



2020

IMMINENT THREAT ASSESSMENT FOR WOOD BISON

(Bison bison athabascaae)



Cat. No.: CW66-605/2020E-PDF
ISBN: 978-0-660-34916-9

Unless otherwise specified, you may not reproduce materials in this publication, in whole or in part, for the purposes of commercial redistribution without prior written permission from Environment and Climate Change Canada's copyright administrator. To obtain permission to reproduce Government of Canada materials for commercial purposes, apply for Crown Copyright Clearance by contacting:

Environment and Climate Change Canada
Public Inquiries Centre
12th Floor, Fontaine Building
200 Sacré-Coeur Boulevard
Gatineau QC K1A 0H3
Telephone: 819-938-3860
Toll Free: 1-800-668-6767 (in Canada only)
Email: ec.enviroinfo.ec@canada.ca

Photo: © Richard Wiacek, Environment and Climate Change Canada

© Her Majesty the Queen in Right of Canada, represented by the Minister of Environment and Climate Change, 2020

Aussi disponible en français

TABLE OF CONTENTS

Introduction.....	4
Imminent threat assessment criteria	5
Imminent threat assessment focus.....	6
Responses to Imminent Threat Assessment Questions.....	8
Question 1: Is the species facing threats?	11
Question 2: Are the threats likely to occur?	12
Question 3a: Will the effect of the threats make the survival of the species highly unlikely or impossible?	16
Question 3b: Will the effect of the threats make achieving the recovery objectives of the species highly unlikely or impossible?	18
Question 4: Do the threats require immediate intervention (to ensure species survival or recovery)?	28
Summary of Imminent Threat Assessment Conclusions.....	32
<i>Table 1. Overall Conclusion – Ronald Lake Bison Herd</i>	33
<i>Table 2. Overall Conclusion – Wabasca Herd</i>	34
References.....	35

INTRODUCTION

In response to concerns about threats to the Ronald Lake Bison Herd, Environment and Climate Change Canada (ECCC) initiated an analysis to determine whether Wood Bison (*Bison bison athabasca*), as a species¹, faces imminent threats to its survival or recovery. This analysis is referred to herein as the imminent threat assessment.

Under section 80(2) of the Species at Risk Act (SARA), the competent Minister must make a recommendation to the Governor in Council for an emergency order if he or she is of the opinion that the species faces imminent threats to its survival or recovery. An imminent threat is one that would render the survival or recovery of the species impossible or highly unlikely, and which cannot be eliminated without immediate intervention.²

The Minister responsible for the Parks Canada Agency is a competent Minister for Wood Bison under SARA where the species occurs on Parks Canada Agency lands. The Minister of Environment and Climate Change Canada is the competent Minister for the species outside of Parks Canada Agency lands and is leading the development of Wood Bison recovery.

The imminent threat assessment is based on the best information available up to

¹ Wood Bison are recognized as a subspecies of American Bison (*Bison bison*); however, to be consistent with terminology in the Species at Risk Act (SARA), the term "species" is used herein when referring to Wood Bison. Under SARA, the term "species" can also represent subspecies.

² For context, see previous threat assessments posted on the public registry: Western Chorus Frog (https://wildlife-species.canada.ca/species-risk-registry/document/default_e.cfm?documentID=2789) and Southern Mountain Caribou (http://registrelep-sararegistry.gc.ca/virtual_sara/files/ImminentThreatAnalysisSmc-v00-2018.Jun-Eng.pdf).

July 2019 on the biology of Wood Bison and associated threats, as summarized in a detailed Species and Threats Summary, as well as Cultural Importance Summaries prepared by ten Indigenous groups. These documents are foundational to the development of the imminent threat assessment, and provide the source and reference material used to develop the imminent threat assessment (see References). The Species and Threats Summary includes information provided by Indigenous communities, the Government of Alberta and the Parks Canada Agency, as well as publicly available documents, which includes the Report of the Joint Review Panel for the Teck Resources Limited, Frontier Oil Sands Mine Project (released in July 2019)³. Officials from Alberta and Parks Canada Agency reviewed drafts of the Species and Threats Summary, and their comments were considered when preparing the final document.

IMMINENT THREAT ASSESSMENT CRITERIA

To help inform the Minister's opinion as to whether imminent threats to survival or recovery of a species exist, the following four questions were considered (following a previous imminent threat assessment completed for Southern Mountain Caribou):

1. Is the species facing threats?
2. Are the threats likely to occur?
3. a) Will the effect of the threats make the survival of the species highly

³ On February 25, 2020, the Minister of Environment and Climate Change [terminated the environmental assessment process](#) for the Teck Frontier Oil Sands Mine Project at the request of the proponent.

unlikely or impossible, and/or

b) Will the effect of the threats make achieving the recovery objectives of the species highly unlikely or impossible?

4. Do the threats require immediate intervention?

If each of these four questions is answered in the affirmative (including either 3a or 3b), it is the view of the ECCC that imminent threats may exist. These questions are referred to below as the “imminent threat questions”.

IMMINENT THREAT ASSESSMENT FOCUS

ECCC undertook a broad and comprehensive evaluation of imminent threat for Wood Bison. Because of the nature of the threats to Wood Bison and the population and distribution objectives outlined in the recovery strategy, the imminent threat assessment considers the species as a whole, as well as individual herds, when responding to the imminent threat questions. The assessment of whether Wood Bison is facing threats (questions 1 and 2), and whether the threats will jeopardize survival of the species (question 3a), considers Wood Bison herds broadly and the species as a whole. In contrast, the assessment of whether the threats jeopardize recovery of the species, and require immediate intervention (questions 3b and 4), considers specific herds, in line with the recovery objectives for Wood Bison in Canada. A scoping analysis was conducted to identify which herds warranted detailed analysis when assessing threats to recovery (see below).

The recovery of a species is dependent on achieving the population and distribution objectives outlined in a recovery strategy. The short-term population

and distribution objectives for Wood Bison (which are relevant for the imminent threat assessment) are to maintain the disease-free status, population size, and range of *all* disease-free Wood Bison herds within the original range of Wood Bison in Canada. Thus, a change in the disease status, population size, or range of *any* disease-free herd can jeopardize achieving the recovery objectives for Wood Bison in Canada.

When assessing imminent threat to recovery, ECCC conducted an initial scoping analysis to identify which herds are facing threats that pose immediate conservation concerns, and thus warrant more detailed analysis. Based on this initial assessment, no immediate conservation concerns were identified for disease-free Wood Bison herds in the Yukon Territory, Northwest Territories or British Columbia, as well as for the Hay Zama herd in Alberta. Most are currently considered stable or increasing, and/or measures are in place to address threats, where necessary. As a result, these herds were not considered further in the assessment. However, two herds – the Ronald Lake and Wabasca herds in northeastern Alberta – were found to be subject to particular stresses or threats

Box 1

The Ronald Lake Wood Bison Herd

The Ronald Lake bison herd is naturally established and genetically distinct from bison in Wood Buffalo National Park. The herd is relatively small, numbering 174 individuals in 2018, and is protected from non-Indigenous harvest under the *Alberta Wildlife Regulations*. The herd is also disease-free, but occurs in close proximity to the diseased Delta herd in southern Wood Buffalo National Park. Indigenous knowledge holders indicate the herd has been present since “time immemorial” and thus existed prior to the introduction of Plains Bison and cattle diseases to Wood Buffalo National Park. Maintaining the herd's genetics is important for Wood Bison recovery, as it contributes to the long-term viability of the species and resilience to future environmental change. The herd is also the last remaining disease-free bison herd that can be harvested by the Athabasca Chipewyan and Mikisew Cree First Nations.

that could affect the recovery objectives for Wood Bison. Consequently, the assessment of imminent threat to Wood Bison recovery focuses on these two herds (see Box 1 and Box 2 for background information on these herds).

Box 2

The Wabasca Wood Bison Herd

The Wabasca bison herd is genetically differentiated from bison in Wood Buffalo National Park and thus important for bison conservation, but its origins are unknown. The herd is also important for local Indigenous groups. The Wabasca bison herd is also disease-free, but is located adjacent to Wood Buffalo National Park in relative close proximity to the park's diseased Garden River herd. The herd is small in size, numbering approximately 16 individuals in 2019. Harvest of the herd is not regulated.

RESPONSES TO IMMINENT THREAT ASSESSMENT QUESTIONS

Question 1: Is the species facing threats?

Yes, Wood Bison as a species currently faces a number of threats. The greatest threat to Wood Bison recovery is the presence of two introduced, cattle-derived diseases (bovine tuberculosis and brucellosis) in bison herds in and around Wood Buffalo National Park (see Box 3). The distribution of diseased herds is shown in Figure 1. Although bison populations in Wood Buffalo National Park persist in the presence of these diseases, the management actions taken by jurisdictions neighboring Wood Buffalo National Park to control disease spread to livestock, ranched bison and disease-free Wood Bison herds greatly limits Wood Bison recovery. For example, a bison control zone has been established in the Northwest Territories to protect the Mackenzie, Nahanni and Hay Zama herds (Figure 1), while surveillance activities have been undertaken in Alberta to protect the Hay Zama herd. Any wild bison detected in the bison control zone or surveillance areas are removed. The implementation of these control

measures reduces the area that can be effectively occupied by bison and restricts expansion of existing herds, in particular in Alberta. Other disease management actions that can limit recovery include herd removal, as occurred for the captive Hook Lake herd in the Northwest Territories, which was eradicated following discovery of bovine tuberculosis in the local population.

Box 3

Bovine tuberculosis and brucellosis in Wood Bison

In the 1920s, approximately 6,600 Plains Bison were introduced to Wood Buffalo National Park, likely carrying with them two cattle diseases (bovine tuberculosis and brucellosis) that have since infected Wood Bison within the park as well as the neighboring Wentzel Lake and Slave River Lowland herds (Figure 1). Plains Bison and Wood Bison also interbred, transferring Plains Bison genes to the Wood Bison population. The three diseased Wood Bison herds in and around Wood Buffalo National Park today contain approximately half (~4,200) of all Canadian Wood Bison. The remaining nine free-ranging herds of Wood Bison in Canada are thought to be disease-free, although two herds – Wabasca and Ronald Lake – are proximate to diseased bison in the park. The presence of these diseases on the landscape is a major driver of management actions taken for Wood Bison today, and is considered a threat to the recovery of the species. The risk of disease transfer to disease-free bison herds outside and in close proximity to Wood Buffalo National Park is considered high.

