Oil Sands Leadership Initiative

Land Stewardship Working Group

Caribou Protection and Recovery Program

Draft Guidelines/Criteria for Workshop Discussion

April 2012

TABLE OF CONTENTS

1. INTRODUCTION

The Oil Sands Leadership Initiative[1] Land Stewardship Working Group (OSLI LSWG) is investigating the technical feasibility of creating a fenced woodland caribou safe zone in northeast Alberta. Most woodland caribou populations in this region are declining, government policy supports continued development of bitumen reserves, and recent caribou management initiatives have concluded that immediate and aggressive management intervention is required (ACC 2009; GOA 2011).

Although immediate action has been identified as a caribou conservation priority in Alberta, no comprehensive programs have been implemented, in part because the nature of action to be taken continues to be debated. A conservation option that is increasingly discussed, but which has not formally been evaluated, is a predator exclusion fence for caribou (Golder 2011). A fenced predator exclosure is considered to be a more natural option than an offsite captive breeding program such as the one recently proposed for Canada's mountain parks. Creation of a caribou safe zone has not yet been attempted for woodland caribou management, and there is uncertainty about the technical, ecological, and political feasibility of this novel and aggressive approach to house and protect caribou in northeast Alberta until sufficient functional habitat can be restored.

The OSLI LSWG acknowledges that there will be, and should be, considerable public interest and debate about the merits of a creating a predator exclosure as a component of a woodland caribou management program. The LSWG wishes to contribute to the debate around this caribou management option by providing a focused, independent evaluation of the technical guidelines or criteria that would be required to implement a predator exclosure, or the science-based reasons why this approach should not be considered further. This initiative is referred to as the Caribou Protection and Recovery Program (CPAR).

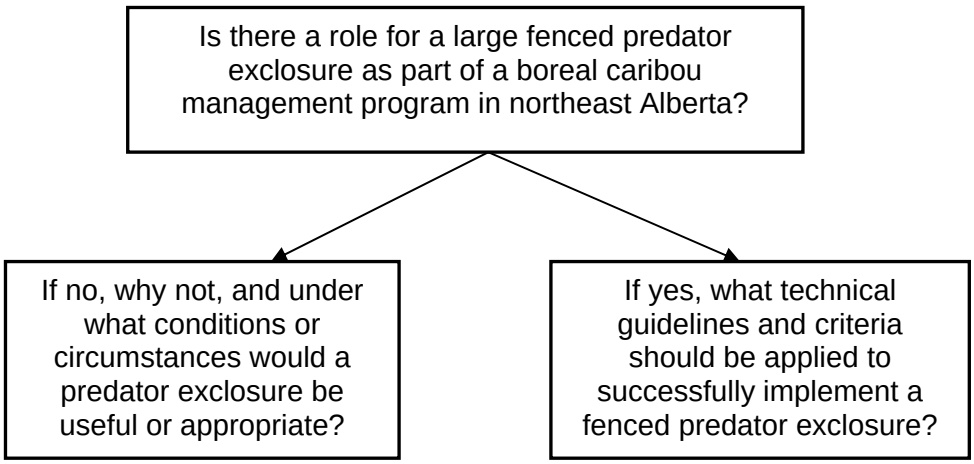
In 2011, the OSLI LSWG commissioned four independent feasibility studies to identify the risks and opportunities of constructing, maintaining, and monitoring a fenced predator exclosure and assess the overall practicality and likelihood of implementing a successful fencing program (Golder 2011, Hab-Tech 2011, Matrix 2011, Terrain FX 2011).A workshop is now planned to broaden discussion of this topic.

> The OSLI LSWG goal is to use best available science to innovate, collaborate, and conduct on-the-ground action that helps conserve caribou. Other OSLI LSWG caribou conservation initiatives include: mapping and monitoring to characterize current and future range condition and key forage resources; accelerated reforestation trials; wetland revegetation trials; line restoration and blocking trials to discourage predator movement; and research on conservation offsets.

[1] The Oil Sands Leadership Initiative is a collaborative network of six in-situ bitumen producers - ConocoPhillips Canada, Nexen Inc., Shell Canada, Statoil Canada, Suncor Energy, and Total E&P Canada - whose goal is to demonstrate and communicate environmental, social, and economic performance and technological advancements.

1.1 WORKSHOP OBJECTIVES

The conclusions from the four independent feasibility evaluations have been integrated into this report[2] and will be used as background material for a technical workshop of around fifty experts on May 16-17, 2012. The goal of the workshop is to bring together technical and scientific experts in caribou ecology, endangered species management, and industrial activities to answer the following questions:



Workshop attendees will be selected to represent key scientific and technical stakeholders as well as the different technical views likely to be encountered during program design and implementation.

If predator exclosure fencing is considered to warrant further consideration based on workshop discussions, the recommended guidelines and criteria would set the foundation for any further work to implement this management option. To this end, workshop participants will also be asked to provide suggestions on implementation and consultation roles and responsibilities.

1.2 REPORT ORGANIZATION

This document prepared for the OSLI LSWG by Terry Antoniuk of Salmo Consulting Inc. and John Nishi of EcoBorealis Consulting Inc. integrates results of the four independent feasibility studies as background for workshop attendees. The document will be revised to reflect workshop discussions and conclusions and identify key biological and technical issues for a caribou predator exclosure in northeast Alberta. If general agreement is reached that a fenced exclosure has technical merit and should be

[2] Note that this document summarizes results of the feasibility evaluations of caribou safe zones and does not represent the views of the OSLI LSWG.

considered further, the final report will also identify criteria and guidelines for implementation.

Information provided in the feasibility evaluations is integrated around five key questions in Section 2:

- **Why** (Section 2.1) discusses the desired outcome and potential benefits of a fenced caribou predator exclosure;
- **How** (Section 2.2) identifies issues and presents draft guidelines for fencing; wildlife, habitat, and access management; and monitoring, research, and adaptive management;
- **Where** (Section 2.3) discusses criteria relevant to siting a fenced predator exclosure;
- **When** (Section 2.4) identifies considerations for duration and completion of a caribou predator exclosure; and
- **Who** (Section 2.5) introduces issues around implementation and consultation roles and responsibilities.

Section 3 then summarizes overall conclusions from the four independent feasibility evaluations and provides a matrix that summarizes key issues; this matrix will be used as a discussion aid during the workshop.

Digital copies of the four feasibility evaluations will be made available to workshop invitees upon request.. Note that for brevity, this document does not contain detailed scientific references as these are available in the feasibility evaluations. Similarly, literal or paraphrased excerpts from the feasibility evaluations have been included here, but are generally not attributed to the original report(s).

