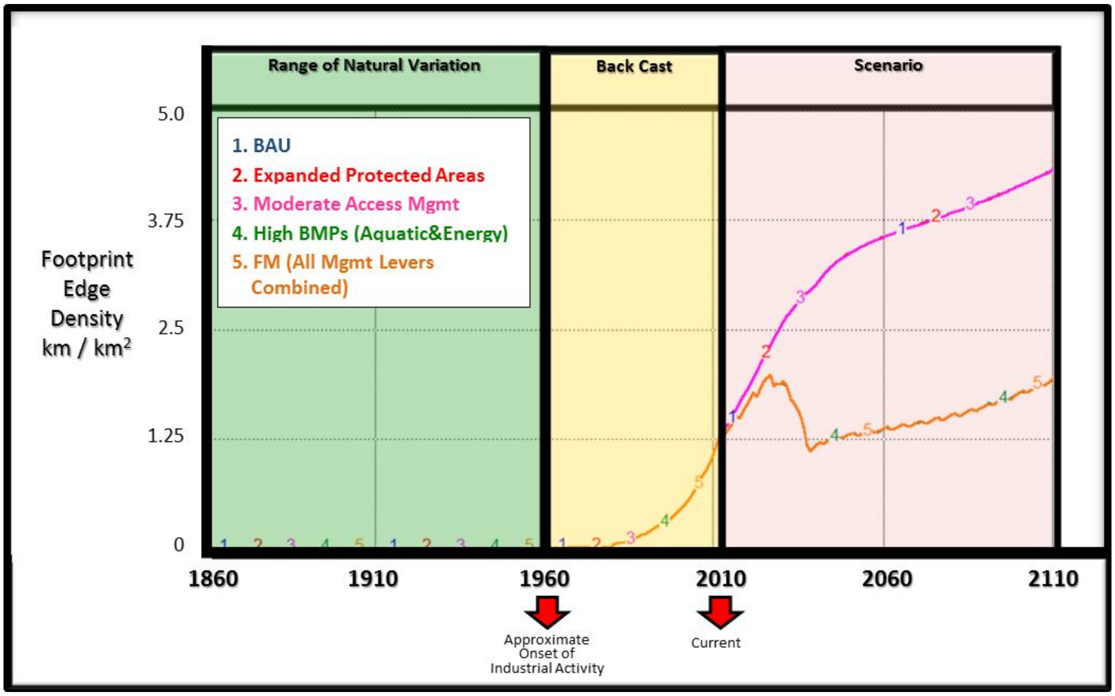


Figure 12: Patterns of net edge density (km/km²; includes reclamation assumptions) for the Business as Usual (BAU) and Fort McKay Scenarios.

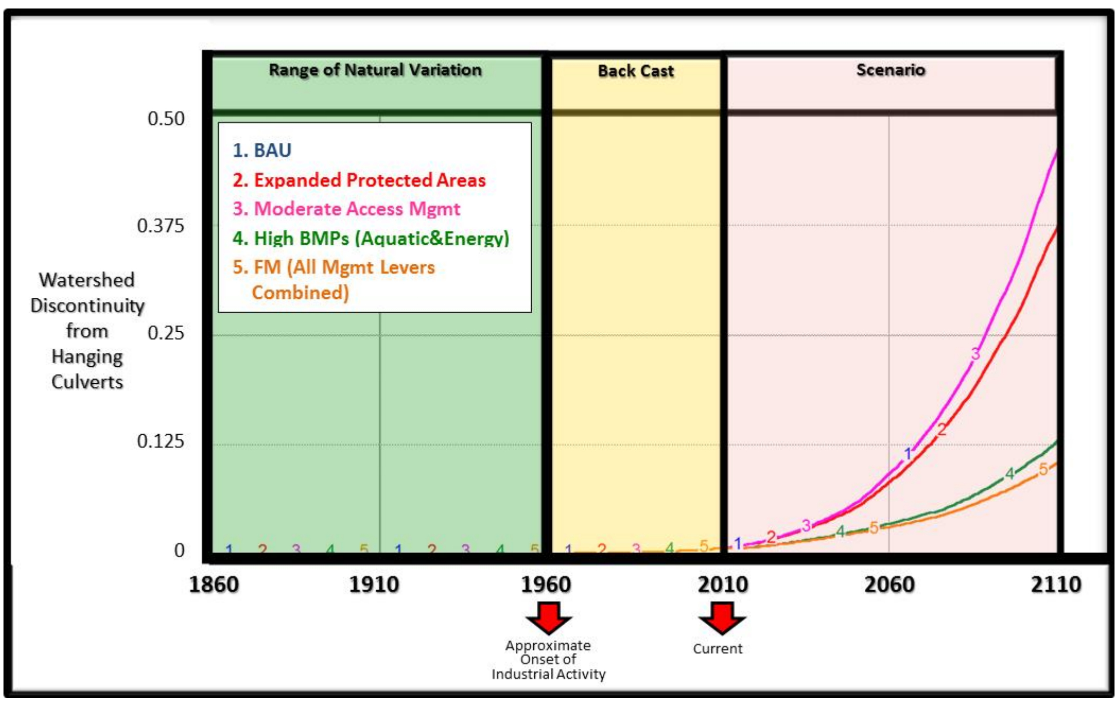


Figure 13: Patterns of watershed discontinuity (fraction of streams that are disrupted) the Business as Usual (BAU) and Fort McKay Scenarios.

10.2 CHANGES IN BIOTIC INDICATORS

Wild animals and plants (biota) are sensitive indicators of ecological changes in boreal ecosystems caused by either natural disturbance regimes (Stelfox, 1995) or human land-uses (see CEMA-SEWG 2008). Individual species may also represent significant value to aboriginal peoples because of spiritual, economic, recreational or subsistence values (see (Garibaldi & Turner, 2004) and (Garibaldi, 2009). Disturbance in general results in an overall direct loss of habitat to plants and wildlife, as well as traditional use areas. Linear disturbance features in particular are a key driver of change for biodiversity indicators. In some cases linear features can improve habitat for species such as moose, by providing access to younger plant communities and increased forage. This positive effect is often over-ridden by increased mortality to moose from motorists, hunters, fishers, trappers, and animal predators using these linear features. Vehicle-wildlife collisions, intentional and unintentional disturbance or harassment, harvest, avoidance of habitat along linear features, and changes in predator-prey dynamics all contribute to the cumulative effects of linear features on wildlife.

10.2.1 Moose

Moose habitat has declined to the lower range of the RNV over the past 50 years of development in the Fort McKay Study Area (**Figure 14**), and most of this decline occurred in the area of intensive industrial development and human activity in and around the surface mines. Increased linear disturbance (i.e., minor roads and seismic lines) allows for access by humans and increased hunting pressures to moose. The modelling results were in alignment with Fort McKay Community members' observations of moose decline due to industrial development and a surge of hunters on the land around Fort McKay over the past few decades, as one member indicated:

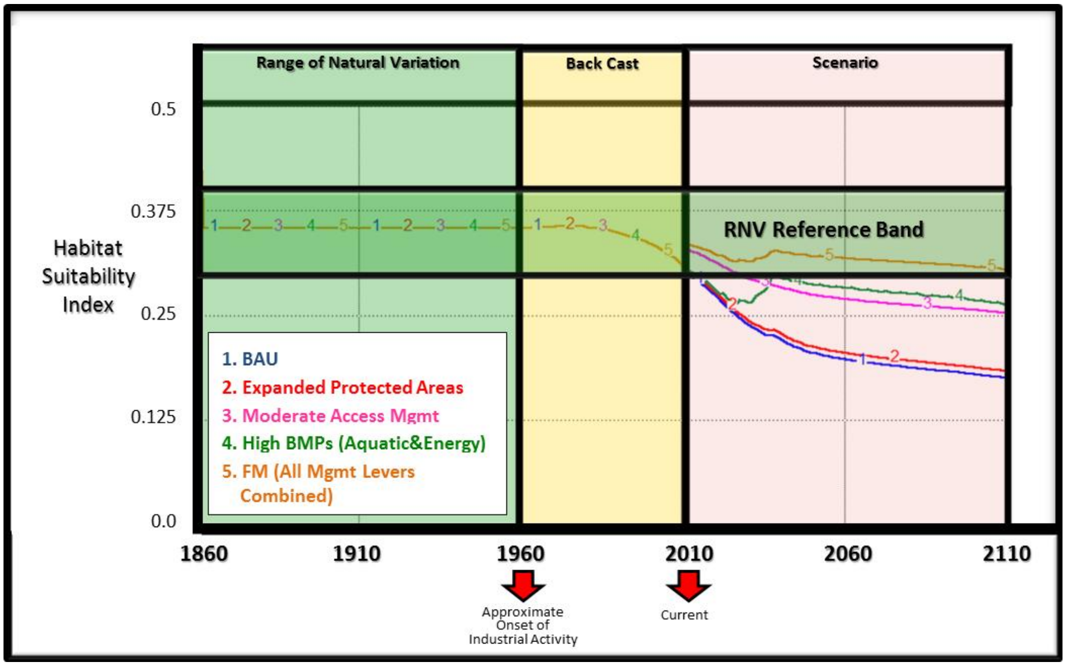
> *I'll tell you one thing. The moose habitat right now is way down. It's all over the place out there, quad tracks all over. And they're not local. They're from out of town. (ID#3, Fort McKay Cumulative Effects Workshop 3, 2012).*

> *Aboriginal people, they've been hunting here for years and years and years. You know. Moose population was never down that much. Ever since they started bringing the people out here now, you know, moose population's way down. I used to kill moose right across the river here. All over the place here. You can't do that now. You gotta go way the hell up there before you can track a moose. And they're going to keep on giving them permits until there are no moose around here for natives to use. (ID#3, Fort McKay Cumulative Effects Workshop 3, 2012).*

The increased population of Fort McMurray and increased access to the land has resulted in hunting pressures and members of the Fort McKay Community experiencing increased "competition" for traditional resources (such as moose) in a landscape where these species are showing a decline: "Over here [referring to near Fort McKay], we cannot go hunting, they are full of people out there. In the fall eh, everybody is hunting out there, camps everywhere." (ID#99, Fort McKay Cumulative Effects Workshop 3, 2012).