The role of disease in regulating bison populations in and around Wood Buffalo National Park remains unclear, as the interactive effects of disease, habitat and predation on bison at the individual and population level are complex and poorly understood. Infected bison can be negatively impacted by these diseases, which can cause increased mortality, reduced fecundity and increased susceptibility to predation. Overall bison mortality attributed to these diseases is low, with advanced tuberculosis causing an estimated 4–6% annual mortality of bison in Wood Buffalo National Park. However, studies have shown that bison that tested positive for both diseases had lower winter survival and reproductive rates than bison that tested positive for one or neither disease. Although the effects of disease can be detrimental to bison, diseased Wood Bison populations have persisted in Wood Buffalo National Park, and population growth rates of diseased herds are considered similar to non-diseased herds, suggesting that population level effects may be minimal. However, the overall effects of disease on long-term population trends in Wood Buffalo National Park remain unclear.

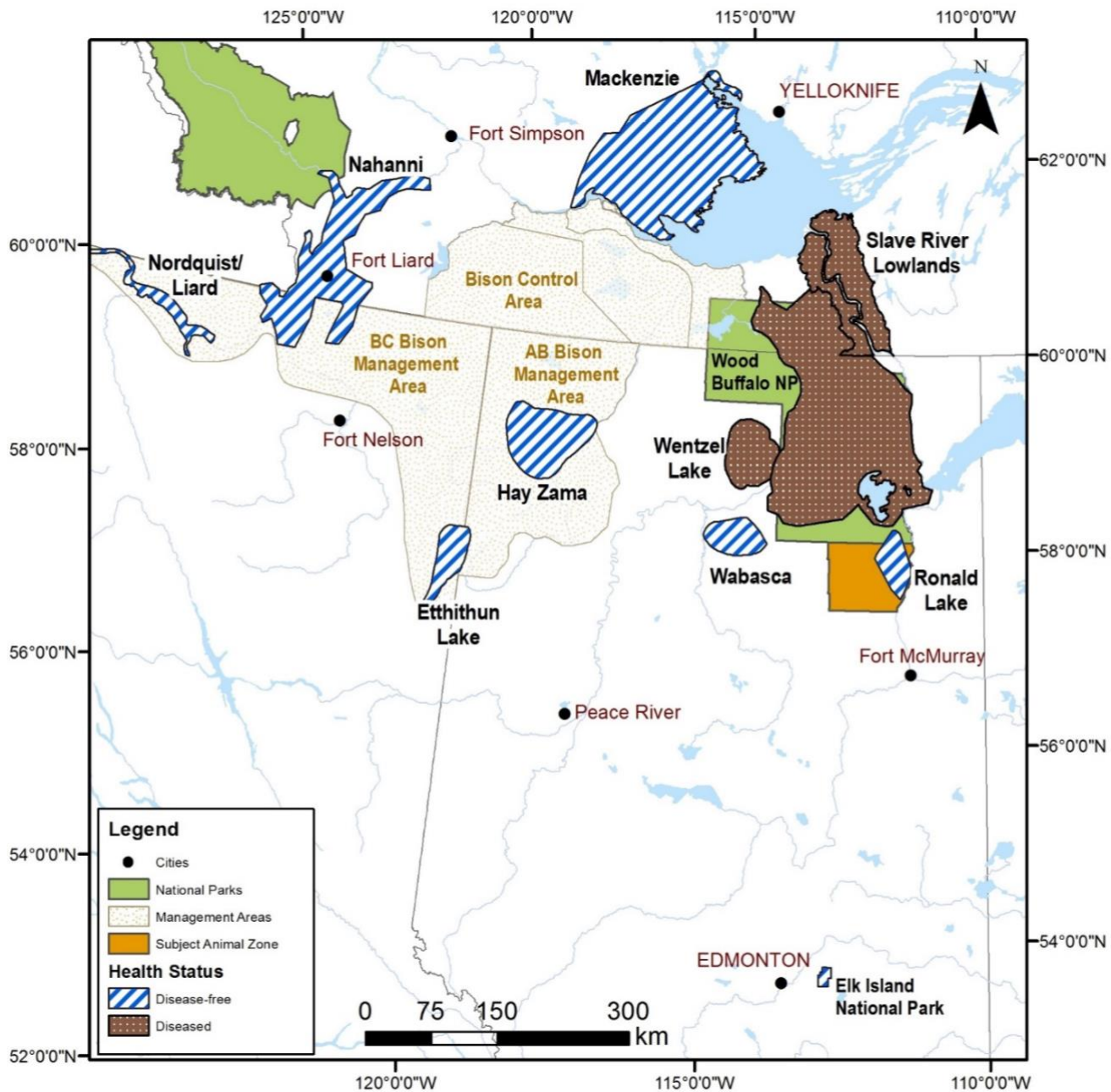


Figure 1. Distribution of diseased and disease-free Wood Bison herds in northwestern Canada, and location of management or control areas. Adapted from: ECCC 2018. Recovery Strategy for the Wood Bison (*Bison bison athabasca*) in Canada. *Species at Risk Act Recovery Strategy Series*.

In addition to the presence of disease and associated disease management

actions, Wood Bison face a number of other threats across their range. These include, but are not limited to industrial development (e.g., oil sands mining; see Box 4), forest harvest, hydro-electric development (and concomitant long-term drying of wetlands and incursion of weeds), unregulated or illegal harvest, anthrax outbreaks, collisions with vehicles, and hybridization with Plains Bison and loss of genetic diversity. Many of these threats affect herds in and around Wood Buffalo National Park, although other herds can be exposed to specific threats, depending on their location and surrounding land use.

While resource development activities (oil and gas exploration/extraction and forest harvesting) have been listed as individual threats, many Indigenous communities have raised concerns that the cumulative impact of these activities over time remains unknown. These activities can impact bison through habitat loss, disturbance of individuals, diminished water and air quality and increased predation and hunting pressure from easier access to these areas.

Question 2: Are the threats likely to occur?

Yes, threats to Wood Bison are likely to occur or are ongoing. While many Wood Bison herds are subject to some type and level of threat, the greatest threat occurs for herds that reside in close proximity to diseased herds in and around Wood Buffalo National Park, given the potential for exposure to bovine tuberculosis and brucellosis.

Box 4

Teck Resources Ltd. Frontier Oil Sands Mine Project (Teck Project)*

Teck Resources Limited has proposed an oil sands mine project in northeastern Alberta, approximately 110 km north of Fort McMurray. This project covers approximately 29,000 ha of boreal forest comprised of wetlands and upland forests, including old-growth forests. If approved, the Project would operate for approximately 41 years. The footprint of the proposed Project overlaps with the southern portion of the Ronald Lake bison herd range, and will affect up to 24% of the herd's total range (both directly and indirectly), based on an analysis of satellite telemetry data, which is supported by Indigenous traditional knowledge.

The Project underwent an environmental assessment by a Canada/Alberta Joint Review Panel (JRP) established under the *Canadian Environmental Assessment Act, 2012* and Alberta's *Responsible Energy Development Act*. On July 25, 2019, the JRP submitted its report to the Minister of Environment and Climate Change. The JRP concluded that the Frontier Project is likely to cause significant adverse environmental effects in a number of areas, including on the Ronald Lake bison herd because of habitat loss and disease transmission. When evaluating the evidence provided by multiple parties, including ECCC, Indigenous groups and Teck, the JRP noted that there is an existing risk of disease transmission to the Ronald Lake bison herd from diseased bison in the Delta herd in Wood Buffalo National Park. The JRP also acknowledged that there is uncertainty regarding the degree to which the Project would increase the risk of disease transmission. However, the JRP could not rule out that the Project would not increase the current risk of disease transmission and, following a precautionary approach, concluded that the Project was likely to have a significant adverse effect on Ronald Lake bison.

The Panel, in its role as the Alberta Energy Regulator, determined the Project is in the public interest and approved the provincial authorizations required for the Project to proceed. The Panel made 44 recommendations in its report directed at Canada and or Alberta, including that the federal government complete the imminent threat analysis for Wood Bison, so that the findings can further inform federal decisions related to the Frontier project.

Disease-free herds in close proximity to Wood Buffalo National Park (e.g., the Ronald Lake, Wabasca and Hay Zama herds in Alberta, and the Mackenzie

herd in the Northwest Territories; see Figure 1) are at risk of contacting diseased bison that disperse from infected herds in and around Wood Buffalo National Park. Management actions that target identification and removal of bison from control or surveillance zones outside Wood Buffalo National Park are ongoing for the Mackenzie and Hay Zama herds, given the continuous nature of the disease threat. The Ronald Lake and Wabasca herds have only recently been classified as disease-free, and management actions have not been implemented for these herds to mitigate risk of disease transmission.

In addition to risk of disease transmission, Wood Bison are subject to ongoing threats from anthropogenic activities and disturbances. These threats vary across bison ranges. Forestry and oil and gas activity is known to occur in or near a number of ranges. Hydroelectric development continues to affect bison habitat in and around the Peace-Athabasca Delta in Wood Buffalo National Park. Oil sands development is also encroaching on the Ronald Lake bison herd, which has been subjected to high levels of disturbance in recent years (see Figure 2), including oil and gas exploration, forestry and (until March 2016) unregulated harvest. This herd will be subjected to additional disturbance if the Teck Frontier Project is approved and built or if industrial activities occur elsewhere in its range (e.g., in the Canadian Natural Upgrading Ltd. [CNUL] lease immediately north of the Teck Frontier Project footprint; Figure 2). A large portion of the herd's range overlaps an area zoned for multiple land uses including oil sands exploration and development, forestry, recreation, gravel extraction, hunting and trapping. As a result, additional anthropogenic disturbances are likely to occur in the herd's range.