2. DESIGN CONSIDERATIONS FOR A PREDATOR EXCLOSURE

2.1 WHY

What is the desired outcome of a fenced caribou predator exclosure?

The following desired outcome is provided for consideration based on information provided in the feasibility evaluations and discussions with the OSLI LSWG:

The desired outcome of a caribou predator exclosure (i.e., a large fenced and actively managed exclosure) is to establish and maintain a viable[3] caribou population in a natural setting while functional habitat[4] is being recovered (likely 40+ years) so that a self-sustaining caribou population[5] can ultimately be established in the absence of a fence.

Three of the four feasibility evaluations commissioned by the OSLI LSWG conclude that a fenced predator exclosure is technically feasible and worth considering further as part of a caribou management program. These evaluations assume that industrial activities would continue within the fenced area and that a viable caribou population can be maintained in the absence of predators. All feasibility evaluations acknowledge that there will be substantial debate about this option among resource managers, regulators, aboriginal groups, politicians, environmental organizations, and the general public. They also note that successful implementation would require a long-term, continuous commitment of resources and funds (in the order of $10 million for construction plus annual maintenance/operating costs plus future removal of infrastructure).

The following potential benefits of a predator exclosure are identified in one or more of the independent evaluations:

1. Provides a controlled natural environment to increase the productivity of caribou within the predator exclosure and establish a viable population in a region where one does not currently appear to exist.
2. Provides a secure source of boreal-ecotype caribou for regular translocation to augment declining regional/provincial populations. Thus a single fenced area could increase caribou abundance in a multi-herd metapopulation.
3. Contributes to caribou recovery and demonstrates to the public that government, industry, and others are working together to conserve woodland caribou in a working landscape.
4. Provides a controlled environment to test the feasibility of habitat restoration and population management options and to undertake research on cause-effect relationships contributing to caribou decline in the absence of predation.
5. Offsets impacts of ongoing industrial activities in the oil sands.

[3] A viable local caribou population is one: with stable or positive population growth; that is large enough to withstand random events (e.g., severe weather) and human-caused pressures; but requires ongoing management intervention to persist.

[4] Functional habitat is caribou habitat that is sufficiently old to provide winter forage, has comparatively small areas of young forest and anthropogenic footprint (i.e., corridors and clearings), and is of sufficient size to provide individual caribou with opportunities to space away from predators.

[5] A self-sustaining boreal caribou local population is one that: on average demonstrates stable or positive population growth over 20 years (i.e., $\lambda \geq 1$; more births than deaths); is large enough to withstand random events and human-caused pressures; and persists over 50 years without the need for management intervention (e.g., predator management or transplants from other populations) (Environment Canada 2011).

6. Allows comparison of the effectiveness of this approach with other conservation options and cost/benefit evaluation for application elsewhere in Alberta and Canada.
7. Contributes to the Environment Canada Proposed Recovery Strategy (Environment Canada 2011a) recommendation to maintain a caribou population in northeast Alberta for national connectivity.
8. Reduces the need for annual, large-scale wolf culls over many decades.
9. Large fenced area with ongoing restoration program would likely be beneficial for some other species with smaller home range sizes and similar general habitat requirements.
10. A fenced predator exclosure could create long-term job opportunities for monitoring, maintenance, and research.

One of the feasibility evaluations concludes that potential adverse consequences of this option could outweigh the potential benefits (Matrix 2011).. Key technical concerns identified in this report include:

1. Challenges with fence construction and maintenance, particularly at river crossings; and
2. High risk of both expected and unintended detrimental and cascading environmental effects to small prey species, other wildlife, and vegetation due to active management of predators, other prey species, and habitat
3. Substantial debate about this option among resource managers, regulators, aboriginal groups, politicians, environmental organizations, and the general public is anticipated and is anticipated to be difficult to address.
4. Caribou population decline rates may be overstated, and industry activity rather than predation may be an important limiting factor, so predator exclosure fencing may not be warranted (Wasser et al. 2011, 2012; Boutin et al. 2012).

2.1.1 Key Questions for Discussion

- Based on the desired outcome statement, is there a role for a large fenced predator exclosure as part of a boreal caribou management program?
- If yes, what technical guidelines and criteria should be applied to successfully implement a fenced caribou predator exclosure?
- If no, why not, and under what conditions or circumstances would a predator exclosure be useful or appropriate?

2.2 HOW

What criteria or guidelines should be applied to establish and maintain a fenced predator exclosure?

Feasibility evaluations identify the following issues for establishing and maintaining a viable caribou population within a fenced predator exclosure:

1. **Fence Design and Maintenance**
2. **Wildlife Management**
   a) exclosure size required for a viable caribou population.
   b) managing caribou health, genetic diversity, and behaviour within the predator exclosure.
   c) managing predator abundance within and adjacent to the predator exclosure.
   d) managing other prey abundance within and adjacent to the predator exclosure.
3. **Habitat Management**
   a) managing forage availability and vegetation condition within the predator exclosure.
   b) managing fire and other natural disturbances (e.g., insect infestations and flooding) within and adjacent to the predator exclosure.
4. **Access Management**
   a) managing human use and industrial activities within and adjacent to the predator exclosure.
5. **Research, Monitoring and Adaptive Management**

These issues, and draft guidelines/criteria to address each one, are described below.

2.2.1 Fencing Criteria or Guidelines

There are many examples world-wide of large fencing projects to protect and augment endangered wildlife populations (e.g., Elk Island National Park), to separate large mammals from human populations, and to reduce vehicle-wildlife collisions (summary provided in Table 2 in Golder 2011). The only relevant precedents for caribou are short-term cow/calf penning programs conducted on the Yukon-Alaska Chisana and Alberta Little Smoky populations to improve calf survival over the critical first weeks of life

2.2.1.1 Fence Design

All feasibility evaluations suggest that game fencing design guidelines for domestic elk and bison[6] can be adopted with slight modifications (Matrix 2011). The following draft guidelines are taken from the evaluations:

1. **Fence height**: at least 2.8 m high fence with 2.5 m high fence material to prevent deer movement, and with 1 electrified wire or a number of wire strands (i.e., offsets) angled out over the outside edge to deter black bear from climbing over. In forested areas, a high tensile cable on top should be considered to reduce damage from falling trees.
2. **Fence material**: mesh wire (15 cm horizontal by <30 cm vertical); electric fencing may be appropriate for small segments, although reindeer husbandry experience suggests that more solid visual barriers are more effective than a wire fence. Smaller mesh fencing is less likely to entangle caribou, but could have greater effects on other smaller species moving across the barrier.
3. **Posts:** material (pressure-treated wooden poles, or steel poles) of sufficient diameter and length buried deep enough in both mineral and wetland substrates and spaced at small enough intervals (e.g., 3.75 m maximum) to keep tension on all portions of the fence and mesh at ground level while accommodating annual freeze/thaw. Smooth metal posts can help reduce grip for climbing animals.
4. **Ground barrier** to deter digging by predators and other prey: smaller mesh wire at base of fence, 60 cm height above ground and either buried to 15 cm depth or laying on the ground surface 60 cm out from the fence.
5. **Gates**: built to similar height and standards as the fence; sufficient to pass people and/or maximum size vehicles/equipment; secured at all times. Consider need for locked, manned or automatic gates or electrified mats (e.g., ElectroBraid™) at each site as part of access management plan (Section 2.3.5). The need for jump-outs or gates for planned or contingency animal exits may be needed.
6. **Minor river crossings**: must maintain integrity in open-water, frozen, and shoulder seasons without affecting fish habitat and fish passage, and not susceptible to damage by stream debris (e.g., large woody debris); may be period during spring break up when fence needs to be removed, allowing caribou movement out and predator/other prey movement in (cantilevered arm-based design is one option; Matrix 2011).
7. **Major river crossings**: must maintain integrity in open-water, frozen, and shoulder seasons without affecting navigability, fish habitat, and fish passage, and not susceptible to damage by stream debris (e.g., large woody debris); may be period during spring break up when fence needs to be removed, allowing

[6] *Livestock Industry Diversification Act Domestic Cervid Industry Directives and Procedures Manual Revised Sept 2011* (GOA 2011).

caribou movement out and predator/other prey movement in (cantilevered arm-based design is one option; Matrix 2011).

8. **Winter road crossings**: gates built to similar height and standards as the fence; sufficient to pass maximum size vehicles/equipment; secured at all times.
9. **All season road crossings**: built to similar height and standards as the fence; sufficient to pass maximum size vehicles/equipment; secured at all times; barriers may be needed to prevent
10. **Setbacks** when parallel to roads, pipelines, powerlines; and other rights-of-way: may be required to reduce risk of collisions and damage from ploughed snow; sufficient distance from trees will reduce risk of damage from falling trees; barriers may be required to further reduce risk of collisions where animals are trapped along roads.
11. **Snow control**: fence alignment or other measures will need to be considered to deal with snow drifting along the fence that would allow animals to cross.
12. **Corners**: reindeer behaviour studies suggest that fences with no dead-ends or right-angle corners are more likely to facilitate natural movement and reduce likelihood of entanglement, injury to wildlife, and incidental predator advantage.
13. **Cleared fence perimeter and access for monitoring and maintenance**: fenceline perimeter should be cleared so that windthrow of trees does not cause fence failures; fence should be accessible by vehicles in all seasons with 3m wide cleared area on both sides.
14. **Visual markers on fence**: may be required to reduce risk of collision or entanglement.

2.2.1.2 Fence Maintenance

1. **Fence material longevity**: standard 25 year life expectancy assumed; so fence replacement budget should be included after this point.
2. **Fence inspection and maintenance**: ongoing (minimum weekly) year-round inspection by dedicated staff assumed for as long as the fence is in place to determine weaknesses, identify and repair breaks and vandalism, remove fallen trees, deal with unexpected snow accumulation, address unanticipated design issues, etc.
3. **Fence removal**: removal of the fence, gates and all associated infrastructure will be required once a self-sustaining caribou population is established.

2.2.2 Wildlife Management Criteria or Guidelines

2.2.2.1 Caribou Population in Exclosure

All feasibility evaluations agree that "a fenced, predator-free, managed population of caribou in suitable habitat can reasonably be expected to increase" (Terrain FX 2011),

and that active management of caribou within the fenced area will be required. Feasibility evaluations assume an initial population of 30-150 animals within a fenced caribou predator exclosure.

1. **Number of caribou required for viable local population**: Golder (2011) conducted three population simulations with highly conservative, realistic, and optimistic assumptions and concluded that with low predator numbers inside an enclosure, sustained growth of an initial population of 30 cows and several bulls is likely. Minimum populations proposed by the two Alberta caribou landscape teams for unfenced areas with low predator density range from at least 50 breeding females to 150 total (WCACLPT 2008; ALT 2009). Environment Canada (2011) demonstrated that even small populations have a high chance of persistence, given good demographic rates, as would be expected within a fenced predator exclosure. The number of caribou to be maintained within an exclosure will directly affect required fenced area size (Section 2.4.1).

   Relevant factors identified by the feasibility evaluations include: natural disturbance regime and habitat carrying capacity (see Section 2.2.3); home range size; age:sex structure; and desired number of caribou relative to regional/provincial recovery objectives.

   a) What demographic criteria or guidelines should be used to determine minimum and maximum caribou abundance (number or density; sex ratio; age structure) to be maintained within a fenced predator exclosure? Feasibility evaluations use densities of 5 to 7.5/100 km^2 to estimate required fenced area size.

   b) What procedures will be required to ensure that caribou remain within the fenced area while the fence is being constructed or for caribou to be captured and translocated into the fenced area once it is in place?

2. **Genetic diversity required for viable local population** within the fenced area: absence of immigration and emigration may lead to reduced genetic diversity over time due to a higher rate of inbreeding and elimination of gene flow among subpopulations. Low genetic diversity has negative fitness consequences and could affect the probability of ultimately establishing a self-sustaining local population. Genetic differences among boreal caribou local populations are poorly understood, and feasibility evaluations did not provide specific criteria or guidelines to describe a viable location population "with sufficient genetic diversity".

   a) What criteria or guidelines should be used to develop genetic management objectives and monitor genetic health of a caribou population within a fenced exclosure? Some considerations include number of founders, and targets for phenotypic or genotypic diversity and effective population size (accounts for sex and age structure in the population).

b) What criteria or guidelines should be used to determine the source of caribou to be translocated into the fenced exclosure to maintain or augment genetic diversity?