Moose habitat continues to decline in the BAU Scenario, deviating from RNV by 51% at 2110 (**Table 1**; **Figure 14**, **Figure 15** and **Figure 16**). Moose habitat suitability in the FM scenario showed an immediate increase due to the implementation of access management, followed by a gradual decline until 2110 (**Figure 14**, **Figure 15** and **Figure 16**). However, the moose habitat suitability remained stable at the lower level of the RNV (~0.32) as a result of the management strategies applied in this scenario.

Access management and industry BMPs (i.e., smaller seismic lines and pulse reclamation of seismic of 10% per 5 years) were key management tools that improved overall moose habitat suitability and populations in the Fort McKay Scenario, keeping them in a "stable" zone (**Figure 14**). These tools resulted in reducing overall access to linear features. However, as indicated in the maps (**Figure 15** and **Figure 16**), protected areas were important at the local level within the study area to maintain integrity of moose habitat through time.



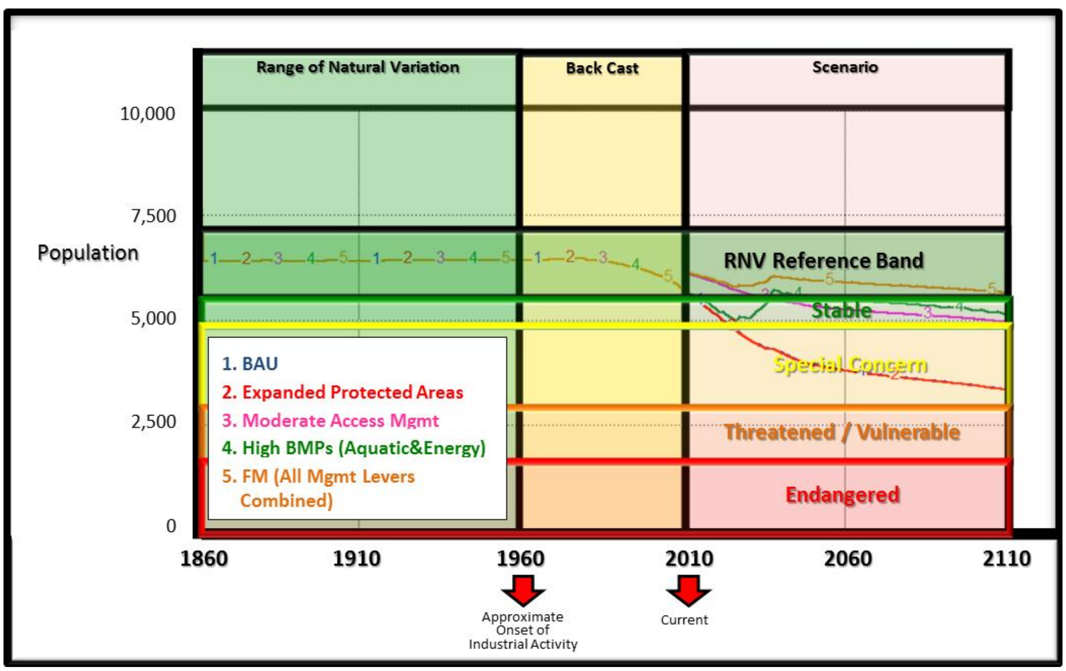


Figure 14: Patterns of moose habitat suitability index in the Business as Usual (BAU) and Fort McKay Scenarios. The bottom graph shows risk bands.

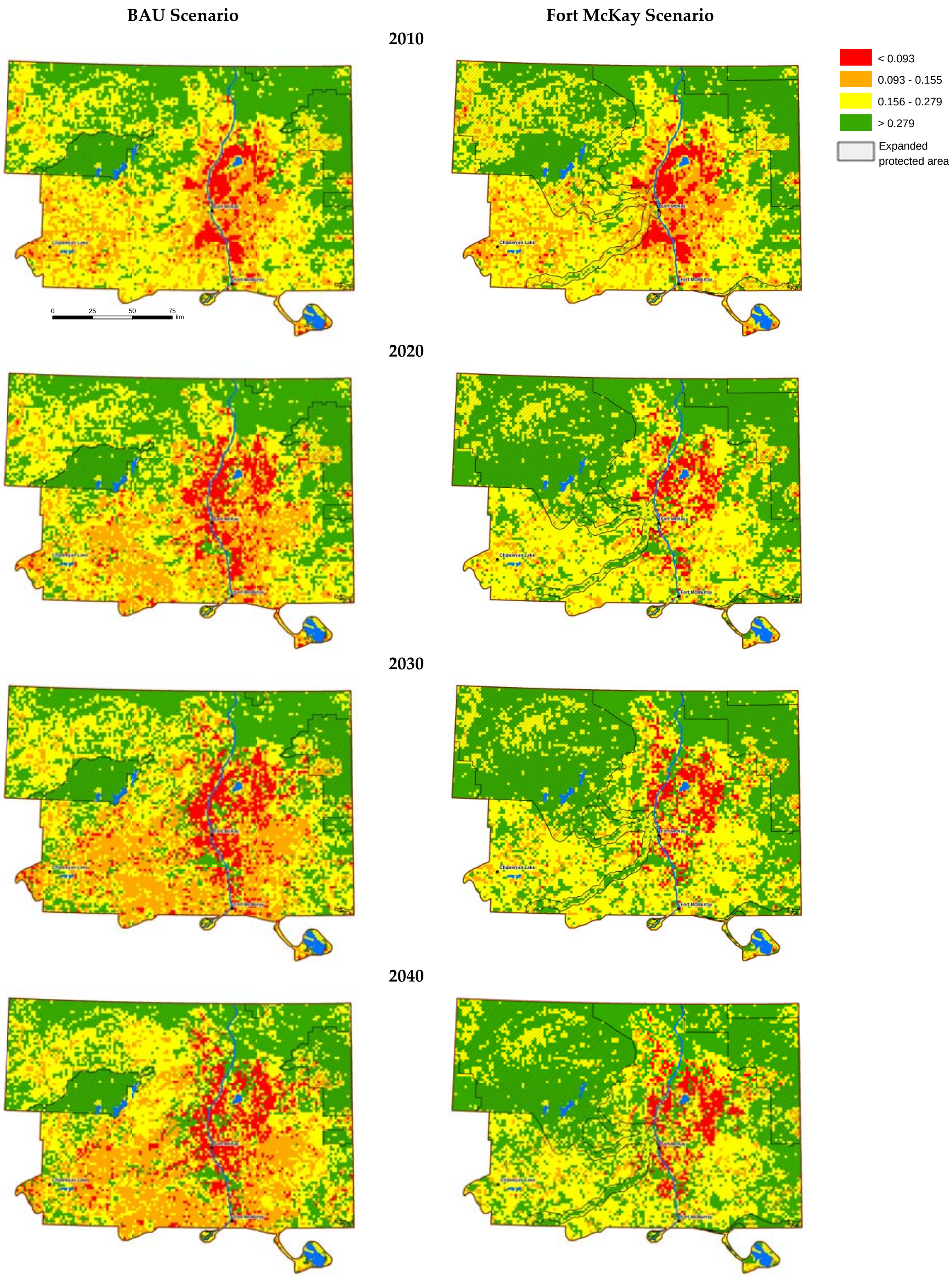


Figure 15: Projected future changes in moose habitat suitability index values, for the Business as Usual (BAU) and Fort McKay Scenarios, years 2010-2040.