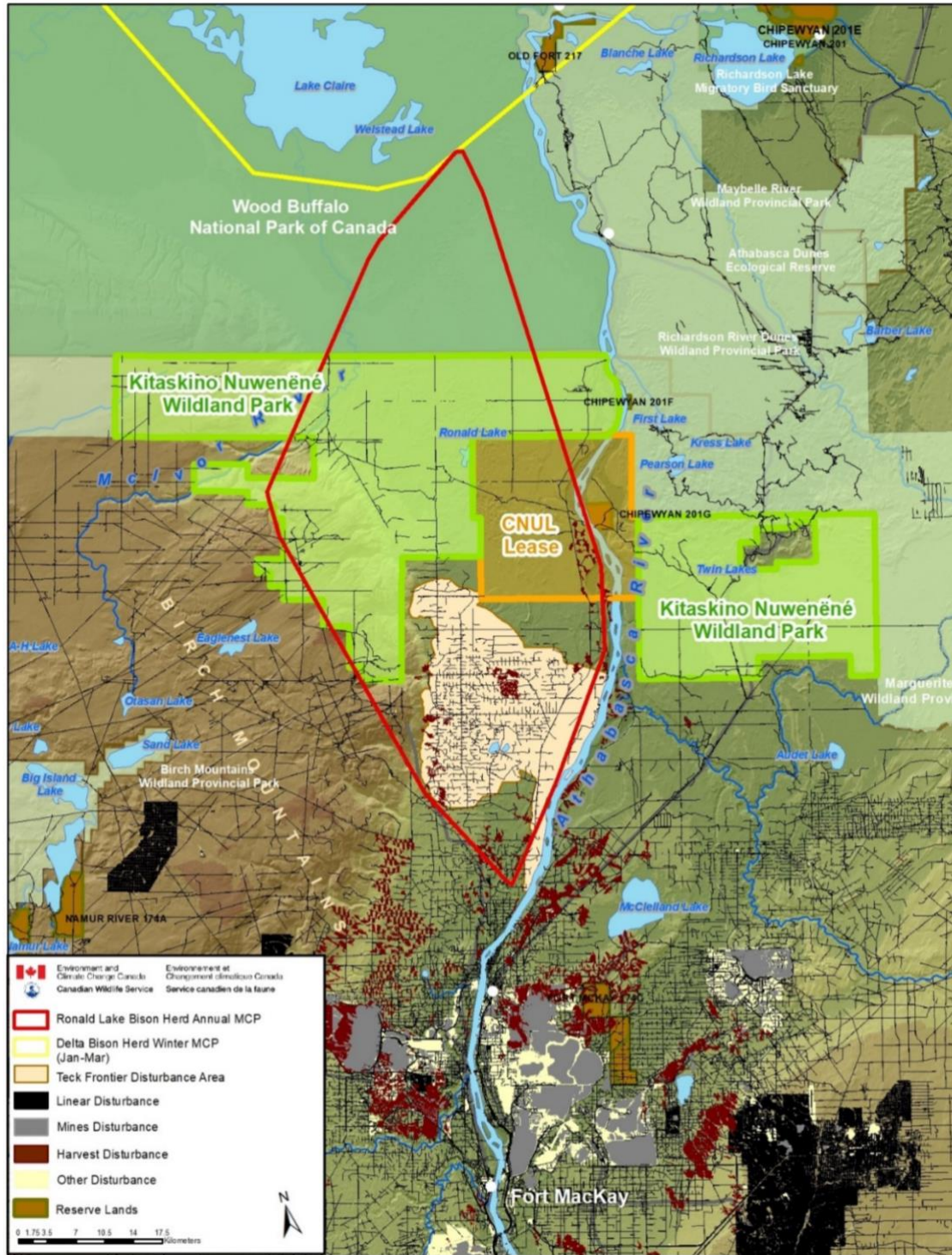


Figure 2. Ranges of the Ronald Lake and Delta Wood Bison herds (based on minimum convex polygons, or MCPs), surrounding regional disturbances, and location of the proposed Teck Frontier Oil Sands Mine and adjacent Canadian Natural Upgrading Ltd. (CNUL) lease. MCPs were generated from bison data

provided by the Parks Canada Agency and the Government of Alberta. Footprint data are from the Alberta Biodiversity Monitoring Institute (www.abmi.ca).

In addition to resource development, hunting can affect a number of herds. Although hunting is regulated for most harvested herds, hunting of the Wabasca bison herd is not regulated, largely because the herd has long been considered diseased. As a result, animals from this herd are not considered wildlife under the Alberta *Wildlife Act*, and are thus not afforded any protection. Bison from the Wabasca bison herd can be harvested at any time and in any number. Recent surveys detected a minimum of 16 animals in the herd; therefore, unregulated harvest could lead to extirpation of the herd, which is now considered disease-free. Because of its small size, the herd is also at risk of extirpation due to stochastic events, such as anthrax outbreaks, drowning, and harsh winters, or other factors such as predation, the extent of which is unknown. These threats could occur at any time, but are difficult to predict.

Question 3a: Will the effect of the threats make the survival of the species highly unlikely or impossible?

No, the effects of the threats will not make survival of Wood Bison, as a species, highly unlikely or impossible, particularly in the near-term, given the overall population size of the species, occurrence of distinct subgroups, and management actions that are being taken or contemplated to mitigate threats to some herds.

A species is considered more likely to survive if it is stable, resilient, widespread, and displays connectivity between subgroups or populations, and is also

protected from anthropogenic effects, as described below (see Box 5). The more attributes a species possesses, the higher its likelihood of continued survival.

Box 5

Attributes that contribute to the survival of a species

Stability: stable or increasing population over a biologically relevant timeframe.

Resiliency: sufficiently large population to recover from periodic disturbances and avoid demographic and genetic collapse.

Widespread distribution (with population redundancy): there are multiple (sub) populations or locations available to withstand catastrophic events and facilitate rescue if necessary.

Connectivity: the distribution of the species in Canada is not severely fragmented.

Protection from anthropogenic threats: non-natural significant threats are mitigated.

There are approximately 8,500 Wood Bison across 12 free-ranging populations widely distributed across western Canada. Overall, the population as a whole appears to be stable, although large population fluctuations can occur because of stochastic events (such as flooding, anthrax outbreaks, etc.). Even in the presence of such events, and the fragmented distribution of herds, Wood Bison are likely to survive as a species in the near-term, given the overall number of individuals and herds. However, the long-term survival of Wood Bison may be hindered by low genetic diversity in re-introduced herds.

The maintenance of genetic diversity within a species is considered critical for species viability and adaptation to changing environmental conditions. Although

low genetic diversity in re-introduced herds remains a concern, bison herds in and around Wood Buffalo National Park, although diseased, harbor important genetic diversity that is critical for the long-term survival of the species. These herds have remained viable in the presence of disease, and thus will continue to contribute to the genetic diversity in Wood Bison and the continued survival of the species. Preliminary actions are also being discussed to identify, in collaboration with Indigenous groups, long-term disease management options in the greater Wood Buffalo National Park area.

Question 3b: Will the effect of the threats make achieving the recovery objectives of the species highly unlikely or impossible?

Yes, the effects of several threats will make achieving the recovery objectives for Wood Bison highly unlikely or impossible. As indicated above, the recovery goals are based on the population and distribution objectives, which are to maintain the disease-free status, population size and range of all disease-free herds in Canada. These objectives can be considered a proxy for assessing recovery for the purposes of an imminent threat assessment.

The analysis conducted by ECCC indicated that two herds, the Ronald Lake bison herd and Wabasca bison herd, are subject to imminent threats that could affect their disease-free status, population size, or range, and for which mitigation measures or management actions have not yet been implemented. Specifically, ECCC finds that there are imminent threats to the disease-free status and range of the Ronald Lake bison herd, and population size of the Wabasca bison herd. Threats to these two herds thus could prevent attainment of the recovery objectives for Wood Bison in Canada. These threats are discussed in more detail below.

Threats to the Ronald Lake Bison Herd

i. Disease Transmission

The presence of bovine brucellosis and tuberculosis in Wood Buffalo National Park bison herds is the greatest threat to the Ronald Lake bison herd. Although the Ronald Lake bison herd is considered disease-free based on recent testing, the close proximity of the herd's range to the diseased Delta bison herd range in Wood Buffalo National Park (Figure 2) suggests there is a high risk of herd contact and disease transmission. Recent telemetry locations of Ronald Lake bison have occurred within 12 km of historical and recent observations of bison in the Delta range during winter. The Ronald Lake bison herd is considerably closer to diseased bison herds in Wood Buffalo National Park than other disease-free herds (e.g., the Hay Zama herd in Alberta and the Mackenzie bison herd in the Northwest Territories) which are considered to be at risk of disease transmission. However, unlike these other herds, management actions have not been taken to reduce disease risk to the Ronald Lake bison herd.

The Ronald Lake bison herd has remained isolated from bison in the Delta herd for considerable time, given its distinct genetic characteristics and disease-free status. However, given the close proximity of the Ronald Lake and Delta bison herd ranges, it is unclear why the herds have not interacted. Bison can readily move long distances, and are known to travel between bison ranges in Wood Buffalo National Park. This suggests a high probability of interaction between the herds.

A number of hypotheses have been proposed to explain the separation of herds and absence of disease in Ronald Lake bison, for which there are varying degrees of support. It is possible that a natural barrier, or limited habitat

availability, blocks or prevents movements between the Ronald Lake and Delta bison herd ranges. However, there is currently limited evidence to support this hypothesis. Conversely, it is possible that, historically, the herd ranges were further apart (thereby minimizing opportunities for herd interaction) but have recently shifted, resulting in a relatively new risk of contact. There is evidence that the Ronald Lake bison herd's range has changed, potentially bringing the Ronald Lake bison herd in closer proximity to the diseased Delta bison herd. Indigenous knowledge indicates that, in recent decades, the southern boundary of the Ronald Lake bison herd's range has been pushed northward by encroaching oil sands development and other disturbances. Recent intensive disturbance in the herd's current range from exploration activities associated with the Teck Frontier Project (see Figure 2), forestry activities, and hunting, has likely also displaced some bison and altered bison movements. Collectively, these pressures may have shifted the herd's range northward and increased the occurrence or distribution of Ronald Lake bison in Wood Buffalo National Park, resulting in an increased (and relatively new) risk of disease transmission. Available information indicates that, historically, Ronald Lake bison may have been absent from southern Wood Buffalo National Park during winter, or occurred infrequently. In contrast, recent telemetry data indicates that a substantial portion of collared Ronald Lake bison have occurred in southern Wood Buffalo National Park during winter. This suggests that the occurrence of Ronald Lake bison in southern Wood Buffalo National Park may have changed over time.