3. **Surplus caribou within fenced predator exclosure**:

   a) Can/should surplus caribou be used to maintain or establish gene flow within a defined boreal caribou meta-population? Based on this question, how should a large fenced predator exclosure contribute to genetic management strategies within a comprehensive boreal caribou population and habitat management program?

   b) What genetic and population criteria should be used to determine when and where to translocate surplus males and females to maintain meta-population connectivity?

   c) Should translocation be used to manage parasites? With / without deer present?

   d) What genetic and population criteria should be used to determine when and where to translocate surplus males and females to augment declining local populations?

   e) What actions would be required to improve survival probability of translocated caribou?

4. **Veterinary services**: veterinary services would be required for monitoring and managing population health of caribou and other wildlife species within the fenced area. For example, veterinary services would be required to establish strategic guidelines and implement field protocols for health management of wildlife populations, risk assessments of animal translocations, as well as handling (capture, immobilization, translocation and release) and clinical treatment of individual animals when required.

   a) What criteria should be used to determine when veterinary services are to be provided to caribou within the fenced area?

   b) Should artificial insemination or other forms of assisted reproduction be applied if needed?

   c) What criteria should be used to determine when and where forage supplementation is required, and how it should be delivered?

5. **Behavioural changes**: the feasibility evaluations identify the potential for behavioural changes if caribou are kept in a predator-free enclosure for several generations.

   a) Is there a need to maintain antipredator behaviour (i.e., flight responses) in caribou within the fenced area, and if so what are the management options (e.g., allow residual wolves)?

   b) Is there a need to avoid caribou habituation to humans within the fenced area and if so what are the management options?

c) What is the likelihood for change in other caribou behaviours due to lack of predators (birthing synchrony, diet, mating, habitat use; unnatural home range fidelity or restricted movement), if multiple generations are managed within a fenced area? What management approaches could be used to mitigate long-term behavioral changes in caribou?

d) What are the scale-dependent management options for maintaining a caribou population in the event of large fire(s) that burns a substantial area of the fenced area? Management options will likely vary depending on fire size (i.e., proportion of fenced area that is burned annually and cumulatively which will affect the total disturbed area)

e) What are the management options for caribou in event of introduction of large number of predators?

2.2.2.2 Predator Management

All feasibility evaluations conclude that ongoing management of predators would be required to successfully implement a fenced caribou predator exclosure; success will hinge on successful predator control (Terrain FX 2011). This is considered necessary to reduce predation rates of caribou females and calves until functional habitat that allows spacing away can be restored.

1. **Initial wolf cull within fenced area**: all feasibility evaluations concluded that to improve caribou survival, an initial wolf cull would be required to remove as many wolves as possible.
2. **Initial cull of other predators within fenced area**: there was no consensus in feasibility studies on whether all other potential predators (black bear, coyote, wolverine, lynx) should be culled within the fenced area to improve caribou survival.
    a. Is there need for a guideline to specify which other predator species should be initially culled/removed from within the fenced area?
    b. Can and should trapping be used to reduce other predator species within the fenced area initially?
3. **Ongoing wolf management within fenced area**: all feasibility evaluations concluded that to improve caribou survival, ongoing wolf management would be required to remove as many wolves as possible each year within the fenced area.
    a. Is there need for a guideline to specify desired or maximum wolf abundance (e.g., total number, density) within the fenced area?
    b. Should sterilization or capture/release outside the fenced area be considered as alternatives to culling over the long-term? If so, what criteria or guidelines should be applied to determine which option is preferred and where wolves would be translocated?

4. **Ongoing management of other predators within fenced area**: there was no consensus in feasibility studies on whether ongoing management would be required to reduce predation from all other potential predators (black bear, coyote, wolverine, lynx).

    a) Is there need for a guideline to specify desired or maximum abundance of each other predator species (e.g., total number, density) within the fenced area?

    b) Can and should trapping be used to reduce other predator species within the fenced area on an ongoing basis?

5. **Ongoing wolf management immediately adjacent to fenced area**: all feasibility evaluations concluded that ongoing wolf management to remove as many wolves as possible each year adjacent to the fenced area would be required to minimize predation.

    a) Is there need for a guideline to specify desired or maximum wolf abundance (e.g., total number, density) in a buffer around the fenced area, and what is the appropriate size of this buffer?

    b) Is there need for a wolf management in areas where 'surplus' caribou are to be released?

6. **Ongoing management of other predators immediately adjacent to fenced area**: there was no consensus in feasibility studies on whether ongoing management would be required to reduce potential for other predator movement into the fenced area from the surrounding area (black bear, coyote, wolverine, lynx).

    a) Is there need for a guideline to specify desired or maximum abundance of each other predator species (e.g., total number, density) in a buffer around the fenced area, and what is the appropriate size of this buffer?

2.2.2.3 Other Prey Management

There is no consensus among feasibility evaluations that ongoing management of other prey[7] populations would be required to successfully implement a fenced caribou predator exclosure. Most evaluations assume it would be necessary to: reduce potential for interspecific disease transmission to caribou from white-tailed deer (e.g., meningeal worm); reduce forage depletion and vegetation damage in the absence of predation within the fenced area; and reduce attraction of predators outside the fenced area.

1. **Initial cull of other prey within fenced area**: there is no consensus in feasibility studies on whether all other potential prey (moose, white-tailed deer,

[7] Other prey in northeast Alberta include moose, deer (white-tailed and possibly mule), beaver, and snowshoe hare. Other ungulates and small mammal species could be included in other areas.

beaver, snowshoe hare) should be culled within the fenced area to improve caribou survival.

a) Is there need for a guideline to specify which other prey species should be initially culled within the fenced area?

b) Can and should subsistence and/or recreational hunting and trapping be used to reduce other prey within the fenced area initially?

c) Are non-lethal methods available to for initial reduction of other prey within the fenced area (e.g., herding to drive some individuals out through fence gap or over jump-outs to adjacent habitat; translocation).

2. **Ongoing management of other prey species within fenced area**: there was no consensus in feasibility studies on whether ongoing management would be required to reduce competition, parasite/pathogen transfer, and predator attraction from all other potential prey species (moose, white-tailed deer, beaver, snowshoe hare) within the fenced area.

   a) Is there need for a guideline to specify a species-specific target density or maximum abundance of other prey within the fenced area?

   b) What would be the expected level of annual effort and offtake required to manage other prey densities within the targets for density and/or abundance?

   c) Can and should subsistence and/or recreational hunting and trapping be used to reduce other prey within the fenced area on an ongoing basis?

3. **Ongoing management of other prey immediately adjacent to fenced area**: there was no consensus in feasibility studies on whether ongoing management would be required to reduce competition, parasite/pathogen transfer, and predator attraction from all other potential prey species (moose, white-tailed deer, beaver, snowshoe hare) in a buffer zone around the fenced area.

   a) Is there need for a guideline to specify desired or maximum abundance of each other prey species (e.g., total number, density) in a buffer around the fenced area, and what is the appropriate size of this buffer?

