Inuvik to Tuktoyaktuk Highway

Wildlife Effects Monitoring Program (WEMP):

Initial Design and Cost Estimates of Proposed Wildlife Studies

WORKING DOCUMENT

DEPARTMENT OF TRANSPORTATION
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
GOVERNMENT OF THE NORTHWEST TERRITORIES

NOTE: THIS IS THE WORKING WEMP. GNWT'S ABILITY TO ADDRESS SPECIFIC OBJECTIVES AND PREDICTIONS IN THE DRAFT WILL DEPEND ON THE TYPE OF MONITORING APPROACHES USED AND THE REQUIREMENT TO HAVE SUFFICIENT WILDLIFE DATA TO TEST PREDICTIONS. THE WEMP WILL BE ADAPTED AND REVISED AS NEEDED (I.E., PENDING CONSULTATIONS WITH CO-MANAGEMENT PARTNERS, NEW INFORMATION, AND IDENTIFICATION OF RESOURCES THAT ALLOW FOR INCLUSION OF ADDITIONAL SPECIES).

Acronyms

COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DDT	an insecticide with the chemical name dichlorodiphenyltrichloroethane
DLP	Defense-of-Life-and-Property
EIS	Environmental Impact Statement
ENR	Department of Environment and Natural Resources
GNWT	Government of the Northwest Territories
GPS	Global Positioning System
ISR	Inuvialuit Settlement Region
km	kilometer
VC	Valued Component of the ecosystem
WEMP	Wildlife Effects Monitoring Program
WPP	Wildlife Protection Plan
RSA	Regional Study Area
RSFs	Resource Selection Functions
TK	Traditional Knowledge
ZOI	Zone of Influence

Contents

1. Introduction

The Government of the Northwest Territories (GNWT), Town of Inuvik, and Hamlet of Tuktoyaktuk will be constructing a 138 kilometer (km) all season highway from north of Inuvik to the Source 177 site near Tuktoyaktuk. The road will take approximately four years to build. Within the GNWT, this project is led by the Department of Transportation (DoT) but the Department of Environment and Natural Resources (ENR) has been providing technical expertise on how potential highway impacts on wildlife and wildlife habitat can be monitored and mitigated.

During the review of the draft Environmental Impact Statement (EIS), a number of concerns were raised on the potential impact of the proposed highway on the distribution and abundance of barren-ground caribou (*Rangifer tarandus*), barren-ground grizzly bears (*Ursus arctos*), wolverine (*Gulo gulo*), and wolves (*Canis lupus*). These species are considered important to harvesters or trappers, and/or they are species at risk or of special concern. Specifically, there are concerns that the highway will lead to the loss and disturbance of wildlife habitat (e.g., den sites) and increased wildlife mortality due to increased harvest pressure and traffic-related mortality along the highway.

There is some baseline wildlife information available in and around the area of the proposed highway, including harvest information, location and demographic data for the Cape Bathurst and Tuktoyaktuk Peninsula herds, and historic information on grizzly bear distribution based on harvest and collared individuals. Information on most other wildlife in this area is relatively sparse. The Inuvik to Tuktoyaktuk Highway (ITH) Wildlife Effects Monitoring Program (WEMP) is designed to evaluate the effect of the proposed highway on the distribution, abundance, and/or direct mortality of barren-ground caribou, barren-ground grizzly bears, and if feasible, wolverines. The program will be targeted to the Regional Study Area (RSA) described in the EIS. The RSA is a 15 km wide buffer running along either side of the proposed highway corridor and existing Source 177 access road (30 km total buffer width) but also includes the larger area that was used for the cumulative effects assessment in the EIS. Although wolves were included in an earlier version of the WEMP, preliminary field surveys conducted in June/July 2013 suggest they should be dropped from the program because it will be difficult to find enough individuals in the RSA to test impact predictions. Wolf harvest in the region will continue to be monitored through existing GNWT programs.

The programs outlined in the WEMP are proposed to occur prior to construction, during highway construction, and after the highway has been opened for use. Monitoring programs will be evaluated annually to evaluate effectiveness and potentially revised based on results (i.e., monitoring programs are designed using an adaptive management framework). This current WEMP proposes monitoring up to 5 years of

highway operation but this timeline will be continually evaluated as more information becomes available.

Sampling will occur in proximity to the road and in areas further from the road to more clearly separate out the impacts of the road from other factors like habitat, weather, and natural variation in wildlife population distribution and abundance (see Underwood 1991, Underwood 1997, Milliken and Johnson 2002). This will assist the GNWT with understanding potential impacts of the highway on wildlife, evaluating impact predictions, and implementing appropriate mitigation actions, if required.