In addition to the distribution of the Ronald Lake bison herd, the distribution and movements of the Delta bison herd may also be important in determining the risk of herd contact and disease transmission. Surveys by the Parks Canada Agency indicate that the number of Delta bison in southern Wood Buffalo National Park varies yearly, and can fluctuate greatly between years. In some

years Delta animals may be absent from this area, but can quickly increase in abundance the following year. The factors affecting the distribution and movements of Delta bison are not known. Delta bison were relatively abundant in southern Wood Buffalo National Park in winter 2009, but have been largely absent from this area since. However, Delta bison have been present in southern Wood Buffalo National Park during 12 (or 75%) of 16 surveys conducted between 1991 and 2019, indicating they regularly occur within this area. As a result, although the risk of disease transmission may vary yearly (and be low in some years), depending on the location of the Delta herd, the risk is likely present in most years, and can increase quickly between years. Thus, the risk in any future year can be high.

Although there is uncertainty as to why the Ronald Lake bison herd has remained isolated from the Delta herd, the current close proximity of the herd ranges, lack of a barrier between the ranges, external pressures on the Ronald Lake bison herd range, and known movements of the Delta herd, collectively indicate there is an imminent (i.e., near-term) risk of herd contact and disease transmission. As outlined in a 2013 Government of Alberta report on managing disease risk in northern Alberta Wood Bison outside of Wood Buffalo National Park, the “proximity of the parent Wood Buffalo National Park disease reservoir puts all outlier herds at high risk of infection”. As a result, measures have been taken to prevent disease spread to the Hay Zama bison herd. Similar measures have not been implemented for the Ronald Lake bison herd, which has only recently been classified as disease-free. Transfer of disease, in particular bovine tuberculosis, to Ronald Lake bison would likely readily occur if they came in contact with diseased animals. Tuberculosis is spread through contact with respiratory secretions from an infected animal, and thus can be readily transmitted between individuals.

ii. Industrial Development: Teck Frontier Project

The largest potential for disturbance within the Ronald Lake bison range is the proposed Teck Resources Limited, Frontier Project. The footprint of the proposed Teck Project overlaps with the southern range of the Ronald Lake Bison herd (Figure 2).

Although there is an existing risk of disease transmission to the Ronald Lake bison herd, given its close proximity to the range of the diseased Delta herd, the Teck Frontier Project, if approved and built, may exacerbate this risk (see Box 4). Development of the Teck Frontier Project will result in the loss of up to 24% of the Ronald Lake bison herd's total range (based on the analysis of telemetry data), as well as up to 18% of the herd's preferred foraging habitat, based on modeling completed by ECCC. The location of movement corridors and availability of foraging habitat indicate that at least some bison will be displaced northward from the mine, potentially increasing the number of Ronald Lake bison in Wood Buffalo National Park, and subsequent risk of contact with diseased Delta bison. Similarly, Indigenous knowledge holders report that Ronald Lake bison are vulnerable to disturbance and would not be able to tolerate further impacts within the herd's range. As development increases, they expect that the Ronald Lake bison herd will move north into Wood Buffalo National Park and/or be forced onto habitat that is marginal.

Although it is uncertain whether the Teck Frontier Project will exacerbate the existing risk of disease transmission, there is considerable evidence that the Ronald Lake bison herd is sensitive to disturbance and will likely move away from the mine if built. In addition, the Teck Frontier Project will result in significant habitat disturbance. Given this disturbance, the Joint Review Panel for the Teck Frontier Project could not rule out that the Project would not displace bison

north towards the park and increase the risk of disease transmission. As a result, following a precautionary approach, the Panel concluded that the Project was likely to cause a significant adverse effect on the herd. ECCC concurs with this conclusion.

Range loss caused by the Teck Frontier Project will result in an additional threat to the recovery of Wood Bison in Canada. The population and distribution objectives for Wood Bison are to maintain the range of all disease-free populations of Wood Bison in Canada. Removal of up to 24% of the herd's range represents a substantial loss of range. Although Teck will progressively reclaim habitat, it is uncertain if reclaimed habitat will provide adequate forage for bison and thus support the herd. The high salinity levels in reclaimed oil sands wetlands can reduce the growth of sedge species (a preferred bison forage), requiring the input of nutrients to facilitate growth. It is unknown if natural growth rates can be re-established in saline wetlands over the long-term. In addition, bison may not return to the mine footprint if they have not used the area for considerable time. As a result, it is uncertain if reclamation will mitigate range loss, and it is expected that bison will avoid the mine for the duration of mine operations and possibly longer if habitat is limiting.

iii. Other Resource Development Activities

The majority of the anthropogenic footprint within the Ronald Lake bison herd's range is associated with exploratory activities for the Teck Frontier and former Shell Pierre River Mine projects, as well as forestry cut blocks at the southern and eastern edges of the range. Although no other activities are known to be approved, it is possible that exploration activities could occur on the CNUL lease north of the Teck Frontier Project (Figure 2) to fulfill leaseholder obligations. Disturbance within this area will have an additive and detrimental effect on

Ronald Lake bison, given the central location of the CNUL lease within the herd's range, and overlap with important habitat for the herd. The CNUL lease overlaps with 16% of the Ronald Lake bison herd's total range, and data gathered between 2013 and 2017 indicate that it is an area of high use by Ronald Lake bison. In addition, the CNUL lease contains a relatively high proportion of winter foraging habitat for the herd, which is key for survival of the herd. Fully developing both the Teck Frontier and the CNUL leases would functionally remove approximately 46% of the total range of the Ronald Lake bison herd, likely resulting in severe consequences to the survival of the herd.

New roads associated with oil exploration, forestry and resource development activities increase access to the herd, which can lead to increased levels of disturbance (e.g., noise, light), pollution, and increased hunting pressure from Indigenous peoples or the likelihood of poaching by non-Indigenous individuals. Linear disturbances can also facilitate wolf travel, and may increase wolf predation on bison. Wolf predation on Ronald Lake bison is thought to be rare; however, it may have increased in recent years according to Indigenous knowledge, possibly in response to increased clearing, road access, and drill pads. In addition, because Ronald Lake bison use diverse and widespread habitats ranging from open meadows to mature forests to open ridges, they may be threatened by cumulative anthropogenic disturbances.

Upcoming forestry activities are restricted to the southern end of the herd's range, generally overlapping with the Teck Frontier footprint. According to Alberta Pacific's 2015 Forest Management Plan, the area is expected to be largely developed for oil sands operation in the next decade or two, and the timber harvested in the area will be mainly salvaged from those operations. Whether forestry activity will continue, or when it will continue, in the absence of oil sands development is not known.

Threats to the Wabasca Bison Herd

i. Unregulated Harvest

The largest single threat faced by the Wabasca bison herd is unregulated hunting. The herd is not protected under the *Alberta Wildlife Act*, so hunting is unregulated and anyone can hunt the herd without a license at any time. Although the overall hunting pressure on the local population is unknown, Indigenous peoples have expressed concern over non-Indigenous hunting, which they consider a threat to the herd, given the herd's small population size. Indigenous peoples do not routinely hunt these bison. The recent (2016) cessation of unrestricted non-Indigenous hunting on the Ronald Lake bison herd may have increased hunting pressure on the Wabasca herd. However, access to the herd is limited, and with so few animals remaining, this may not represent a financially viable option for outfitters.

The small population size of the Wabasca bison herd indicates that the loss of even a few individuals from additional harvest (or other causes) could threaten the persistence of the herd. The disappearance of this herd would make achieving the recovery objectives of Wood Bison highly unlikely or impossible.

ii. Disease Transmission

The Wabasca bison herd occurs proximate to the diseased Garden River bison herd in Wood Buffalo National Park (Figure 1) and, according to a 2013 Government of Alberta report, may be at a high risk of contracting disease. Local Indigenous groups have indicated that bison move between the Wabasca and diseased Garden River bison herd in southwestern Wood Buffalo National Park; however, the absence of disease in the Wabasca bison herd

suggests that contact between the herds has not occurred. Recent sightings of individuals in the Wabasca and Garden River bison herds have been separated by approximately 30-50 km (depending on survey year), which may be sufficient to maintain herd separation. To date, the Wabasca bison herd range has experienced relatively little habitat disturbance, thus animals have likely not been displaced. This is likely to continue in the near-term, based on known resource development plans (see below). As a result, the risk of disease transmission in the near-term may not be high. However, this risk may change if future disturbance in the range pushes Wabasca bison closer to the Garden River bison herd range. Overall, there are uncertainties in the movements of both the Wabasca and Garden River bison herds (in particular males that can move long distances), and in the proximity of these herds. More information is required on the movements of both herds to understand the risk of disease transmission, and potential changes to risk that may occur as a result of resource development.

Other than disease itself, disease management actions may present a threat to the Wabasca bison herd. The Wabasca bison herd was estimated to consist of 30 to 40 Wood Bison in 2010, but between 2011 and 2014, animals were culled to test for disease, for a total of 24 animals. The impact of this cull on the herd is unknown, but may have contributed to the herd's decline.

The relative close proximity of Wabasca bison to livestock and ranched bison west of Wood Buffalo National Park also raises issues should the herd become diseased. If diseased, there would likely be strong pressure from ranchers to cull the herd to reduce disease transmission risk. In addition, since local Indigenous peoples may avoid consuming diseased bison, the spread of diseases to the Wabasca herd could also prevent local Indigenous peoples from practicing their asserted or established Aboriginal or Treaty Rights.

iii. Resource Development

The threat posed by anthropogenic disturbance related to natural resource development is low for the Wabasca bison herd compared to other herds. The range remains relatively undisturbed, as only ~1% has been directly impacted by anthropogenic disturbance. However, between 2010 and 2015, the length of linear features (i.e., roads, seismic lines) within the range almost doubled, from 182 km to 359 km, likely increasing the level of disturbance, pollution, and potentially predation.