2.2.3 Habitat Management Criteria or Guidelines

2.2.3.1 Managing Forage

All feasibility evaluations assume that caribou within the fenced exclosure would be able to subsist solely on natural forage. Comparatively little is known about the diet and nutritional requirements of woodland caribou. Research and monitoring will be required to document the health and condition of caribou within the fenced exclosure and confirm that carrying capacity is not being exceeded.

a) What criteria or guidelines should be used to design a forage monitoring program within the fenced area?

b) What research is required to address key data gaps on caribou diet and nutritional requirements.

2.2.3.2 Managing Fire and Natural Disturbance

Some feasibility evaluations assume that fire would be actively suppressed within the predator exclosure to functional habitat and forage loss. Others assume that the fenced area should be large enough to accommodate natural disturbance.

1. **Fire and Disturbance Management:** should fire be actively managed, or should the fenced exclosure be sufficiently large to accommodate natural disturbance over its anticipated life?
   a) What criteria, guidelines or analyses should be used to estimate natural fluctuations in carrying capacity to be encountered over the life of the fenced area (based on fire and insect infestation rates, potential influence of climate change, natural succession, flood risk, and assumed time to functional habitat recovery)?
   b) What contingency criteria or guidelines should be used to deal with a large forest fire that could kill a large number of caribou within the fenced exclosure?
   c) In the event of a large uncontrolled fire, what criteria should be used to determine when and where forage supplementation is required, and how it should be delivered?

2.2.3.3 Restoring Functional Habitat

Feasibility evaluations did not provide specific guidance on active restoration of functional habitat within and adjacent to the fenced predator exclosure.

1. **Restoring functional habitat within the fenced area**: all feasibility evaluations assume that industrial activities would continue within the fenced area and assume that a viable caribou population can be maintained in the absence of predators. However, restoration of functional habitat would ultimately be required to establish a self-sustaining caribou population.
   a) Is there a need for guidelines or criteria to specify the functional habitat restoration measures to be implemented within the fenced area?
   b) Should the Environment Canada (2011b) total disturbance-recruitment relationship be applied to define and monitor functional habitat within the fenced area?
2. **Restoring functional habitat within a buffer zone around the fenced area**: feasibility evaluations suggest that the fenced area may not be sufficiently large to establish a self-sustaining population, but that it could act as a nucleus to grow sufficient functional habitat.

a) Should a buffer zone immediately adjacent to the fenced area be actively managed to improve probability of establishing a self-sustaining population? If so, how should guidelines or criteria specify the functional habitat restoration measures to be implemented within the fenced area?

2.2.4 Access Management

2.2.4.1 Managing Human Use

1. **Access Management Plan**: will be required to determine procedures for managing industrial, aboriginal, recreational, and other access at each gate. The need for locks, manned or automated gates will need to be evaluated at each site.

2.2.5 Research, Monitoring, and Adaptive Management

2.2.5.1 Wildlife Monitoring

All feasibility evaluations agree that continuous monitoring of caribou, predator, and other prey population dynamics in the fenced predator exclosure will be required over the life of the initiative. Monitoring will also be needed to confirm caribou feeding patterns, improve knowledge of the nutritional and diet requirements of boreal-ecotype caribou, and help confirm carrying capacity of the fenced area. Collection of routine caribou blood samples for disease screening and genetic profiling should also be conducted.

Monitoring of any translocated caribou and other prey would also be required to determine their fate and contribution to local populations.

There is no consensus among feasibility evaluations about the type of monitoring required in the buffer zone immediately adjacent to the fenced area. Some evaluations conclude that predator abundance should be monitoring in this buffer because these individuals are more likely to try to enter the caribou predator exclosure.

1. **Wildlife monitoring**: is there a need for guidelines or criteria to specify the wildlife monitoring program to be implemented within a fenced area?

2.2.5.2 Habitat Monitoring

All feasibility evaluations agree that continuous monitoring of habitat condition within the fenced area will be required over the life of the initiative. This should include the distribution and availability of lichen biomass, status of habitat restoration work, and lichen/forage recovery following natural disturbance.

1. **Habitat monitoring**: is there a need for guidelines or criteria to specify the habitat monitoring program to be implemented within a fenced predator exclosure?

2.2.5.3 Human Use Monitoring

All feasibility evaluations note that human use within the fenced area will need to be monitored to minimize unintended effects from illegal harvest and harassment. Remote cameras have been identified as one option for continuous systematic monitoring.

1. **Human use monitoring:** is there a need for guidelines or criteria to specify the access and human use monitoring program to be implemented within a fenced predator exclosure?

2.2.5.4 Ecosystem Monitoring

As noted previously, two feasibility evaluations discuss potential for unintended detrimental and cascading environmental effects to small prey species, other wildlife, and vegetation due to active management of predators, other prey species, and habitat .

1. **Ecosystem monitoring:** is there a need for guidelines or criteria to specify the ecosystem monitoring program to be implemented within a fenced predator exclosure? Should any monitoring complement the existing Alberta Biodiversity Monitoring Institute program?

2.2.5.5 Research

All feasibility evaluations discuss a number of research opportunities that a fenced caribou safe zone would create.

1. **Research:** is there a need for guidelines or criteria to specify research priorities and restrictions within a fenced predator exclosure?

2.3 WHERE

What criteria or guidelines should be used for selecting potential locations of a caribou predator exclosure(s)?