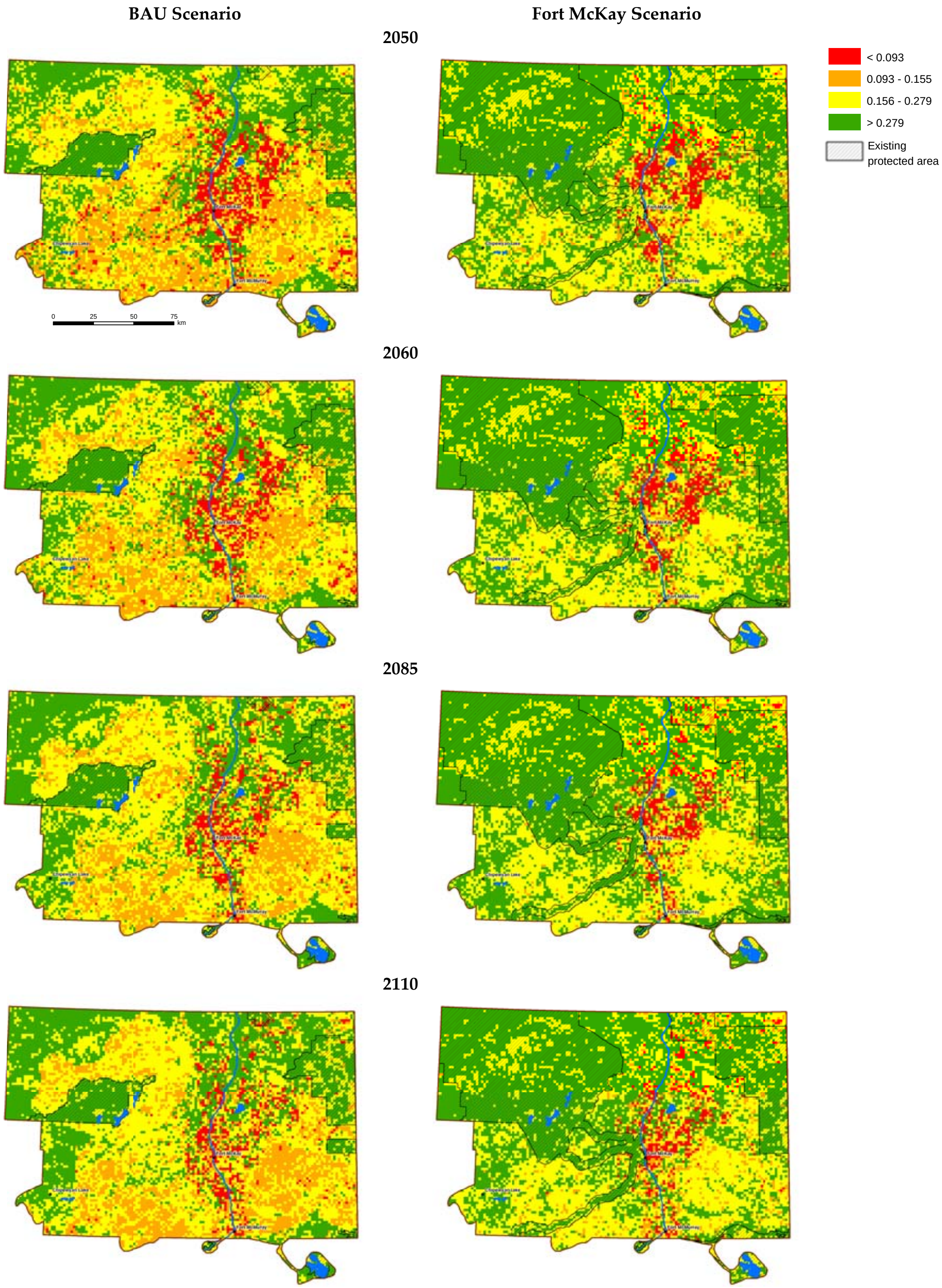
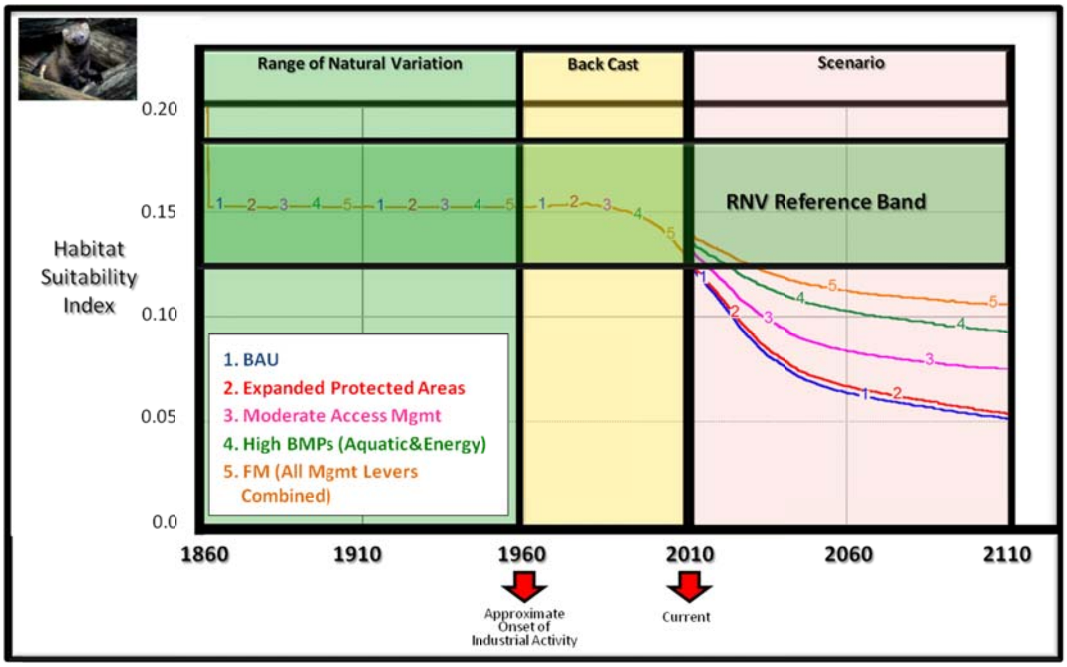


Figure 16: Projected future changes in moose habitat suitability index values, the Business as Usual (BAU) and Fort McKay Scenarios, years 2050-2110.

10.2.2 Fisher

In contrast to moose, which prefer younger forests, fisher prefer older forest with large intact areas. Since onset of industrial development in the Fort McKay Study Area, the quality of fisher habitat declined by 17% to the lower range of RNV (0.13) (**Table 1**; **Figure 19**) due to the fragmentation of the landscape, increased human access and to the loss of older forests to development, forest logging and fire. As a Fort McKay Community member noted: "You know, the fur bearing animals are decreasing in numbers every year. Do they [government and industry] listen to that? Not so much as the minerals in the ground, is more important. "(ID#3, Fort McKay Cumulative Effects Workshop 3, 2012).

Under the BAU Scenario, fisher habitat quality declines substantially, reaching a 65% decline from RNV at 2110 which is considered threatened and vulnerable. Similar to moose, the decline of fisher habitat is inversely related to increasing linear features (and associated edge) in the study area, but the decline for fisher is greater than that of moose due to the loss of mature and older forest habitat in the future simulation. In contrast, in the FM Scenario, fisher habitat still declines with increased in situ development, but the implementation of BMPs of seismic lines and access management result in less overall impacts to fisher habitat (45% decline from RNV in 2110, considered special concern; **Figure 19**). Expanded protected areas important to maintain core intact habitat for fisher at the local scale throughout the Fort McKay Study Area (**Figure 20** and **Figure 21**), which is essential to maintain sustainable fisher habitat in the context of intensive bitumen development fragmenting the landscape.



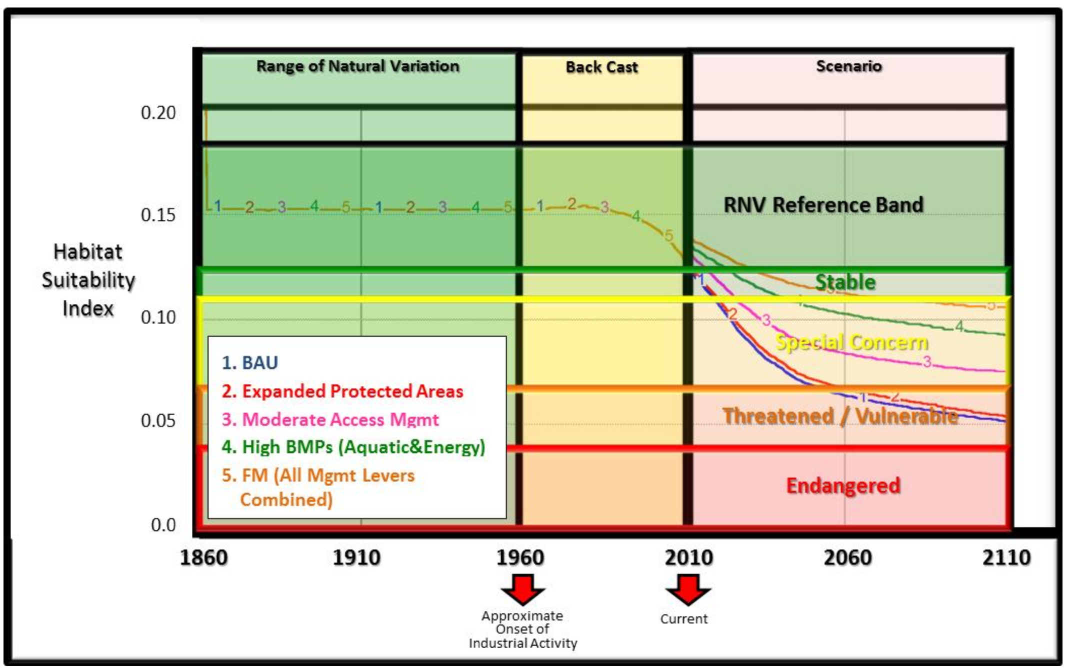


Figure 17: Fisher habitat suitability index for the Business as Usual (BAU) and Fort McKay Scenarios. The bottom graph shows the risk criteria superimposed on the graph.