Increased access and disturbance associated with forestry may represent a longer-term rather than near-term threat to Wabasca bison. A recent (December 2017) update to the Forest Management Plan for Forest Management Agreement 0200040, which estimates annual allowable cut from 2016 onwards for periods of 10 to 50 years, indicates that little forest harvest will occur in the Wabasca Operating Unit in the near-term (until approximately 2026, or year 10 of the operating period). This area overlaps the western portion of the Wabasca bison herd range. However, harvest is projected to occur in this area in the longer-term (year 10 to 50 of the operating period). This indicates that forestry may have little impact on the Wabasca herd in the near-term (up to year 2026), but may be a concern over the longer term (after 2026). Although cut blocks may allow bison to access fresh grown grass in spring, Indigenous knowledge holders indicate that Wabasca bison avoid areas with greater human disturbance, which is consistent with behaviours observed in the Ronald Lake bison herd.

Oil and gas exploration is not anticipated in the near future. However, hydroelectric development has potentially impacted the Wabasca bison herd

range. Indigenous knowledge indicates that since the early 1970s, the area has been dewatered and degraded as a result of the presence of hydroelectric dams. The effects of these changes on bison are unknown.

Question 4: Do the threats require immediate intervention (to ensure species survival or recovery)?

Yes, the threats identified for the Ronald Lake and Wabasca bison herds require immediate intervention to ensure they do not jeopardize achieving the recovery objectives for Wood Bison in Canada. In regards to the Ronald Lake bison herd, measures are not in place to address the existing risk of disease transmission to the herd or exacerbated risk caused by the Teck Frontier Project, if approved and built. Also, measures are not in place to address range loss for the herd if the Teck Frontier Project is built. In regards to the Wabasca bison herd, measures are not in place to address unregulated harvest. Collectively, disease transmission to the Ronald Lake bison herd, range loss for the Ronald lake bison herd, and reduction (or extirpation) of the Wabasca bison herd, will jeopardize achieving the recovery (population and distribution) objectives for Wood Bison in Canada, unless measures are implemented to address these threats. Additional information on why immediate intervention is required for each herd is provided below.

Ronald Lake Bison Herd

i. Disease Transmission

Available evidence indicates that there is an existing risk of disease transmission to the Ronald Lake bison herd. Although there is uncertainty as to why the Ronald Lake bison herd has remained isolated from diseased Delta bison, the

current close proximity of the two herd ranges and absence of a natural barrier separating the herds indicates there is an imminent (near-term) risk of herd contact and disease transmission. This risk may be variable between years, depending on the location of the Delta bison herd, but has been present in most years based on systematic surveys of the Delta herd. In addition, the risk may have increased in recent years because of disturbance in the southern portion of the Ronald Lake bison herd's range, which may have pushed some bison northwards. Because of the risk of disease transmission from diseased bison herds in and around Wood Buffalo National Park to neighboring herds, the governments of Alberta and the Northwest Territories have implemented disease control or management programs for the Hay Zama and Mackenzie bison herds, respectively. However, no such program exists for the Ronald Lake bison herd, in part because it has only recently been classified as disease-free. Given its much closer proximity to diseased bison than the Hay Zama or Mackenzie bison herds, disease management measures are imperative, and immediate intervention is required to ensure the Ronald Lake bison herd remains disease free.

The extent and efficacy of measures underway or planned for implementation in the immediate future by ECCC, the Government of Alberta and the Parks Canada Agency are insufficient to address the threat of disease transmission to the Ronald Lake bison herd. While these parties are engaged in the planning of actions to address broad disease issues in and around Wood Buffalo National Park, no immediate and direct actions are pending for the Ronald Lake bison herd. A suite of actions is likely required, both in WBNP and in Alberta, to mitigate the risk of disease transmission to the herd. These measures are required to address the existing risk of disease transmission, as well as an increased risk that may occur if the Teck Frontier Project is built.

ii. Industrial Development: Teck Frontier Project

Approval and subsequent construction of the Teck Frontier Project may exacerbate the existing risk of disease transmission to the Ronald Lake bison herd, and will result in substantial range loss. The effects of both threats will jeopardize achieving the population and distribution objectives for Wood Bison, and thus recovery of the species. As a result, immediate intervention would be required should the Teck Frontier Project be approved and built. Measures implemented to mitigate the existing risk of disease transmission for the Ronald Lake bison herd would be effective at addressing the increased risk of disease transmission caused by the Teck Frontier Project. However, because of uncertainties in the effectiveness of reclamation, additional measures would need to be implemented to address range loss.

iii. Other resource development projects

Other than the Teck Frontier Mine Project, there is currently no approved oil and gas exploration or production within the range of the Ronald Lake bison herd that is known to ECCC, and there are also no known future oil and gas activities that have been approved. However, there is potential for exploration activities to occur in the CNUL lease immediately north of the Teck Frontier Project during winter 2019/2020. It is currently unknown if this will occur. Forestry activity is planned to begin in 2021 in the most southern portion of the Ronald Lake bison herd; however, this may be dependent on the approval of the Teck Frontier Project, since the planned harvest is reliant on the reclamation of timber removed during construction of the mine. No immediate action is required to address the potential threats associated with these activities at present. However, initiation of exploration activities in the CNUL lease during winter 2019/2020 would be highly detrimental to the Ronald Lake bison herd, given the importance of this area for bison. Immediate intervention would be required if

such activities were to occur.

Wabasca Bison Herd

i. Unregulated Harvest

The Wabasca bison herd is currently not protected from harvest. Given its small size, any additional mortality of individuals could have a catastrophic effect on the persistence of the herd, leading to herd extirpation. Immediate action is required to address the threat of unregulated harvest.

ii. Disease Transmission

The Wabasca bison herd's proximity to diseased herds suggests that there may be potential for future disease transmission. Indigenous knowledge holders have indicated that there is regular exchange of bison between the Wabasca bison herd and the diseased Garden River bison herd in southwest Wood Buffalo National Park; however, this is not supported by available data showing absence of disease in the Wabasca bison herd. The 30 to 50 km distance between individuals in the Wabasca and Garden River bison herds, coupled with little planned disturbance within the Wabasca bison herd's range, suggest that the risk of herd contact may be low in the near-term. However, there is little information on the movement of the herds, and predictions of disease transmission are uncertain. It is likely that the risk of disease transmission will increase in the longer-term based on plans for forest harvest in the Wabasca range after 2026. Transmission of disease to the herd could lead to lethal removal of the herd, given the risk it may pose to livestock.

Given that risk of disease transmission may be low in the near-term, immediate action is not considered necessary to mitigate disease risk. However, because of

uncertainties in herd movements, studies should be considered to more accurately determine herd distribution and movement patterns to provide greater certainty of disease risk.

iii. Resource Development

Human disturbances related to hydroelectric generation and oil and gas exploration do not present imminent threats to the Wabasca bison herd since no associated activities are anticipated within the herd range in the near term. Forestry activities are not scheduled in the Wabasca Operating Unit until after 2026, based on best available information, and thus do not represent an imminent threat; however longer-term harvest plans suggest forestry represents a future threat. Forestry activities in the herd's range could increase stress on animals, leading to altered range and distribution of the herd due to avoidance, and potentially increased predation and hunting pressure due to easier access. Although immediate action is not required, future action may be necessary to protect the herd from disturbance and displacement.

SUMMARY OF IMMINENT THREAT ASSESSMENT CONCLUSIONS

Based on best available information, ECCC concludes that there is no imminent threat to the survival of Wood Bison in Canada. Sufficient numbers of individuals and local populations exist across the species' range to maintain the species in the event individual herds (such as the Ronald Lake or Wabasca bison herds) are lost or otherwise lose their viability. However, over the long-term, loss of herds could affect the genetic variability within the species, thereby affecting the resiliency of Wood Bison to adapt to environmental change.

In contrast to imminent threat to survival, the Department concludes that there

is an imminent threat to the recovery of Wood Bison in Canada. Imminent threat to recovery is based on whether the effect of threats make achieving the recovery objectives of the species highly unlikely or impossible, such that immediate intervention is required. The recovery objectives are to maintain the disease-free status, population size, and range of all disease-free Wood Bison herds within the original range of Wood Bison in Canada. There are several existing and proposed threats to the Ronald Lake and Wabasca herds that make achieving the recovery objectives of Wood Bison highly unlikely or impossible.

For the Ronald lake bison herd, there is an existing risk of disease transmission because of its proximity to diseased bison in Wood Buffalo National Park. Immediate actions are required to prevent disease transmission, as done for other herds near WBNP. Construction of the Teck Frontier oil sands mine, if approved, will exacerbate this risk and thus also require intervention. The Teck Frontier Project will also remove up to 24% of the Ronald Lake bison herd's range, resulting in substantial range loss. These threats on their own or combined, make achieving the recovery objectives of Wood Bison impossible or highly unlikely. The overall imminent threat assessment conclusions for the Ronald Lake bison herd are summarized in Table 1.

Table 1. Overall Conclusion – Ronald Lake Bison Herd

Imminent Threat Assessment Question	Potential Imminent Threats Assessed		
	Disease and disease management	Teck Frontier Project (if the Project is approved and built)	Other resource development projects

Is the species facing a threat?	Yes	Yes	Yes
Is the threat likely to occur?	Yes	Yes	Yes
Will the threat make achieving the recovery objectives unlikely or impossible?	Yes	Yes	Unknown: dependent on exploration activities in CNUL lease
Does the threat require immediate intervention?	Yes	Yes	Unknown: dependent on exploration activities in CNUL lease
Is there an Imminent Threat?	Yes	Yes	Unknown: dependent on exploration activities in CNUL lease

For the Wabasca bison herd, unregulated harvest threatens the herd's persistence, given the small size of the herd, and requires immediate intervention to ensure the herd is not extirpated. Disease and resource development are not considered imminent threats, but could affect the herd in the longer-term. There is some uncertainty regarding the movements of the Wabasca herd and nearby diseased Delta herd, and studies are recommended to address this uncertainty to determine disease risk. The overall imminent threat assessment conclusions for the Wabasca herd are summarized in Table 2.