All feasibility evaluations conclude that it should be feasible to select a suitable area of caribou habitat in northeast Alberta but acknowledge that selection of the proposed site(s) will be a key issue. The four evaluations identify the following desired attributes to be considered when locating a caribou predator exclosure:

Access and Physical Attributes

- minimize river crossings;
- maximize all season access to boundary to facilitate fence construction and maintenance (most feasibility evaluations incorporated highways or major

roads as fenced area boundaries when feasible, but measures would be needed to reduce mortality of animals trapped along roads);

- maximize well drained areas and mineral soil substrate suitable to support fencing;
- further north to minimize potential direct and indirect influence of climate change;

Wildlife and Habitat Characteristics

- select area with detailed study of caribou movement and distribution to define current abundance, habitat use, and population dynamics;
- include sufficient functional habitat to support desired caribou population and all life history attributes. Feasibility evaluations assume that the fenced predator exclosure would including all or portion of an existing caribou local population range with animals present. Available information suggests that one and sometimes several distinct 'herds' are found within each of the four caribou local population ranges in northeast Alberta (ASRD and ACA 2010);
- include critical habitat that is traditionally used by individuals (e.g., cows display some fidelity to calving sites);
- lowest current densities of predators and other prey;
- functional connectivity to other ranges;
- incorporate areas with ongoing habitat restoration or restoration trials;
- incorporate conservation areas identified in the Lower Athabasca Regional Plan and Zone 1 areas identified by ALT (2009) as candidates areas where caribou conservation would be the priority designated land use;

Land Use Characteristics

- area for which support from aboriginal groups, other land users (e.g., trappers, outfitters) and stakeholders is greatest;
- lowest current land use intensity;
- fewest conflicts with existing land use dispositions and potential future forest harvest and bitumen development; and
- no conflict with existing or proposed land management direction (e.g., provincial parks). Obviously, existing tenure holders within a proposed caribou predator exclosure would need to be support the long-term operation and access restrictions associated with a fenced exclosure. For this reason, feasibility evaluations assume that areas with leases held by OSLI members should be considered priorities.

2.3.1 Aboriginal Interests

Addressing traditional aboriginal use and interests of a fenced caribou predator exclosure and adjacent buffer will be critical to success and this will require extensive consultation with aboriginal groups and individuals who use the proposed area for subsistence and cultural purposes.

2.3.2 Fenced Area Size

Feasibility evaluations assume the size of the fenced caribou safe zone would be 600 to 4,800 km^2 to sustain a viable population in existing primary caribou habitat that provides the necessary attributes for all life history functions, and is sufficiently large to maintain sufficient habitat with ongoing natural disturbance. Criteria or guidelines applied to determine the number of caribou to be maintained within an exclosure (see Section 2.2.2.1) would obviously be a key factor in calculating optimum fenced area size.

2.3.3 Candidate Areas

Feasibility evaluations discuss the relative advantages and disadvantages of the following candidate areas for a fenced predator exclosure in northeast Alberta (Figure 1):

- Egg-Pony and Wiau herd areas of the East Side Athabasca River (ESAR) local population range (Golder 2011; Matrix 2011);
- Audet herd area [or another herd area] of the Richardson local population range (Hab-Tech 2011; Terrain FX 2011);
- North end of the West Side Athabasca River (WSAR) local population range (Golder 2011; Hab-Tech 2011);
- Christina herd area of the East Side Athabasca River (ESAR) local population range (Hab-Tech 2011); and
- Cold Lake Air Weapons Range (CLAWR) local population range (Golder 2011).

Obviously, extensive discussion with government, industry, aboriginal groups, other land users, environmental organizations, recreational users, will be required to select final fence boundaries should this management option be pursued. Additional information on consultation and implementation issues is provided in Section 2.5.

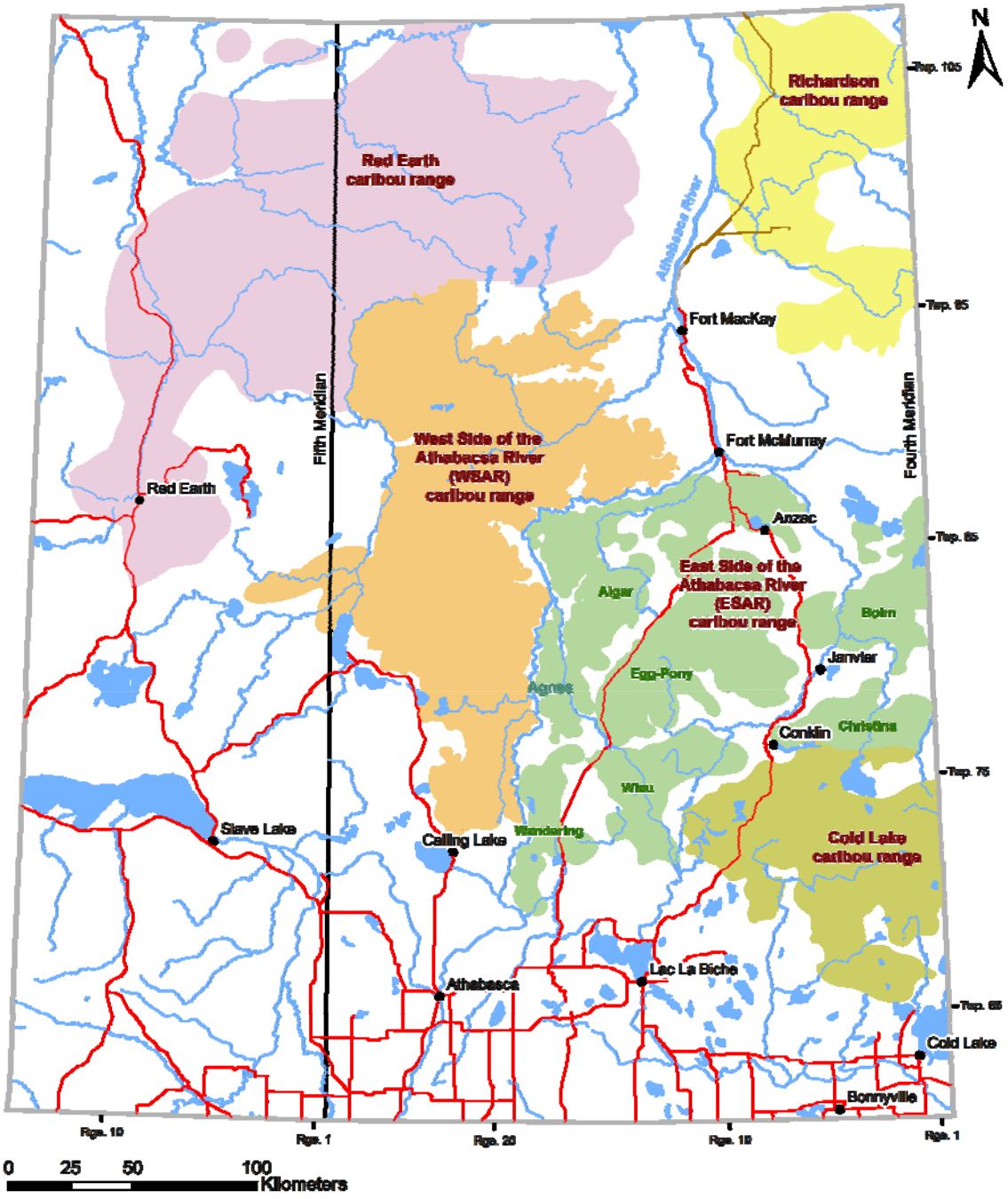


Figure 1. Boreal caribou local population ranges in northeast Alberta.