Figure 18: Projected future changes in fisher habitat suitability index values in the Business as Usual (BAU) and Fort McKay Scenarios, years 2010-2040.

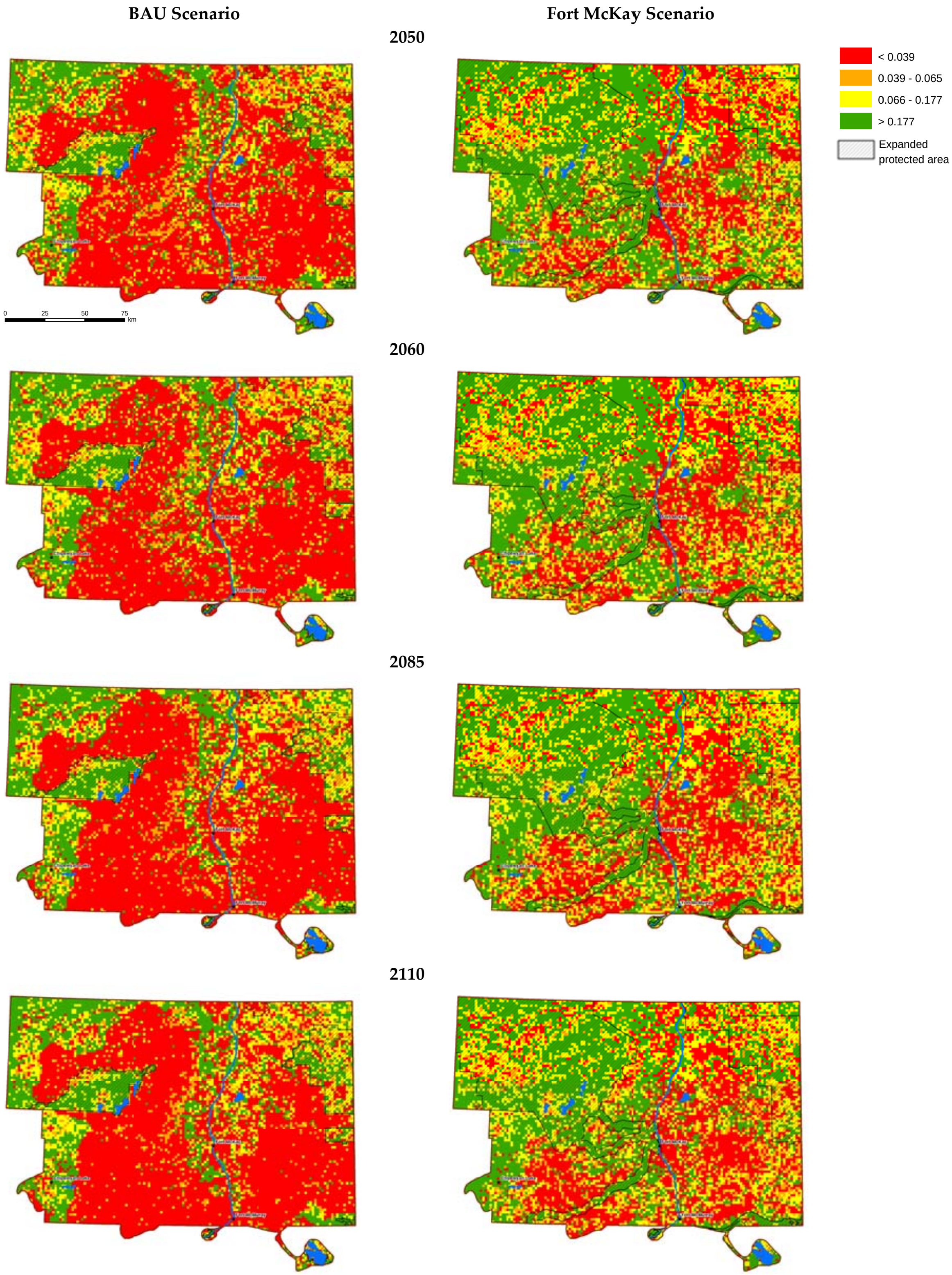


Figure 19: Projected future changes in fisher habitat suitability index values in the Business as Usual (BAU) and Fort McKay Scenarios, years 2050-2110.

10.2.3 Index of Native Fish Integrity

Index of Native Fish Integrity (INFI) has decreased by 65% since the onset of industrial development in the Fort McKay traditional territory, mostly due to fragmentation of the land and hanging culverts. Poor maintenance of culverts and clear span bridges will improve the performance of INFI; this is a BMP that Fort McKay is asking for in all new projects. Note that INFI is an index for fish composition, so as INFI approaches 0, it indicates that the key fish like walleye targeted by fisherman are lost, but other "small" fish will still be present.

Under a BAU scenario, INFI is projected to plummet further over the next three decades, and to remain in a collapsed state for the rest of the 100 year simulation period (99% decrease from RNV). The continued decline in INFI is related to increased habitat fragmentation and watershed discontinuity due to hanging culverts, and the influence of unrestricted access and heavy fishing pressure from a growing regional human population (**Figure 22**). The FM scenario results in marked improvement of the regional INFI status (**Figure 22**) as a result of moderate access management practices that reduce public access across and associated fishing pressures. Despite the initial improvement, INFI continues to decline due to increased linear development and fragmentation of streams and rivers. INFI declines from RNV by 58% at 2110 in the FM Scenario, and the status is considered "acceptable." The main effect of BMPs on INFI is through the replacement of hung culverts at a rate of 10% annually. Although replacing only 10% of hung culverts annually might seem low, the compounded effect through time is great.

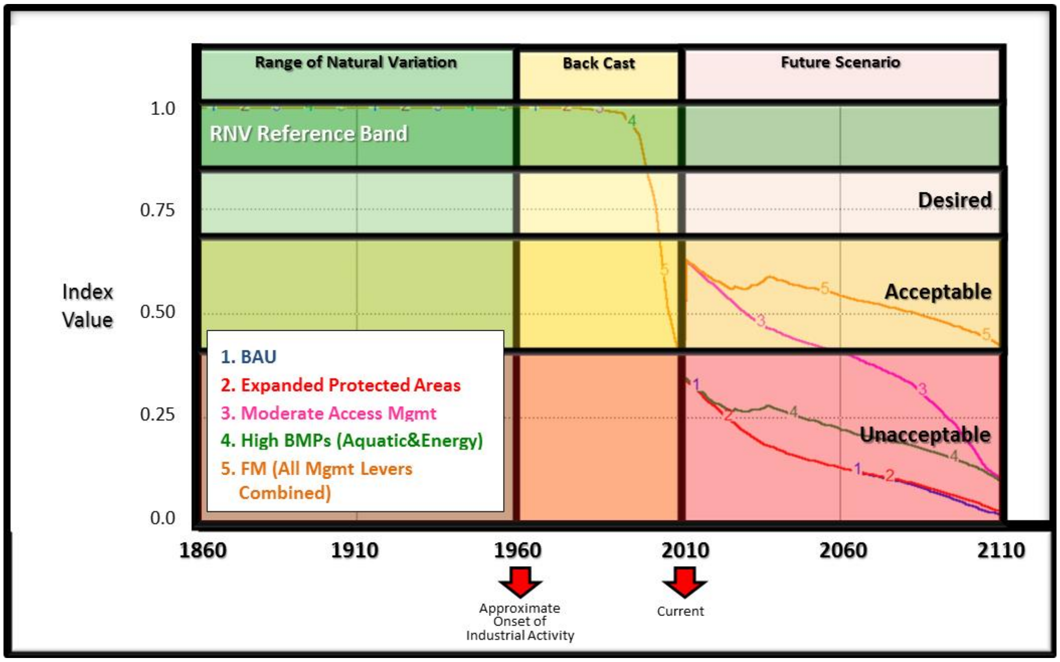


Figure 20: Patterns of the Index of Native Fish Integrity (INFI) for the Business as Usual (BAU) and Fort McKay Scenarios.

10.2.4 Berries

Blueberry (*Vaccinium myrtilloides*) and bog cranberry (*Vaccinium vitis-idaea*) are important food-plant species for the community of Fort McKay. These two species comprised the "edible berry" indicator for this Project. The quantity and quality of edible berries is affected by industrial activities, as a result of direct habitat loss and also indirect effects, primarily from road dust or other dust related to industrial development (e.g., tailings dust).

Model results show a slight decrease in edible berry habitat since the onset of industrial development (**Figure 23**), mainly related to the increase of roads and the dusting effect. However, Focus Group members indicated that berry habitat in and around Fort McKay has decreased and berry quality has declined due to dust and concerns of air pollution: EF1-"I used to walk a long ways to pick berries. Then there was no dust eh. Used to be just trails." (ID#3, Fort McKay Cumulative Effects Workshop 2, 2012).

In addition, Community members noted that due to industrial development, it is more difficult to access key berry picking sites.

Edible berry habitat will decline in the BAU Scenario, reaching a 33% decline from RNV at 2110 (**Figure 23**). Declines are primarily related to habitat loss and increased roads and associated dust effects. In the

FM scenario, edible berry habitat decline was less (20% decline from RNV at 2110), primarily because of reduced "traffic" and associated dust as a result of access management on secondary roads. In the model, we assumed that dust reduces the quality of berries near disturbance footprints, resulting in less desirable berries for traditional harvest or effecting berry production.