Table 2. Overall Conclusion – Wabasca Bison Herd

Imminent Threat Assessment Question	Potential Imminent Threats Assessed		
	Disease and disease	Unregulated harvest	Resource development

	management		activities (forestry)
Is the species facing a threat?	Yes	Yes	Yes
Is the threat likely to occur?	No (near-term) Yes (long-term)	Yes	No (near-term) Yes (long-term)
Will the threat make achieving the recovery objectives unlikely or impossible?	No (near-term) Yes (long-term)	Yes	No (near-term) Yes (long-term)
Does the threat require immediate intervention?	No (but studies on herd movement recommended)	Yes	No (but studies on herd movement recommended)
Is there an Imminent Threat?	No	Yes	No

REFERENCES

(Source material referenced in the Species and Threats Summary and supporting the imminent threat assessment)

Alberta Biodiversity Monitoring Institute (ABMI). 2017. ABMI Human Footprint Inventory: Wall to Wall Human Footprint Inventory. Edmonton, AB. (<https://www.abmi.ca/home/data-analytics/da-top/da-product-overview/Human-Footprint-Products/HF-inventory.html?scroll=true>)

Alberta Environment and Parks and Alberta Conservation Association. 2017. Status of the American Bison (*Bison bison*) in Alberta: Update 2017. Alberta Environment and Parks. Alberta Wildlife Status Report No. 38 (Update 2017. Edmonton, AB. 134 pp.

- Alberta-Pacific Forest Industries Inc. 2015. Alberta-Pacific FMA Area 2015 Forest Management Plan. 671 pp.
- Armstrong, T. 2014. Slave River Lowlands Wood Bison population estimate. Unpublished Report. Environment and Natural Resources, Government of the NWT. Fort Smith, NT. 3pp.
- Armstrong, T. and K. Cox. 2011. Project: 2009 Slave River Lowlands Wood Bison Population Estimate. Unpublished Report.
- Armstrong, T. and R.J. Boulanger 2016a. 2016 Mackenzie Wood Bison Population Estimate. Unpublished Report. Government of the Northwest Territories. Fort smith, NT.
- Armstrong, T. and R.J. Boulanger 2016b. 2016 Slave River Lowlands Wood Bison Population Estimate. Unpublished Report. Government of the Northwest Territories. Fort Smith, NT. 3pp.
- Athabasca Chipewyan First Nation (ACFN). 2017. Series of Interviews with ACFN Elders held August 28-31, 2017.
- Athabasca Chipewyan First Nation (ACFN). 2018. ACFN cultural importance summary to support the Imminent Threat Assessment of the Ronald Lake Bison Herd. 24 pp.
- Ball, M.C., T.L. Fulton, and G.A. Wilson. 2016. Genetic analyses of wild bison in Alberta, Canada: implications for recovery and disease management. *Journal of Mammalogy* 97(6): 1525-1534.
- Belanger, R.J., C.A. DeMars, L.J. Hecker, M.A. Edwards, and S.E. Nielsen. 2017. Ronald Lake Wood Bison Research Program: Annual Report 2017. University of Alberta, Edmonton, Alberta, Canada. Unpublished Report.
- Belanger, R.J., L.J. Hecker, L.T. Dewart, S.E. Nielsen, and M.A. Edwards. 2018.

- Ronald Lake Wood Bison Research Program: Annual Report 21 December 2018. University of Alberta, Edmonton, Alberta, Canada. Unpublished Report.
- Bison Disease Task Force (BDTF). 1988. Evaluation of brucellosis and tuberculosis in bison in northern Canada. Report prepared for the Inter-jurisdictional Steering Committee by the Bison Disease Task Force.
- Bradley, M., A. Handel, P. Sargent. 2002. Wood Buffalo National Park Bison Survey. March 2002. Wood Buffalo National Park, Unpublished Report.
- Bradley, M., and J. Wilmshurst. 2005. The fall and rise of bison populations in Wood Buffalo National Park: 1971-2001. *Canadian Journal of Zoology* 83: 1195-1205.
- Canada National Parks Act: Wood Buffalo National Park Game Regulations (1978). *Canada Gazette Part II*, 111(11). Retrieved from the Justice Laws website: <http://laws-lois.justice.gc.ca/eng/regulations/SOR-78-830/page-1.html>
- Canadian Food Inspection Agency. 1999. Risk Assessment on Bovine Brucellosis and Tuberculosis in Wood Buffalo National Park and Area. Animal Health Risk Analysis. Animal, Plant and Food Risk Analysis Network.
- Candler, C. 2012. Technical Memorandum: ACFN Knowledge and Use data analysis in relation to Teck Frontier Proposed Winter Drilling Program. 6 pp.
- Candler, C. and the Firelight Group Research Cooperative (FGRC) with the Athabasca Chipewyan First Nation (ACFN). 2012. Athabasca Chipewyan First Nation Integrated Knowledge and Land Use Report and Assessment for Shell Canada's Proposed Jackpine Mine and Expansion and Pierre River Mine. 268 pp.
- Candler, C. 2013. Athabasca Chipewyan First Nation Knowledge and Use Report and Assessment for Teck Resources Limited Proposed Frontier Oil Sands Mine Project. 204 pp.
- Candler, C. and the Firelight Group Research Cooperative with the Athabasca Chipewyan First Nation. 2013. Athabasca Chipewyan First Nation Knowledge and Use Report and Assessment for Teck Resources Ltd Proposed Frontier Oil

Sands Mine Project.

Candler, C., S. Leech, C. Whittaker, and the Firelight Group with Mikisew Cree First Nation. 2015a. *Sakâw Mostos: Mikisew Cree First Nation Indigenous Knowledge Study*. Mikisew Cree First Nation and The Firelight Group Research Cooperative, Victoria, BC. 64 pp.

Candler, C. G. Ginger, M. Malone, the Firelight Group with Mikisew Cree First Nation. 2015b. *Wîyôw'tan'kitaskino (Our Land is Rich), a Mikisew Cree culture and rights assessment for the Proposed Teck Frontier Project Update*. 230 pp.

Carbyn, L.N., S.M. Oosenbrug, and D.W. Anions. 1993. *Wolves, bison and the dynamics related to the Peace-Athabasca Delta in Canada's Wood Buffalo National Park*. Canadian Circumpolar Research Series No. 4. Canadian Circumpolar Institute, University of Alberta, Edmonton, Alberta. 270 pp.

Choquette, L.P.E. and Broughton, E., 1967. *Anthrax in bison, Wood Buffalo National Park and the Northwest Territories. Report for the year*.

COSEWIC. 2013. *COSEWIC assessment and status report on the Plains Bison *Bison bison bison* and the Wood Bison *Bison bison athabascaae* in Canada*. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xv + 109 pp.

Cortese, L., and J. McKinnon. 2015. *Wood Buffalo National Park Bison Survey*. March 2014. Wood Buffalo National Park, Unpublished Report.

Cotterill, S., and D.W. Johns. 2018. *Technical review of the Imminent Threat Assessment Summary for Wood Bison*. Unpublished report. Alberta Environment and Parks. 4 pp.

Cronin, M. A., M. D. MacNeil, N. Vu, V. Leesburg, H. D. Blackburn, and J. N. Derr. 2013. *Genetic variation and differentiation of bison (*Bison bison*) subspecies and cattle (*Bos taurus*) breeds and subspecies*. *J Hered* 104:500-509.

DeMars, C.A., S.E. Nielsen, and M.A. Edwards. 2015. *Ronald Lake Bison (*Bison**

bison) Project Update. December 2015. Unpublished Report.

DeMars, C.A., S.E. Nielsen, and M.A. Edwards. 2016. Range Use, Habitat Selection, and the Influence of Natural and Human Disturbance on Wood Bison (*Bison bison athabascae*) in the Ronald Lake Area of Northeastern Alberta. Unpublished Report.

DeMars, C.A., S.E. Nielsen, and M.A. Edwards. 2017. Range Use, Habitat Selection, and the Influence of Natural and Human Disturbance on Wood Bison (*Bison bison athabascae*) in the Ronald Lake Area of Northeastern Alberta. March 2017 Update. 40 pp. Unpublished Report.

Dragon, D., and B. Rennie. 1995. The ecology of anthrax spores: Tough but not invincible. *Canadian Veterinary Journal* 36:295-301.

Elkin, B., Armstrong, T., and Ellsworth, T. 2013. Anthrax Emergency Response Plan. Department of Environment and Natural Resources, Government of the Northwest Territories. File Report No. 139. 121 pp.

Environment and Climate Change Canada. 2012. Recovery Strategy for the Woodland Caribou (*Rangifer tarandus caribou*), Boreal population, in Canada. *Species at Risk Act Recovery Strategy Series*. Environment and Climate Change Canada. Ottawa. xi + 138pp.

Environment and Climate Change Canada. 2018a. Recovery Strategy for the Wood Bison (*Bison bison athabascae*) in Canada. *Species at Risk Act Recovery Strategy Series*. Environment and Climate Change Canada. Ottawa. viii + 59 pp.

Environment and Climate Change Canada. 2018b. Environment and Climate Change Canada's Final Submission to the Joint Review Panel Regarding the Frontier Oil Sands Mine Proposed by Teck Resources Limited. Chapter 4: Terrestrial Environment. <https://www.ceaa->

acee.gc.ca/050/documents/p65505/125101E.pdf

Fekete, S. 2015. Mikisew Cree First Nation Indigenous Knowledge Report to inform: The Federal Wood Bison Recovery Strategy. 17 pp.

Fekete, S. 2018. Mikisew Cree First Nation Cultural Threat Assessment on the Ronald Lake Bison Herd. 23 pp.

Fish and Wildlife Division. 2008. Report of Alberta's Endangered Species Conservation Committee: June 2006. Alberta SRD, FWD, Edmonton, Alberta. 44 pp.

Fort Chipewyan Métis Local 125. (March 3, 2015). *Summary of Community Meeting with Environment Canada for Wood Bison Recovery Strategy Development*. Canadian Wildlife Service unpublished report. Fort Chipewyan, AB.

Fort Chipewyan Métis Local 125 and Bertolin, C., Dennis, J., Dertien, K., Donald, G., Finigan, K., Geller, D., Méra, P., Miskimmin, B., Spink, D., and Su, D. 2015. Review of Teck Resources Ltd. Frontier Oil Sands Mine Project Update. iv + 172 pp.

Fort Chipewyan Métis and Woven Paths Consulting Inc. 2015. Fort Chipewyan Métis Local 125 Métis Land Use and Ecological Knowledge Study (FCML 125 MLU/EK Study) Final Report. vii + 114 pp.