Key elements of the proposed program are new and specific to the effects of the highway. Some elements of the program fit into existing ENR strategies[1,2] but new resources for this work are needed. The WEMP is expected to be used in combination with the Wildlife Protection Plan (WPP) for construction and use of the highway after construction[3].

2. Objectives

The WEMP includes proposed monitoring of effects on caribou, grizzly bear, wolves, and if feasible, wolverines using a variety of methods. The primary objectives of all monitoring activities will be to:

- Determine wildlife distribution and/or abundance within the RSA and adjacent areas prior to highway construction (i.e., establish a pre-disturbance baseline of information from which to determine the potential impacts of the highway).
- Test the prediction made in the EIS that the ITH will have limited impacts on wildlife by comparing wildlife abundance and distribution within the RSA before highway construction to wildlife abundance and distribution within the RSA during and up to five years after highway construction. More specifically, the WEMP will:
    - Monitor the direct habitat loss as the project progresses
    - Monitor and measure changes in distribution and abundance of key wildlife species as borrow site activities and highway right-of-way construction progresses (e.g., determine if there is a Zone of Influence or ZOI along the highway; this may be evident if wildlife use the area around the highway less than expected by chance and/or are less abundant near the highway than expected by chance).

[1] Caribou Forever – Our Heritage, Our Responsibility: A Barren-ground Caribou Management Strategy for the Northwest Territories 2011 – 2015.
[2] Western NWT Biophysical Study
[3] in previous version of the draft WEMP, the WPP was referred to as a Wildlife and Wildlife Habitat Protection Plan (WWHPP)

    - Monitor and measure changes in distribution and abundance once the highway is completed (e.g., determine if the ZOI changes once construction is over).
- Determine the amount of wildlife lost to vehicular mortality.
- Determine if the highway is resulting in additional harvest mortality on wildlife species within the RSA.
- Use the information from this program to mitigate and manage highway impacts where possible (e.g., using an adaptive management approach, test the effect of reducing highway speed on the ZOI for caribou).
- Use the information from this program to inform best practices associated with future highway developments in the NWT (i.e., the proposed Mackenzie Valley Highway). The wildlife information collected during this program will also be used to inform cumulative effects assessment and management within the Inuvik Region and the NWT as a whole.

3. Components of a species-based wildlife effects monitoring program

3.i. Barren-ground caribou

Rationale:

Caribou are an important big game species in the Inuvialuit Settlement Region (ISR). Previous radio-collar information indicates that caribou from the Cape Bathurst and Tuktoyaktuk Peninsula herds use the area where the highway corridor is proposed (Figures 1 and 2). Use takes place mainly between October and April. Collar data from November 2010 to October 2013 are shown on Figures 3 and 4. Caribou from the Bluenose-West herd have also used the proposed corridor when their numbers were high (Nagy *et al*. 2005). Based on studies conducted on barren-ground caribou in other parts of Canada[4], it is expected that caribou will initially avoid the highway during construction and after the highway opens until they become habituated to the new disturbances. After habituation to the highway, caribou are expected to cross it regularly as long as traffic volume remains low and additional linear structures are not built adjacent to the road. There may remain an area of reduced use along the highway corridor.

[4] Literature reviewed by Wolfe et al. (2000) showed that "... infrequently travelled transportation corridors resulted in low numbers of road-kills, did not deter road crossing by caribou, and had no observable effect on traditional migration routes, annual distribution, or energetic costs (Klein 1971; Johnson and Todd 1977; Johnson 1985; Russell and Martell 1985). Traditional migrations have continued across constructed railways or roads in Newfoundland (Bergerud 1971), Yukon (Surrendi and DeBock 1976; Russell and Martell 1984), British Columbia (Johnson and Todd 1977) and Alaska (Skoog 1968), but have ceased after construction of a railway and a highway between summer and winter ranges in Norway (Nellemann et al. 2000)."

GNWT's assessment of the response of caribou to the highway will be based primarily on the analysis of caribou radio-collar movements and habitat use and selection before, during, and up to five years after highway construction. This type of analysis has been carried out for caribou elsewhere in the NWT and southern jurisdictions and will show if caribou are less likely to cross the highway than expected and if caribou use areas around the highway less than expected.

ENR deployed a number of GPS collars on caribou in the Cape Bathurst and Tuktoyaktuk Peninsula herds in March 2012. Collars were deployed to initiate the baseline collection of information for the WEMP and in preparation for the July 2012 population surveys for both herds. Collars are used to locate herds during population surveys and other surveys (e.g., recruitment).

Location information will also be combined with harvest data, incidental observation and mortality data (vehicle collisions, etc.), and traffic volume information within the RSA to get a better understanding of the impact of the highway on direct mortality and if this mortality is significant at the population level. This information will be used to determine if any actions, such as signage or harvest management along the highway, are necessary.