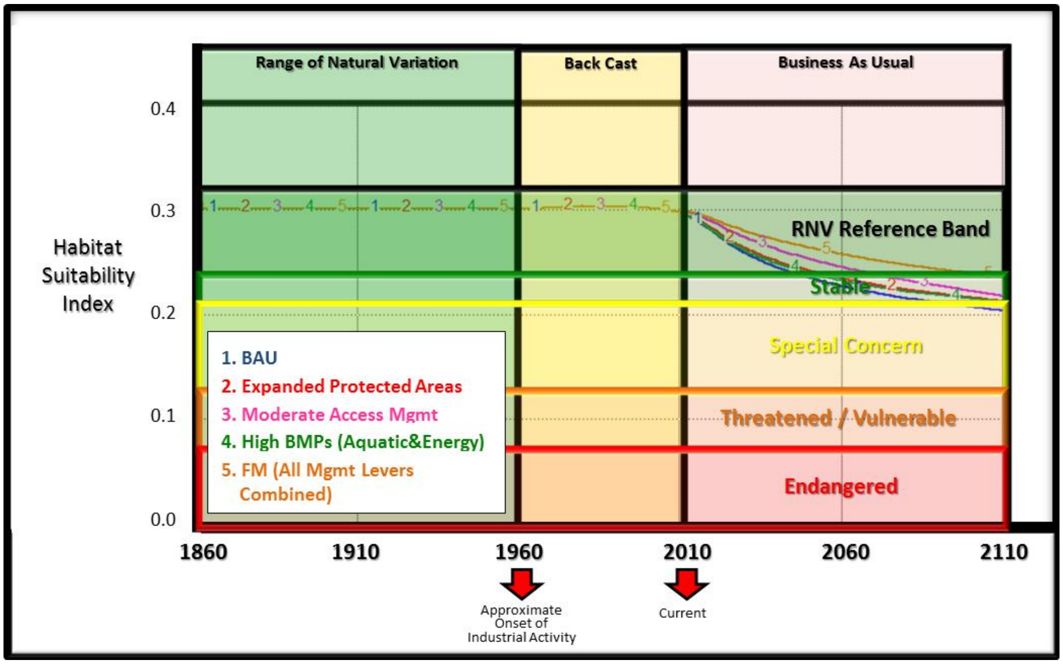


Figure 21: Edible berry habitat suitability for the Business as Usual (BAU) and Fort McKay Scenarios.

10.3 INDUSTRIAL LANDSCAPE STUDY AREA

The model results for the Industrial Landscape Study Area (**Figure 4**) were similar to those described for the Fort McKay Study Area above (Sections 10.1 and 10.2). However because this study area is more intensively developed, primarily by surface mining, the effects are more pronounced for both the landscape and biotic indicators (for biotic indicators see Figures **Figure 22** and **Figure 23**). For example, there is greater edge density, less intact core area and greater watershed discontinuity in the Industrial Landscape than there is in the larger Fort McKay Study Area. Similarly, moose habitat is much lower in the Industrial Study Area than in the larger traditional territory. The management options implemented in FM Scenario will have relatively less influence on the biotic indicators in the Industrial Landscape Study Area because this area is so heavily disturbed and lacks protected areas, therefore even with reduction of 50% access and implementation of aggressive industry BMPs, ecological indicator will still remain at levels far below RNV (**Figure 22** and **Figure 23**).

Results from the modelling are in alignment with Fort McKay's experience of industrial impacts in and around the hamlet. Community members in the Fort McKay Focus Group indicated that their experience of industrial impacts and hunting pressures are much more extreme in and around Fort McKay and the mines. One Community member expressed concern that the hamlet of Fort McKay will eventually become completely surrounded by industry, with no opportunities for traditional land use near the Community: 1- "Twenty years from now they'll be no room. Fort McKay's going to be all fenced in here. Industry's going to take over all around us. It's going to be just fenced in here. You got no place to go. Even the moose can't come in around here." (ID#3, Fort McKay Cumulative Effects Focus Group Workshop 3, 2012). Community members in the Focus Group and in the larger Community consultation process have expressed concern that the rest of the Fort McKay territory, especially the area around Moose and Buffalo Lakes, will also become surrounded by industry and impacted in a similar way (as Fort McKay) in the future. Central to this concern, is the recent proposed in situ development near Moose and Buffalo Lakes, such as that of Dover OPCO (2010) which comes within less than 2 km of the reserves (Dover Operating Corp., 2010)at Moose and Buffalo Lakes (See Lagimodiere 2013 for maps of projects near Moose and Buffalo Lakes).

Results from the modeling of the Industrial Study Area underscore the importance of establishing areas in Fort McKay's traditional territory that are protected from industrial development to serve as anchors for both maintaining ecological integrity and biodiversity in the territory, but also for supporting cultural values and traditional land use. The Moose and Buffalo Lake area is one example of a place that is culturally important to Fort McKay, both historically and currently. Many Community members view it as a "refugia" from industrial development, a place where they can go to seek peace from the noise, activity and pollution surrounding the hamlet of Fort McKay today (from the Fort McKay Community Consultation in 2011 and 2012). In addition, some Community members have expressed concern about the safety of traditional foods near industrial development (e.g., near surface mining) and that the traditional foods near Moose and Buffalo lakes are still relatively safe due to its current distance from the majority of industrial development in the region (from the Fort McKay Community Consultation in 2011 and 2012).

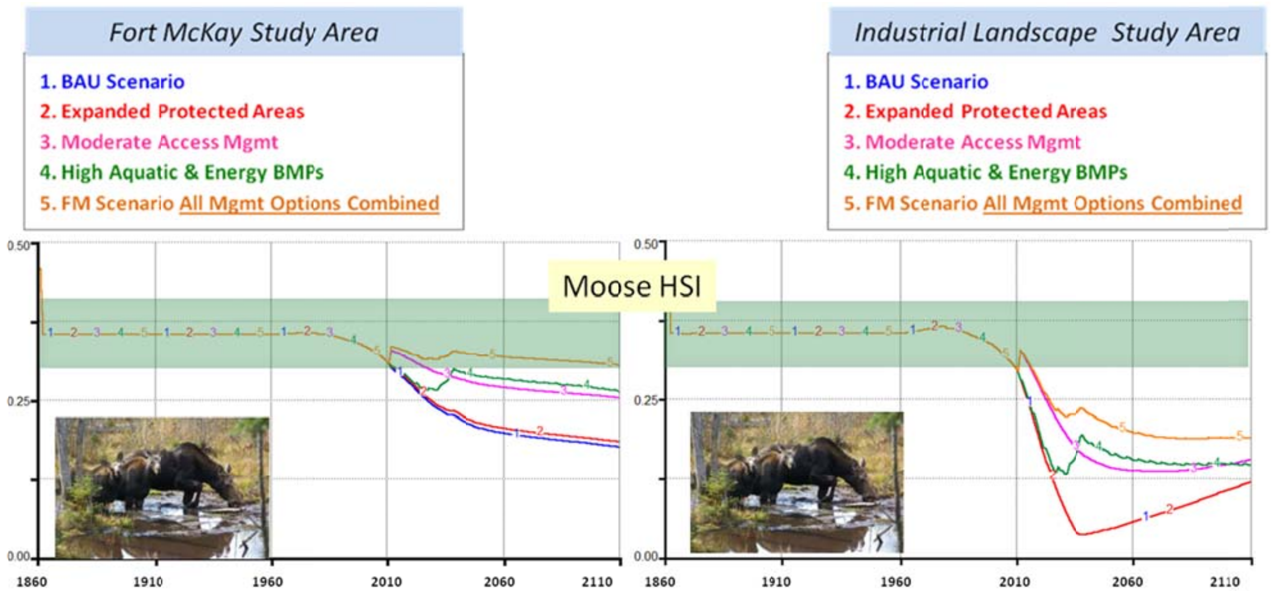


Figure 22: Patterns of moose habitat suitability index (HSI) and moose habitat suitability population in the Fort McKay Study Area in comparison to the Industrial Landscape Study Area, for both the business as usual (BAU) and Fort McKay (FM) Scenarios. Numbers on the graphs represent the moose habitat suitability population, including the range of natural variation (RNV) average on the upper left, and on the right the two numbers represent the range of moose habitat suitability population reflected by the various management levers. All management options are shown, including Best Management Practices (BMPs). The RNV is depicted as the green band on the graph.