Fort McKay First Nation (FMFN). 1994. *There is Still Survival Out There*. The Arctic Institute of North America. Alberta, Canada.

Fort McKay First Nation (FMFN). (April 23 2015). *Summary of Community Meeting with Environment Canada for Wood Bison Recovery Strategy Development*. Canadian Wildlife Service unpublished report. Fort MacKay, AB.

Fort McKay Métis Local #63. 2018. *Summary of the Cultural Importance of the Ronald Lake Wood Bison to Fort McKay Métis Local #63*. Unpublished report submitted to Environment and Climate Change Canada. 10 pp.

Fort McKay Métis Sustainability Centre (MMSC). 2016. *Teck Frontier Mine Project Fort McKay Métis Integrated Cultural Assessment*. pp. 589.

Fort McKay Métis Sustainability Centre (MMSC). 2018. *Provincial Status Assessment of Wild Bison – Fort McKay Métis Community Association Status Review Form*. 2 pp.

- Fort McMurray Métis Local 1935. 2014. *Summary of Community Meeting with Environment Canada for Wood Bison Recovery Strategy Development* (Oct 21, 2014). Canadian Wildlife Service unpublished report. Fort McMurray, AB.
- Fort McMurray Métis Local 1935. 2017. Letter from Fort McMurray Métis Local Council 1935 to the Joint Review Panel re: Comments on the additional information submitted by the proponent (Jul 21, 2017).
- Fort Nelson First Nation. (June 23, 2015). Letter to Environment Canada regarding the Draft Recovery Strategy for Wood Bison in Canada. Fort Nelson, BC.
- Fort Nelson First Nation and Shifting Mosaics Consulting. 2015. Fort Nelson First Nation: Interaction with Fire and Wood Bison. RR1 Mile 295 Alaska Highway. Fort Nelson, BC, Canada. 34 pp.
- Fuller, W.A. 1950. Aerial census of northern bison in Wood Buffalo Park and vicinity. *J. Wild. Manage.* 14(4): 445-451.
- Fuller, W.A. 1962. The biology and management of bison of Wood Buffalo National Park. Canadian Wildlife Service, Wildlife Management Bulletin Series 1, 16:1-52.
- Gainer, R., 1985. Free-roaming bison in northern Alberta. *Alberta Naturalist*, 15, pp.86-87.
- Gates, C.C., B. Elkin, and D. Dragon. 1995. Investigations, control and epizootiology of anthrax in an isolated, free-roaming bison population in northern Canada. *Canadian Journal of Veterinary Research* 59:256-264
- Gates, C. C., J. Mitchell, J. Wierchowski, and L. Giles. 2001a. A landscape evaluation of bison movements and distribution in northern Canada. AXYS Environmental Consulting Ltd., Calgary, AB. 113 pp.
- Gates, C.C., R.O. Stephenson, H.W. Reynolds, C.G. van Zyll de Jong, H. Schwantje, M. Hoefs, J. Nishi, N. Cool, J. Chisholm, A. James, and B. Koonz. 2001b. National Recovery Plan for the Wood Bison (*Bison bison athabascae*). National Recovery Plan No. 21 Recovery of Nationally Endangered Wildlife (RENEW). Ottawa, Ontario. 50 pp.
- Golder Associates. 2002. Canadian Natural Resources Limited Horizon Project

Volume 3 Appendix A-I Traditional Land Use Study.

Golder Associates. 2014. Teck Frontier Bison Remote Camera Monitoring Program Results.

Government of Alberta. 2013. Managing Disease Risk in Northern Alberta Wood Bison – Outside of Wood Buffalo National Park. 2012-2013 Progress Report. June 2013.

Government of Alberta. 2015. Managing Disease Risk in Northern Alberta Wood Bison – Outside of Wood Buffalo National Park. 2014-2015 Progress Report. July 2015.

Government of Alberta. 2016a. Wildlife Management Unit 531 Bison Mark-Resight Survey (2015). Environment and Parks, Aerial Survey report.

Government of Alberta. 2016b. Wood Bison Hunt - Hay-Zama. Alberta Environment and Parks. Website: <https://mywildalberta.ca/hunting/game-species/wood-bison-hunt-hay-zama.aspx> [Accessed November 23, 2017].

Government of Alberta. 2017a. Managing Disease Risk in Northern Alberta Wood Bison – Outside of Wood Buffalo National Park, 2015–2016 Progress Report. ii+10 pp.

Government of Alberta. 2017b. Wood Bison (*Bison bison athabasca*). Website: <http://aep.alberta.ca/fish-wildlife/wild-species/mammals/wild-cattle-related/wood-bison.aspx> [Accessed November 24, 2017].

Government of Alberta. 2018a. Aerial Wildlife Survey Report: Hay-Zama Aerial Wood Bison Survey. 2 pp.

Government of Alberta. 2018b. Forest Management Plan Approval Decision – Alberta-Pacific Forest Industries Inc. Forest Management Agreement 9100029. 37 pp.

- Government of Northwest Territories. 2017. Bison Control Area. Website: <http://www.enr.gov.nt.ca/en/services/wood-bison/bison-control-area> [Accessed November 24, 2017].
- Hamilton, S., E. Merrill, and J. Wilmshurst. 2005. Estimates of winter carrying capacity for bison in Wood Buffalo National Park. Report to Wood Buffalo National Park, Fort Smith, NT.
- Harper, W.L., J.P. Elliott, I. Hatter, and H. Schwantje. 2000. Management Plan for Wood Bison in British Columbia. B.C. Minist. Environ., Lands and Parks, Victoria, BC. 43 pp.
- Jaremko, Deborah. 2017. Canadian Natural sees 'significant value' breathing new life into deferred Shell oilsands mine. <http://www.jwnenergy.com/article/2017/11/canadian-natural-sees-significant-value-breathing-new-life-deferred-shell-oilsands-mine/> [Accessed April 20, 2018]
- Jensen, O.C. 2005. Assessing suitable and critical habitat for Wood Bison (*Bison bison athabasca*) using Remote Sensing and Geographic Information Systems. Masters of Science Thesis, University of Alberta, Edmonton, Alberta.
- Joint Review Panel. 2019. Report of the Joint Review Panel. Teck Resources Limited Frontier Oil Sands Mine Project. Fort McMurray Area. July 25, 2019. 2019 ABAER 008. CEEA Reference No. 65505.
- Joly, D.O., and F. Messier. 2001. Limiting effects of bovine brucellosis and tuberculosis on wood bison within Wood Buffalo National Park. Final Report, March 2001. University of Saskatchewan, Saskatoon, SK.
- Joly, D.O., and F. Messier. 2004a. Testing hypotheses of bison population decline (1970-1999) in Wood Buffalo National Park: synergism between exotic disease and predation. *Canadian Journal of Zoology* 82:1165-1176.

- Joly, D.O., and F. Messier. 2004b. Factors affecting apparent prevalence of tuberculosis and brucellosis in Wood Bison. *Journal of Animal Ecology* 73:623-631.
- Joly, D.O., and F. Messier. 2005. The effect of bovine tuberculosis and brucellosis on reproduction and survival of Wood Bison in Wood Buffalo National Park. *Journal of Animal Ecology* 74:543-551.
- Kelly, E.N., D.W. Schindler, P.V. Hodson, J.W. Short, and R. Radmanovich. 2009. Oil sands development contributes polycyclic aromatic compounds to the Athabasca River and its tributaries. . *Proceedings of the National Academy of Science, USA* 106:22346-22351.
- Kelly, E.N., J.W. Short, D.W. Schindler, P.V. Hodson, M. Ma, A.K. Kwana, and B.L. Fortina. 2010. Oil sands development contributes elements toxic at low concentrations to the Athabasca River and its tributaries. *Proceedings of the National Academy of Science, USA* 107:16178-16183.
- Komers, P.E., F. Messier, C.C. Gates. 1993. Group structure in wood bison: nutritional and reproductive determinants. *Can. J. Zool.* 71:1367-1371.
- Letter from Athabasca Chipewyan First Nation (ACFN) to Alberta Environment and Parks (AEP). (December 2, 2015)
- Letter from Athabasca Chipewyan First Nation (ACFN) to Environment and Climate Change Canada (ECCC). (December 2, 2015)
- Letter from Athabasca Chipewyan First Nation (ACFN) to Teck Resources Limited. (October 2, 2011). RE: 2012 Winter Drilling Program
- Letter from the Métis Nation of Alberta (MNA) 1909 to Teck Resources Limited (Teck). (June 10, 2016)
- Letter from Shell to Canadian Environmental Assessment Agency (CEAA). (February 23 2015). Notice of Withdrawal of the Pierre River Mine Project Applications.
- Little Red River Cree Nation. (February 27, 2015). Letter to Environment Canada:

- LRRCN Input to the draft National Wood Bison Recovery Strategy Report. AB. Lutz-Wallace, C., C. Turcotte, D.A. Stevenson, B. Elkin, M. Koller-Jones, J. Nishi, and G. Wobeser. 2006. Isolation of *Mycobacterium bovis* from a Wood Bison in a wildlife conservation project in the Northwest Territories. *Canadian Veterinary Journal* 47:317-318.
- Lynam, M.M., J.T. Dvonch, J.A. Barres, M. Morishita, A. Legge, and K. Percy. 2015. Oil sands development and its impact on atmospheric wet deposition of air pollutants to the Athabasca Oil Sands Region, Alberta, Canada. *Environmental Pollution* 206:469-478.
- Mackenzie Bison Working Group. 2018. Mackenzie Bison Management Plan. File Report No. 151. Government of the Northwest Territories.
- McCormack, P. 1992. The Political Economy of Bison Management in Wood Buffalo National Park. *Arctic* 45: 367-380.
- Management and Solutions in Environmental Science (MSES). 2017. Using Indigenous Knowledge of the Mikisew Cree and Western Science to Estimate Habitat Viability of the Ronald Lake Bison Herd. 46 pp.
- McFarlane, K., G.A. Wilson, and J.S. Nishi. 2006. Management strategies for conservation of genetic diversity in Wood Bison (*Bison bison athabascae*). File report 135. Department of Environmental and Natural Resources, Government of the Northwest Territories. xii + 75 pp.
- Merkle, J.A., S.G. Cherry and D. Fortin. 2015. Bison distribution under conflicting foraging strategies: site fidelity vs. energy maximization. *Ecology* (7): 1793-1801.
- Mikisew Cree First Nation (MCFN). 2013. Response of the Mikisew Cree First Nation to the Report of the Joint Review Panel for the Shell Jackpine Mine Expansion Project and sections of the Federal Crown Consultation Report, submitted to the Federal Consultation Coordinator. 131 pp.
- Mikisew Cree First Nation (MCFN). February 25, 2015. Summary of Community Meeting with Environment Canada for Wood Bison Recovery Strategy Development. Canadian Wildlife Service unpublished report. Fort Chipewyan,

AB.