2.4 WHEN

What criteria or guidelines should be used to complete the fenced caribou safe zone initiative?

Given recommendations for immediate action, it is assumed that a fenced predator exclosure would be undertaken as soon as possible, pending results of aboriginal and stakeholder engagement and receipt of all required approvals.

2.4.1 Program Duration

Based on the draft objectives (Section 2.1) and feasibility evaluations, a fenced predator exclosure should be maintained until sufficient functional habitat is present and predator densities are low enough to establish a self-sustaining caribou population. The Athabasca Landscape Team (ALT 2009) estimated a 30-50 year lag time following reclamation of industrial footprints before forest becomes old enough to be considered functional.

1. **Self-sustaining population characteristics:** what population metrics or attributes should be used to confirm that the fenced caribou population can be self-sustaining so that the fence may be removed?
2. **Functional habitat characteristics**: what metrics or attributes should be used to confirm that sufficient functional habitat has been restored to establish a self-sustaining population?

2.5 WHO

What criteria or guidelines should be used to select the group or individual to establish and maintain a fenced caribou predator exclosure, and the groups or individuals that must be involved prior to implementation?

Alberta's Woodland Caribou Policy (GOA 2011) states that "caribou conservation is a shared government, public and private sector responsibility, led by government. A comprehensive, integrated partnership approach is needed to commit financial and other resources, in a manner which maximizes their effectiveness."

2.5.1 Roles and Responsibilities

Feasibility evaluations assume that industry would fund the caribou predator exclosure initiative, but would not implement it, because the private sector does not have the authority to manage species at risk or other wildlife, and would be in a perceived conflict-of-interest situation. Given this, the best alternative is assumed to be an independent arms-length organization conducting or coordinating the following activities:

- fence installation and maintenance;
- predator control (likely government only);
- other prey control (could include aboriginal groups and hunters);
- caribou capture and translocation;
- wildlife monitoring;
- habitat monitoring; and
- research.

a) Who should lead any future work to discuss, design, and if appropriate implement, a fenced predator exclosure as part of a broader boreal caribou population and habitat management program?

2.5.2 Implementation Considerations

Terrain FX (2011) identified several legal, regulatory, and policy complexities and gaps that would need to be addressed to successfully implement a fenced caribou predator exclosure. Other feasibility evaluations note that a decision to proceed with a fenced exclosure must involve all affected managers, groups, companies, individuals, and appropriate caribou experts.

1. **Land use considerations**: there should be no conflict with existing or proposed land management direction (e.g., provincial parks). Obviously, existing forestry, oil and gas, and other tenure holders within a proposed predator exclosure would need to be support the long-term operation and access restrictions associated with a fenced exclosure. Though beyond the scope of this initial phase, aboriginal and public support for the concept and specific location is also assumed to be a prerequisite.
2. **Regulatory review and approval**: would the existing regulatory regime need to be changed to allow a fenced predator exclosure to be constructed and operated on public lands? What approvals would be required for construction, operation, maintenance, wildlife management, and access management?

b) OSLI LSWG has retained Terrain FX to develop a 'regulatory road map' for the caribou predator exclosure concept. This evaluation will not be

available to workshop participants prior to the workshop, but the author(s) will be in attendance and available to provide their perspective.

3. **Aboriginal engagement:** feasibility evaluations identify the need for active engagement with potentially affected aboriginal groups and individuals because of potential effects on access and traditional land use opportunities and requirements to manage caribou, moose, deer, wolf, and possibly other wildlife distribution and abundance. A thorough engagement plan and resources to implement it will be required.
4. **Public consultation and engagement:** A thorough engagement plan and resources to implement it will be required. Feasibility evaluations conclude that there will likely be regional, national, an international interest in this proposal.
5. **Roles and responsibilities**: If an arm's length, independent body will implement - should this be established now to take next steps and maintain independence?
    a) Who would be the logical political champion(s) for a fenced caribou predator exclosure?
    b) How would a predator exclosure initiative be coordinated with other caribou management initiatives undertaken by government and industry (i.e., predator/prey population control; habitat restoration; and habitat protection)?

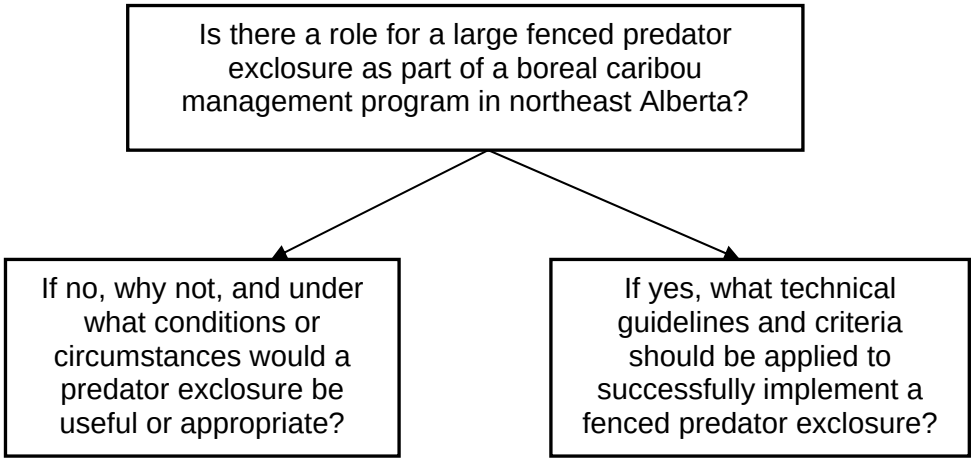
3. CONCLUSIONS

The Oil Sands Leadership Initiative Land Stewardship Working Group (OSLI LSWG) is investigating the technical feasibility of creating a fenced woodland caribou predator exclosure(s) in northeast Alberta. This option is being increasingly discussed, but has not yet been attempted for woodland caribou management. There is uncertainty about the technical, ecological, and political feasibility of this novel and aggressive approach to house and protect caribou.

The OSLI LSWG acknowledges that there will be, and should be, considerable public interest and debate about the merits of a creating a predator exclosure as a component of a woodland caribou management program. The LSWG wishes to contribute to the debate around this caribou management option by providing a focused, independent evaluation of the technical guidelines or criteria that would be required to implement a caribou predator exclosure, or if no appropriate for northeast Alberta, the conditions under which this approach would be appropriate and unacceptable.