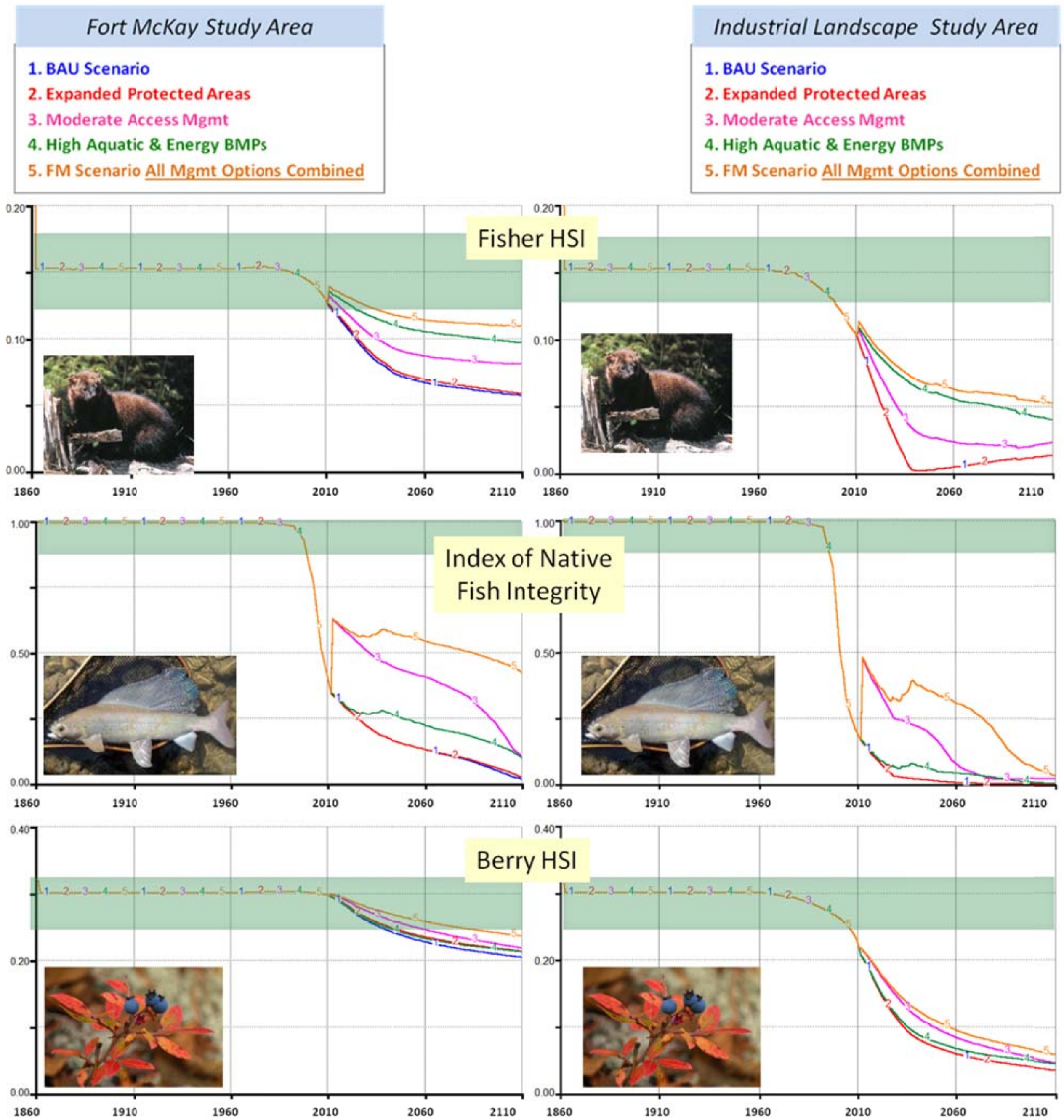


Figure 23: Biotic indicator performance in the Fort McKay and Industrial Landscape study areas, relative to the business as usual (BAU) and Fort McKay (FM) scenario assumptions. All management options are shown including Best Management Practices (BMPs). The RNV is depicted as the green band on the graph.

10.4 Sensitivity Analyses

Additional sensitivity analyses were conducted to understand the relative influence of management strategies and scale of the study area on selected indicators. Sensitivity analyses were conducted for pace of development, protected area size, degree of access management, the various best management practices and reclamation. Key results from the sensitivity analyses are highlighted here.

10.4.1 Pace of development

Pace of development was not a key management tool that the Fort McKay Focus Group thought was realistic to focus on because the sentiment was that the Government of Alberta would not support slowing the pace of bitumen development, but may be more willing to support other management options. However, the Focus Group was interested in understanding how ecological indicators would perform if the pace of development was slower. If the development pace was decreased by 50%, linear disturbance (and edge) would also decrease significantly due to less in situ development occurring on the landscape. This would result in some improvement in the biotic indicators that are negatively affected by linear disturbance and associated access, such as native fish and moose. However, if the bitumen development pace slowed, access management would still be required to improve performance of biotic indicators as the landscape is already highly fragmented.

10.4.2 Protected areas

Expanding protected areas to 1.2 times that of the Fort McKay scenario would result in an increase in intact core area habitat as long at the protected area was considered a "no development" zone. Core area habitat is important to supporting overall landscape ecological integrity and biodiversity (Carlson, 2013) and also to maintaining opportunities for traditional opportunities in a heavily industrialized landscape (Fort McKay Industry Relations Corporation (IRC), 2010).

10.4.3 Access management

Fort McKay Focus Group members considered access management as an essential management tool that should be implemented in the territory (as well as the region) to improve wildlife populations and reduce overall hunting, trapping and fishing pressures. The sensitivity analysis for access management showed that 100% access management, or "high" access management (See Appendix A, Table A-5) resulted in no significant changes to landscape indicators "moderate" or 50% access management (which showed dramatic positive influences on biotic indicators (see Section 10.2), as reducing human access has no direct implications to the actual disturbance footprint on the landscape. However, increased "high" access management showed positive influences to biotic indicators. The concept of 100% access management was not a "realistic" management option supported by the Fort McKay Focus Group, rather it was agreed that some (i.e., 50% reduction of access) was necessary to the larger traditional territory, and that this should also result in greater restrictions on hunting, trapping and fishing by non-Aboriginal public.

10.4.4 Industry Best Management Practices

Sensitivity analyses for BMPs assessed the relative contribution that each practice has to performance of landscape and biotic indicators. Modeling results showed that narrow seismic lines (0.75 m) is the most effective BMP for reducing overall linear disturbance (and edge effects) in the study area, and consequently leads to improvements for biotic indicators. Pulse reclamation of seismic lines was also influential, as it results in faster reclamation of seismic lines (i.e., reclaiming 10% of seismic lines ever 5 years). The narrow seismic line BMP is a reduction from current seismic line size of 2.75 (on average) to 0.75, which is substantially smaller and allows for these lines to reclaim quickly and the small size of the line impede their use for humans and predators. Some companies are already implementing this BMP and as part of the CEMA-SEWG (2008) and LARP initiative (ALCES Group, 2009), industry participants indicated that this BMP was reasonable for future seismic development. However, it would need to be required by the regulators to ensure broad application and realize positive implications to ecological indicators in the region.

10.4.5 Reclamation

Sensitivity analyses were performed to address the uncertainty that habitats can be effectively reclaimed to their pre-disturbance conditions (i.e., destination of reclaimed habitats back to their pre-disturbance condition – See Appendix A, Table A-7and Table A-8 where mine disturbances result in a loss of certain vegetation types, such as peatland communities). These analyses also addressed the current uncertainty on the efficiency of reclamation in returning critical habitat conditions for ecological indicators (i.e., reclaimed habitat was "discounted" in value for ecological indicators or HSI**).** Results from the sensitivity analysis emphasized that the direct changes to landscape composition and area resulting from different reclamation trajectories of disturbance had little influence on performance of indicators. Furthermore, discounting habitat suitability coefficients for surface mines had minimal impact.

Overall Fort McKay Focus Group members indicated a concern that Alberta (i.e., industry, public and the government) place unrealistic expectations on the role of reclamation in mitigating effects from industry and improving overall ecosystem integrity for the region. Members indicated that reclamation is too slow and is still being developed (e.g., there is still no certainty that peatlands or muskeg can be successfully reclaimed), that it should not be relied on as the primary tool for mitigating landscape change, and that other tools like BMPs, access management and protected areas are more likely to improve the future performance of indicators and assist in maintain opportunities for traditional land use. Further, the Focus Group expressed uncertainty if and when reclaimed landscapes will sustain healthy wild animal and plant populations that are desired and utilized through traditional hunting, trapping, and foraging activities.

11 CONCLUSION

The pre-industrial disturbance landscape supported sustainable traditional land use by aboriginal people, including those of Fort McKay. Today, pressures from industrial development and associated human activity have caused a key decline in ecological indicators in the study area, where most severe declines are in and around the Mineable Oil Sands Area near Fort McKay. Current pressures are primarily a result of the surface mines and associated infrastructure as well as some in situ and associated human use of linear disturbance features in the study area. However, the model forecasts indicate that in situ is in the early stages of growth and will have an even more dramatic impact on ecological indicators in the future due to land fragmentation and the increased opportunity for humans to access the land for recreation, hunting, trapping and fishing. Although most EIAs claim no or minimal significant cumulative impacts for every new proposed project, there have been and will likely continue to be significant cumulative effects in Fort McKay's traditional territory. This supports Community members' experience of industrial effects on the land.

Results from this Project assist Fort McKay in understanding options and their relative effectiveness for moderating the impacts of development and retaining some opportunities for traditional land use. According to the business as usual projections in this Project and work previously done by CEMA-SEWG (2008), ecological indicators will continue to decline unless immediate management action is taken. Management options were identified, that if adopted and implemented, would have dramatic positive implications for the future health and integrity of ecosystems in the Fort McKay traditional territory, but would still allow for substantial bitumen development in the area. Management options include:

- expanding areas protected from industrial development and anchoring them around environmental and cultural objectives, where these areas are no development zones with access and harvesting management for the public;

- developing a coordinated access management plan that is enforced by the Government of Alberta for the study area (and ideally for the entire LARP region) to reduce human motorized (and Off Highway Vehicles) access by at least 50%;
- including regulatory requirements for industry BMPs that seek to reduce growth of overall disturbance footprint, where the most influential practices include improved culvert maintenance/repairs, reducing the size of seismic lines to 0.75 m s and pulse reclamation of 10% of seismic lines every 5 years and such that these disturbances can reclaim more quickly.