Mitchell, J.A., and C.C. Gates. 2002. Status of Wood Bison (*Bison bison athabascae*) in Alberta. Alberta Sustainable Resource Development, and Alberta Conservation Association, Wildlife Status Report No. 38, Edmonton, Alberta. 32 pp.

Moyles, D. 2010. Bison surveys in the Wabasca-Mikkwa area, February 17-19 and March 24, 2010. Unpublished Report (15 April 2010), Alberta Sustainable Resources Development. Peace River, AB. 10 pp.

Nishi, J.S. 2002. Surveillance activities under the Northwest Territories Bison Control Area Program (1987 – 2000). Department of Resources, Wildlife and Economic Development, Government of the Northwest Territories. Manuscript Report No. 145. 32 pp.

Nishi, J.S., T.K. Shury, and B.T. Elkin. 2006. Wildlife reservoirs for bovine tuberculosis (*Mycobacterium bovis*) in Canada: Strategies for management and research. *Veterinary Microbiology* 112:325-338.

Nishi, J.S., T.R. Ellsworth, N. Lee, D. Dewar, B.T. Elkin, and D.C. Dragon. 2007. Cross-Canada Disease Report: An outbreak of anthrax (*Bacillus anthracis*) in free-roaming bison in the Northwest Territories, June-July 2006. *Canadian Veterinary Journal* 48:37-38.

Nishi, J.S. 2016. Status of the American Bison (*Bison bison*) in Alberta, Update of Mitchell, J.A. and Gates, C.C., 2002. *Status of the Wood Bison (Bison bison athabascae) in Alberta*. Alberta Sustainable Resource Development. Unpublished. 154 pp.

Nishi, J.S. 2010. A review of best practices and principles for bison disease issues: Greater Yellowstone and Wood Buffalo Areas. American Bison Society Working Paper No. 3.

- Novakowski, N.S. 1957. Aerial resurvey of bison in Wood Buffalo National Park and surrounding areas, 1957. Unpubl. Rept. Can. Wildl. Serv., Edmonton, AB. CWSC-216. 12 pp. + maps.
- O'Connor D. and Métis Nation of Alberta Association Local (MNAAL) 1909. 2015. Métis Nation of Alberta Association Local 1909, Phase 1, Traditional Knowledge and Use Baseline Study, Frontier Mine Project. *xiii* + 91 pp.
- Parks Canada. 2005. Bison Movement and Distribution Study Final Report. 1990-1993. Wood Buffalo National Park, Forts Smith, NT. Unpublished Report.
- Phillips, C.J.C., C.R.W. Foster, P.A. Morris, and R. Teverson. 2003. The transmission of *Mycobacterium bovis* infection to cattle. *Research in Veterinary Science* 74:1-15.
- Redburn, M.J., W.L. Strong, and C.C. Gates. 2008. Suitability of boreal mixedwood clearcuts as Wood Bison (*Bison bison athabascae*) foraging habitat in north-central Alberta, Canada. *Forest Ecology and Management* 255:2225-2235.
- Reynolds, H.W., C.C. Gates, and R.D. Glaholt. 2003. Bison (*Bison bison*). Pp 1009-1060 in Feldhamer, G.A., B.C. Thompson, and J.A. Chapman (eds.). *Wild Mammals of North America: Biology, Management, and Conservation*. 2nd Edition. The Johns Hopkins University Press, Baltimore and London.
- Schindler D.W. (2015) Human-Caused Ecological Changes and Threats to the Peace-Athabasca Delta and Wood Buffalo National Park. Summary of Current Scientific Findings and Assessments. An independent, technical summary prepared for Mikisew Cree First Nation.
- Schramm, T. and Krogman, N. 2001. Caribou Mountains Critical Wildlife Habitat and Traditional Ecological Knowledge Study. Department of Renewable Resources, University of Alberta, Sustainable Forest Management Network, Final Project Report 2001-8. 33 pp.
- Schramm, T., Krogman, N., Hudson, R.J., and Freeman, M.M.R. 2002. Caribou

Mountains Critical Ungulate Habitat and Traditional Ecological Knowledge Study: A GIS Analysis. Department of Renewable Resources, University of Alberta, Sustainable Forest Management Network, Final Project Report 2002-3. 37 pp.

Schramm, T. 2005. Woodland Cree Traditional Environmental Knowledge of Critical Ungulate Habitat in the Caribou Mountains of Alberta. Ph.D. dissertation, University of Alberta, Edmonton, Alberta. 246 pp.

Shury, T.K., J.S. Nishi, B.T. Elkin, and G.A. Wobeser. 2015. Tuberculosis and brucellosis in Wood Bison (*Bison bison athabasca*) in northern Canada: a renewed need to develop options for future management. *Journal of Wildlife Diseases* 51:543-554.

Soper, J.D. 1941. History, range and home life of the northern bison. *Ecological Monographs* 11:347-412.

Species at Risk Committee. 2016. Species Status Report for Wood Bison (*Bison bison athabasca*) in the Northwest Territories. Species at Risk Committee, Yellowknife, Northwest Territories.

Strong, W.L., and C.C. Gates. 2009. Wood bison population recovery and forage availability in northwestern Canada. *Journal of Environmental Management* 90:434-440.

Sunder, S., P. Lanotte, S. Godreuil, C. Martin, M.L. Boschioli, and J.M. Besnier. 2009. Human-to-human transmission of tuberculosis caused by *Mycobacterium bovis* in immunocompetent patients. *Journal of Clinical Microbiology* 47: 1249-1251.

Tallcree First Nation. (May 28, 2015). *Summary of Community Meeting with Environment Canada for Wood Bison Recovery Strategy Development*. Canadian Wildlife Service unpublished report. North Tallcree, AB.

Tan, T., Nielsen, S.E., Edwards, M.A. Ronald Lake Bison (*Bison bison*) March 2013 –

- March 2014 Telemetry Data Study, Preliminary Summary Report, January 2015. 58 pp.
- Teck Resources Limited (Teck). 2015. Frontier Oil Sands Mine Project Update. Volume 3: Assessment Update, Section 11: Wildlife. 405 pp.
- Teck Resources Limited (Teck). 2016. Frontier Oil Sands Mine Project. Responses to Supplemental Information Request No. 5, April 2016.
- Teck Resources Limited (Teck). 2017a. Draft Ronald Lake Bison Mitigation, Monitoring and Adaptive Management Plan; Frontier Oil Sands Mine Project. ii + 53 pp.
- Teck Resources Limited (Teck). 2017b. Teck Resources Limited Responses to Joint Review Panel Information Request: Package 7 - Wildlife and Biodiversity. v + 124 pp.
- Teck Resources Limited (Teck). 2018a. Errata to Teck Resources Limited Response to Joint Review Panel Information Request 10.20. iii + 118 pp.
- Teck Resources Limited (Teck). 2018b. Assessment of the Potential Effects of the Frontier Oil Sands Mine Project on the Outstanding Universal Value of Wood Buffalo National Park Heritage Site. ii + 55 pp.
- Tessaro, S.V. 1987. A descriptive and epizootiologic study of brucellosis and tuberculosis in bison in northern Canada. Ph.D. dissertation, University of Saskatchewan, Saskatoon, Saskatchewan. 320 pp.
- Tessaro, S.V., L.B. Forbes and C. Turcotte. 1990. A survey of brucellosis and tuberculosis in bison in and around Wood Buffalo National Park, Canada. *Canadian Veterinary Journal* 31: 174-180
- Thiessen, C. 2010. Peace Wood Bison Project: Annual Report 2009/10. Peace Region Technical Report, British Columbia Fish and Wildlife Section. 22 pp.

- Traylor-Holzer, K. Submitted. Population Viability Analysis of Bison DOI Populations: Draft Report. Submitted to IUCN SSC American Bison Specialist Group. 30 pp.
- UNESCO World Heritage Centre (WHC) & International Union for Conservation of Nature (IUCN). 2016. Report of the joint WHC/IUCN Monitoring Mission to Wood Buffalo National Park, Canada 25 September – 4 October 2016. V + 79 pp.
- Van Camp, J. 1987. Predation on bison. Pp 25-33 in H.W. Reynolds and A.W.L. Hawley (eds.). Bison ecology in relation to agriculture development in the Slave River lowlands, Northwest Territories. Occasional Paper No. 63. Canadian Wildlife Service, Ottawa, Ontario.
- Varley, N., and K.A. Gunther. 2002. Grizzly bear predation on a bison calf in Yellowstone National Park. *Ursus* 13:377-381.
- Vassal, M. and R. Kindopp. 2007. Wood Buffalo National Park Bison Total Count. Feb/March 2007. Wood Buffalo National Park, Unpublished Report.
- Willow Springs Strategic Solutions. 2014. Métis Traditional Land Use and Occupancy Study: Teck Resources Limited – Frontier Oil Sands Mine Project. 53 pp.
- Wildlife Act, Revised Statutes of Alberta (2000, c. W-10). Retrieved from the Alberta Queen's Printer website: <http://www.qp.alberta.ca/documents/acts/w10.pdf>
- Wilson, G.A., and C. Strobeck. 1999. Genetic variation within and relatedness among wood and plains bison populations. *Genome* 42:483-496.
- Wobeser, G. 2009. Bovine tuberculosis in Canadian wildlife: an updated history. *Can. Vet. J.* 50(11):1169-1176.
- Worton, B.J. 1989. Kernel methods for estimating the utilization distribution in home-range studies. *Ecology*, 70, 164.