The conclusions from four independent feasibility evaluations commissioned by the OSLI LSWG (Golder 2011, Hab-Tech 2011, Matrix 2011, Terrain FX 2011) have been integrated into this report and will be used as background material for a technical workshop of around fifty experts on May 16-17, 2012.

Background material provided in this report will be used at the workshop to answer the following questions:



This report summarizes the following issues identified in the four feasibility evaluations, along with a number of draft technical guidelines and criteria to address them:

- Fence Design and Maintenance
- Managing Caribou, Predators, and Other Prey
- Managing Forage
- Managing Fire and Natural Disturbance
- Restoring Functional Habitat
- Managing Human Use
- Wildlife Monitoring, Research and Adaptive Management
- Habitat and Biodiversity Monitoring, Research and Adaptive Management
- Human Use Monitoring and Management
- Siting
- Program Duration
- Implementation Roles and Responsibilities
- Consultation and Engagement

A systematic risk review included in one of the feasibility evaluations (Hab-Tech 2011) is thought to provide a useful framework for summarizing key technical challenges. Their Failure Modes and Effects Analysis (FMEA) is a systematic method of identifying and preventing process problems before they occur. It is mainly used in product development and operations management for analysis of potential failure modes within a system by classifying the severity and likelihood of the failures. In FMEA, failures are prioritized according to how serious their consequences are, how frequently they occur, and how easily they can be detected. After ranking severity (S), occurrence (O), and detectability (D) of risk factors, a Risk Priority Number (RPN) is calculated by multiplying the three numbers: RPS = S x O x D. Hab-Tech's adapted and simplified FMEA for a fenced caribou predator exclosure is provided in Table 1.

Table 2 provides a table of similar format with all issues identified by the feasibility evaluations. This summary table is intended to be a way to help readers and invitees consolidate technical information and evaluate overall benefits and risk of the fenced predator exclosure option. This table may be used as a discussion aid at the May workshop.

Hab-Tech (2011) Failure Modes and Effects Analysis (FMEA) evaluation for the fenced caribou predator exclosure concept.

Failure Modes & Effects Analysis (FMEA) Worksheet.
Analysis of *potential* economical, evolutionary, and ecological risks involved with implementing a fenced woodland caribou safe zone.

Failure Modes & Effects Analysis (FMEA) Worksheet.
Analysis of *potential* economical, evolutionary, and ecological risks involved with implementing a fenced woodland caribou safe zone.

Type of cost/ risk	Scale	Potential failure/risk type	Potential effect(s) of failure	Severity	Potential cause(s) of failure	Likelihood	Controls	Detectability	RPN	Recommended actions/ Mitigation
Financial	Short term	Fence failure	Barrier breached by carnivores, leading to predation on target species	5	Tree falls, decrepitude, tunnelling animals	3	Daily/weekly fence surveying	1	15	Repair fence. Erradicate carnivores.
Evolutionary	Long term	Prevention from evolving traits that protects from evolutionary processes	Losing effective anti-predator behavious	5	Absence of predators	5	Population monitoring	5	125	Re-introduce predators
	Long term	Isolation of metapopulations	Sustainability of the isolated populations may be lower than original population	9	Movement between sub populations is prevented	10	Population monitoring	5	450	Introduce individuals from outside populations
	Long term	Collapse in gene flow	Termination of the genetic processes critical to the maintenance of heterozygosity	9	Movement between sub populations is prevented	10	Population monitoring	5	450	Introduce individuals from outside populations
Ecological	Short term	Prey-traps occuring along fence	Increased mortality due to predation (e.g coyote).	5	Poor fence alignment	3	Avoid fence alignment along natural "trap" areas. Monitoring fence line.	3	45	Realign problem area.
	Short term	Exclusion of natural processes that regulate population in response to resource availability	Over use of resources	5	Removal of predators, prevention from moving out of area.	5	Population and plant community monitoring (monitoring lichen availability in the fenced area would provide an early warning)	5	125	Translocation of animals to other areas. Re-introduction of predators. Removalof fence/open gates.
	Short term	Small predators increase in number	Decline/extinction of small prey	9	Removal of top predator	5	Population monitoring on ecosystem scale	5	225	Control of small predators.
	Long term	Prevention of large scale movement (within bioclimatic envelopes)	Local extinction	9	Fence blocks movement in case of global warming	5	Populatuion and climate monitoring	5	225	Establish natural corridor within bioclimatic envelope
	Short term	Prevention of small scale movement (e.g. in reaction to fire)	Local population extinction due to forest fire	10	Fence prevents movement in reaction to forest fire	8	Considerations in placement, install remote gates, constant fire watch	7	560	Immediate action required, including: fire fighting, opening gates, removal of fence, etc.

Rating scales:					
Severity:	10 - Severe effect on population	Likelihood:	10 - Very likely	Detectability:	10 - Impossible to detect in time
	5 - Moderate effect on population		5 - Likely		5 - Difficult to detect in time
	1 - Limited effect on population		1 - Highly unlikely		1 - Easy to detect in time

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Table 2. Technical issues summary for the large fenced caribou safe zone concept.

Category	Scale	Potential failure/risk	Potential effect(s) of failure	Severity	Potential cause(s) of failure	Likelihood	Controls		RPN	Recommended actions/ Mitigation
Fencing		Fence Design							0	
		Fence Maintenance							0	
Wildlife Management		Caribou							0	
		Wolves and Bears							0	
		Other Predators							0	
		Other Prey							0	
Habitat Management		Forage							0	
		Fire and Natural Disturbance							0	
		Restoring Functional Habitat							0	
Access Management		Human Access and Use							0	
Research, Monitoring and Adaptive Management		Wildlife Monitoring							0	
		Habitat Monitoring							0	
		Human Use Monitoring							0	
		Ecosystem Monitoring							0	
		Research							0	
Location		Size							0	
		Access and Physical Attributes							0	
		Wildlife and Habitat							0	
		Land use							0	
		Aboriginal Values							0	
		Candidate Areas							0	
Duration		Program Duration							0	
Implementation		Roles and Responsibilities							0	
		Land use Conflicts							0	
		Regulatory Process							0	
		Aboriginal Engagement							0	
		Public Consultation and Engagement							0	

	Rating Scales:	Severity:	10 - Severe effect on population	Likelihood:	10 - Very likely
			5 - Moderate effect on pop'n		5 - Likely
			1 - Limited effect on pop'n		1 - Highly unlikely

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