In order to ensure protected areas support ecological integrity and biodiversity in the study area, these areas must have strict management regulations, permitting absolutely no development to occur within the protected areas and limited access (Carlson, 2013). Implementation of access management and BMPs will help to maintain healthy habitat and wildlife populations in protected areas and in the surrounding developed landscape.

As part of LARP, the Government of Alberta endorsed expanded protected areas (referred as "conservation areas") of approximately 16% "additional protected areas" in the Lower Athabasca Region (Government of Alberta, 2012); See **Figure 2** for location of conservation areas in the Fort McKay traditional territory), of which only 12.6% of that is located within the Fort McKay traditional territory. The protected areas were designed to have no or minimal market-grade bitumen to minimize conflict with the energy sector, and existing oil and gas tenure is honoured within these areas, as a result, some level of development may still occur on this "protected" landbase. Consequently, the current protected area network under LARP will result in less environmental protection (e.g., some industrial development is honored, multi-use corridors, and motorized public access for hunting, fishing and recreation is allowed) and is not adequate to sustain the ecological indicators required to support Fort McKay's traditional land use activities in the context of an intensive industrial landscape. For traditional land users in Fort McKay, the LARP protected areas are located on the periphery of their traditional territory with immense development occurring between the hamlet of Fort McKay and the protected areas. The ability to access and use these areas for traditional purposes is much more limited than it would be if the protected areas were closer to people's homes and traplines.

Protected areas alone will not mitigate all direct and indirect impacts from industrial development in the LARP region. Additional management requirements are necessary to mitigate impacts to ecological indicators, such as improved industry best management practices and access management of the public. However, there is limited discussion and commitment in LARP (Government of Alberta, 2012) with regards to access management and enforcement of aggressive and innovative best management practices for industry in the region. It is essential that these management options are integrated into a land-use plan, as one management option is not sufficient to repair the decline of ecological indicators in the study area, rather the combination of all management tools are required to effectively improve future ecosystem health and function while still allowing for bitumen development. Results from this Project will help advance Fort McKay's discussions with the Government of Alberta and industry on land use planning initiatives for Fort McKay's traditional territory.

One key objective of this Project was to identify future land-use decisions that are most compatible with the long-term goals of the community of Fort McKay. As such, the Project evaluated management options that could best meet these goals for the future landscape. The Project approach allowed for active involvement in land use planning by Community members and the community-engagement process that was followed can be built on for future Fort McKay work to further address land use planning initiatives in the Community (e.g., development of an access management plan). The land-use planning Community engagement process integrates well with the established Community consultation process led by the FMSD, and is an opportunity integrate feedback on land-use planning from the broader Community. Focus Group members were interested in continuing to be involved in land-use planning initiatives and indicated that it was important that the community have direct input to decisions around land-use planning for the territory:

> *"We need to have, we need to be able to do, work together as a community to decide these things in order for us to be able to take it to the table, to leadership, or to industry, and say o.k., this is what we want. This. And it's going to benefit the whole community. Not just us today, but our grandchildren and our great grandchildren. Because seriously if we start giving, if we lose Moose Lake, we may as well not call ourselves Indians because we won't be able to hunt, we won't be able to trap, we won't be able to fish, we won't be able to live off the land. We gave up everything. We will not be Indians." (ID#99, Fort McKay Cumulative Effects Study Workshop 2, 2012).*

Results from this Project, emphasize the need for socially responsible development of bitumen resources in Alberta's oil sands region, as the culture, society and traditional economy of the people of Fort McKay are inextricably linked to the regional landscapes and ecosystems that support and shape them. The social, cultural, and economic health of the community of Fort McKay is dependent on opportunities in the industrial economy, but is also dependent on functioning surrounding ecosystems and on the ecological goods and services provided by these ecosystems. This dependence is particularly important for the indigenous people of Fort McKay, who have a culture and society (including spirituality, medicine, and methods of teaching) that are deeply rooted in, and have co-evolved through time and generations with, the ecosystems of the northern boreal forest.

12 REFERENCES

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APPENDIX A

Additional Supporting Figures and Tables

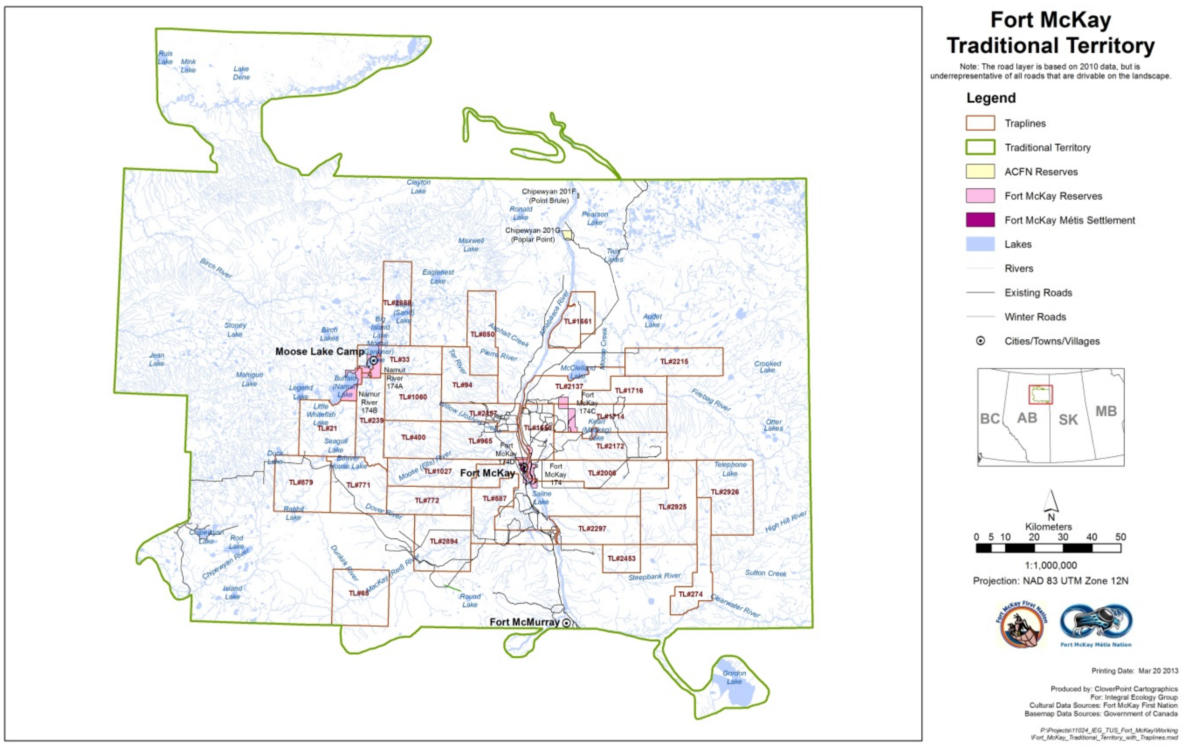

Figure A-24: Location of the community of Fort McKay in Alberta, Canada, showing the traditional territory boundary and Fort McKay's traplines

Table A-3: Characteristics of landscape types (LT) and footprint types (FT) in the Fort McKay Study Area

	Landscape Type (LT)	ALCES LT Code	Current Area (ha)	Current Length (km)		Footprint Type (FT)	ALCES FT Code	Current Area (ha)	Current Length (km)
1	Hardwood	Hw	358,938	-	1	MajRd	MajRd	1,460	584
2	Mixedwood	Mw	212,560	-	2	Min Rd	MinRd	1,336	890
3	White spruce	WhSp	102,805	-	3	Gravel Pit	GrPit	2,377	227
4	Pine	Pine	509,575	-	4	Tranmission Line	TransLne	482	160
5	Closed Black Spruce	ClBlSpruce	228,655	-	5	Rail	Rail	-	-
6	Riparian Forest	RipF	264,413	-	6	Industrial Facility	IndFac	4,889	528
7	Open Black Spruce	OpBlSp	330,709	-	7	Disposal Overburden	DispOverb	4,547	137
8	Black Spruce Lichen Moss	BlSpLiMo	76	-	8	Urban	UrbanL	2,749	94
9	Open Fen	OpFen	733,655	-	9	Camps	RRCamp	300	6
10	Bog	Bog	580,289	-	10	Tailings Pond	TailPond	9,111	187
11	Native Herbaceous	Herb	40,613	-	11	Seismic	Seismic	12,501	31,252
12	Tall Shrub	TShr	4,119	-	12	Wellsite	Wellsite	15,013	6,448
13	Short Shrub	ShShr	10,436	-	13	Pipeline	Pipeline	5,103	4,252
14	Small Lotic (streams)	SmLo	3,395	33,950	14	Surface Mine	SurfMine	39,901	855
15	Large Lotic (rivers)	LaLot	16,477	1,750			SubTotal	99,769	45,620
16	Endpit Lake	EPLake	-	-					
17	Lentic (lakes)	Lentic	116,740	-					
18	Beach Dune	BeDune	5,497	-					
19	Cultivated Crop	CultCr	-	-					
20	Forage Crop	Forage Crop	40	-					
		SubTotal	3,518,992	35,700					
	TOTAL AREA OF STUDY AREA		**3,618,761**						

Note: Major roads had paved or gravel surfaces with a minimum width of 12.5 m, whereas minor roads were graveled or unimproved surfaces with an average width of 7.5 m.

Table A-4: Characteristics of landscape and footprint types in the Industrial Landscape Study Area.

	Landscape Type (LT)	ALCES LT Code	Current Area (ha)	Current Length (km)		Footprint Type (FT)	ALCES FT Code	Current Area (ha)	Current Length (km)
1	Hardwood	Hw	175,857	-	1	MajRd	MajRd	1,362	545
2	Mixedwood	Mw	67,447	-	2	Min Rd	MinRd	751	501
3	White spruce	WhSp	37,970	-	3	Gravel Pit	GrPit	446	148
4	Pine	Pine	67,577	-	4	Tranmission Line	TransLne	-	-
5	Closed Black Spruce	ClBlSpruce	108,109	-	5	Rail	Rail	2,377	227
6	Riparian Forest	RipF	71,853	-	6	Industrial Facility	IndFac	9,111	187
7	Open Black Spruce	OpBlSp	62,979	-	7	Disposal Overburden	DispOverb	4,547	137
8	Black Spruce Lichen Moss	BlSpLiMo	33	-	8	Urban	UrbanL	2,706	93
9	Open Fen	OpFen	275,228	-	9	Camps	RRCamp	-	-
10	Bog	Bog	165,085	-	10	Tailings Pond	TailPond	4,715	509
11	Native Herbaceous	Herb	14,662	-	11	Seismic	Seismic	5,654	14,134
12	Tall Shrub	TShr	329	-	12	Wellsite	Wellsite	13,383	5,748
13	Short Shrub	ShShr	3,886	-	13	Pipeline	Pipeline	3,425	2,854
14	Small Lotic	SmLo	853	8,528	14	Surface Mine	SurfMine	39,901	855
15	Large Lotic	LaLot	8,896	945			SubTotal	88,378	25,937
16	Endpit Lake	EPLake	-	-					
17	Lentic	Lentic	18,679	-					
18	Beach Dune	BeDune	73	-					
19	Cultivated Crop	CultCr	-	-					
20	Forage Crop	Forage Crop	40	-					
		SubTotal	1,079,556	9,473					
	TOTAL AREA OF STUDY AREA		**1,167,934**						

Table A-5: Key model assumptions for access management

Sensitivity	Access Management (AM)	Indicators: Moose (HSI)	Indicators: Fisher (HSI)	Indicators: Berry (HSI)	Indicators: Index of Native Fish Integrity (INFI)
1	**No AM (BAU Scenario)**	Variable buffer width ranging from 100 to 500 for most footprints. Use varied between 25-50%	10% use of buffer width in HSI model	10% use of buffer width in HSI model	Study Area is accessible to public (0% Access Management)
2	**Moderate AM (FM Scenario)**	2X increase in habitat effectiveness and population size. Modeled as an increase to 50-80% footprint buffer width use in the HSI model.	2X increase in habitat effectiveness and population size. 50% use of buffer width in HSI model	75% use of buffer width	50% Access Management
3	**High AM**	2.5X increase in habitat effectiveness and population size. Modeled as an increase to 60-90% footprint buffer width use.	3X increase in habitat effectiveness and population size. 75% use of buffer width in HSI model	90% use of buffer width	100% Access Management
Comments / Assumptions		Overall response of moose is predominantly shaped by behavioral (avoidance) and demographic response (i.e., hunter kills) associated with linear features	Key assumption is degree to which fisher perceive seismic lines to be an edge and mortality (avoidance) associated with linear features	Key assumptions (uncertainties) are influence of dust as a function of access and reclaimed habitats having no value to edible berries in comparison to pyrogenic habitats	INFI is more sensitive to fragmentation (hung culverts & watershed discontinuity)

Table A-6: Examples of best (beneficial) management practices (BMPs) for the business as usual (BAU) and Fort McKay (FM) scenarios. The "aquatic management strategies" are those applied to streams and rivers, and the "energy sector strategies" are those implemented primarily by oil and gas companies.

Aquatic Management Strategies	Intent and Description	Units	Business as Usual (BAU)	High BMP (FM)
Hanging culvert replacement	Reduce the level of lotic discontinuity (i.e., breaks in water flow) on the landscape by removing and replacing "hanging" culverts	Percent of hanging culverts replaced annually	0%	10%
Energy Sector Strategies	**Intent and Description**	**Units**	**Business as Usual (BAU)**	**High BMP (FM)**
Seismic line width	Narrower seismic lines will take up less land and will be faster to reclaim	meters	2.75 m (~25 y)	0.75 m (~5 y)
Seismic line pulse reclamation	Pulse reclamation of seismic lines is a specific best practice intended to reduce the number of seismic lines over time by actively reclaiming a certain percentage of seismic lines over a specific time period	% (of seismic lines) / yr	0% / 0	10% / 5
Pipeline spatial overlap with roads	Increase spatial overlap between pipelines and roads to reduce the direct and indirect effects of these two linear features	%	0%	50%
SAGD well pad area (ha)	Increased well pad area to allow higher number of wells per pad, which will ultimately reduce the overall number of wellpads and associated "edge" in the landscape, as well as reduce the number of access roads to wellpads	Hectares	12 ha	15 ha
SAGD wells/pad	Greater dependency on directional drilling (i.e., placing more wells on a single pad), will result in fewer wellpads and fewer access roads	# wells / pad	18	25
Faster reclamation of wellsites	More aggressive and progressive reclamation to reduce linear "edge" effects from well pads. Note: Access roads to the wellpads are assumed to be permanent features in the Fort McKay ALCES model, even after the wellpads are reclaimed.	Relative index	wellpad exists for 40 yrs	wellpad exists for 20 yrs
Faster reclamation of surface mine features	Increase reclamation rate of surface mine features (mines), more progressive and aggressive reclamation planning and implementation	Relative index	30 yr (active mine life)	20 yr (active mine life)

Table A-7: Footprint reclamation assumptions for the business as usual and the Fort McKay scenarios

Disturbance Footprint	Defined Lifespan (y)	Reclamation Destination
Major Roads	Permanent	Not relevant
Minor Roads	Permanent	Not relevant
Gravel Pits	Permanent	Not relevant
Forestry Roads	3 years	Reclaimed to original vegetation type
Transmission Lines	Permanent	Not relevant
Rail	Permanent	Not relevant
Industrial Features	Permanent	Not relevant
Urban	Permanent	Not relevant
Rural Residential	Permanent	Not relevant
Disposal overburden	30 years	Reclaimed to back to vegetation types as per CEMA-SEWG assumptions (Table A6)
Tailings ponds	30 years	Reclaimed to back to vegetation types as per CEMA-SEWG assumptions (Table A6)
Surface mine (oil sands)	30 years	Reclaimed to back to vegetation types as per CEMA-SEWG assumptions (Table A6)
Seismic Lines	Related to seismic line width (~25 year lifespan for seismic lines with 2.75 m average width)	Reclaimed to original vegetation type
Wellpads	40 years	Reclaimed to original vegetation type
Wellpad Access Roads	Permanent	Not relevant
Pipeline	Permanent	Not relevant

Reclaimed Habitat Quality

There remains much uncertainty as to the habitat quality that will be provided by reclaimed landscapes relative to naturally disturbed landscapes (e.g., those disturbed by fire). To assess these uncertainties, we tested three assumptions in which the value of the reclaimed habitat quality was discounted:

1. reclamation destinations for footprints associated with surface mining of oil sands;
2. reclamation destinations for footprint associated with in situ well extraction of bitumen; and
3. discounting of HSI values for landscape types that have been reclaimed from surface mine and in situ footprints.

Reclamation for surface mining was either reclaimed back to the original landscape type or it was reclaimed according to destinations set by CEMA-SEWG (2008; also see Table A-7). Similarly, in situ disturbance was either reclaimed to original landscape types or if the areas was a disturbed wetland type (e.g., bog or fen treed peatlands, only 50% of it would reclaim back to the original landscape type and the other 50% would reclaim to a low-value wetland type (like an open fen) - this approach was taken to incorporate the current uncertainty over the ability to reclaim regionally common organic wetland types, treed and shrubby bogs and fens.

Table A-8: Reclamation destinations for mine disturbance as established by CEMA-SEWG (2008).

Landscape Types Targeted for Reclamation	Percentage of the Mine Disturbance Feature
Mixedwood	52%
White Spruce	12%
Closed Black Spruce	1%
Bog	3%
Herbaceous	9%
Tall Shrubland	5%
Endpit Lake	18%
Sum	**100%**

For habitat suitability, the base assumption was that ecological indicator HSI values for anthropogenic (i.e., reclaimed) landscape types were the same as HSI values created by natural wildfire disturbance. However, we tested alternate assumptions for anthropogenic landscape types where the HSI values were discounted by 20% and 40% (i.e., making the reclaimed habitat less valuable to ecological indicators). As with the sensitivity analyses affecting in-situ reclamation destinations, this approach was taken to address the current uncertainty on the efficiency of reclamation in returning critical habitat conditions for ecological indicators.