Potential for future increased caribou hunting from the road:

In other portions of the NWT, roads have provided harvesters with easier access to caribou herds and are considered to have helped accelerate declines of herds at low numbers (e.g., the Bathurst herd). Although harvest of the Cape Bathurst herd has been suspended since 2007, there is concern that the ITH will increase hunter access to the herd once harvest is re-opened. If the area around the highway is reopened to hunting, the impact of the ITH on harvest of caribou will need to be monitored and managed via harvest management actions developed in collaboration with co-management partners. Management actions could include check stations and public education programs.

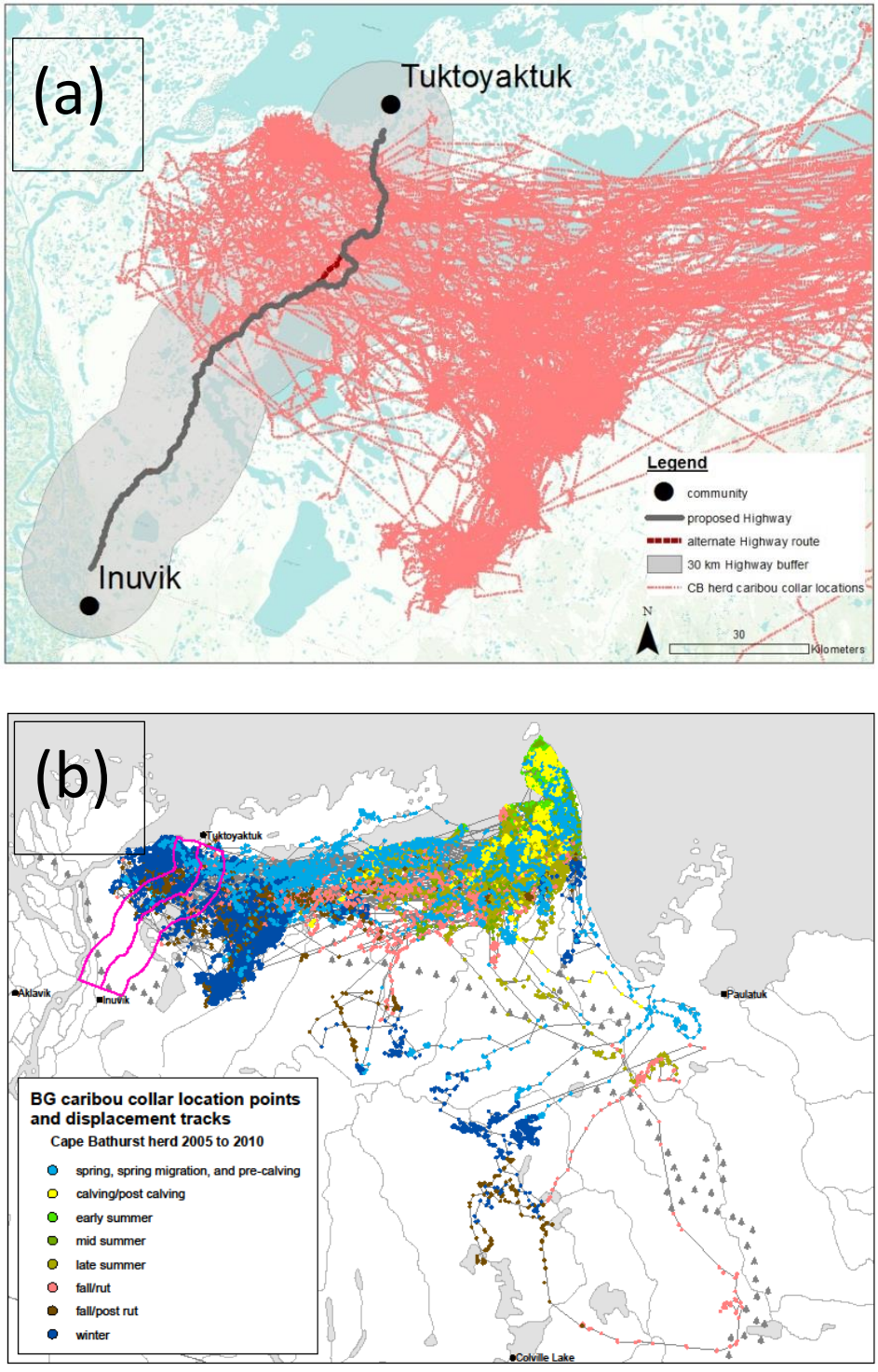

FIGURE 1: ENR's barren-ground caribou collar data from the Cape Bathurst (CB) herd between 2005 – 2010 within the area of the proposed Inuvik to Tuktoyaktuk Highway. (a) Collar data shown is from all seasons (year-round). (b) Seasonal locations and movement tracks for 2005 – 2010. This figure includes data up to October 2010.

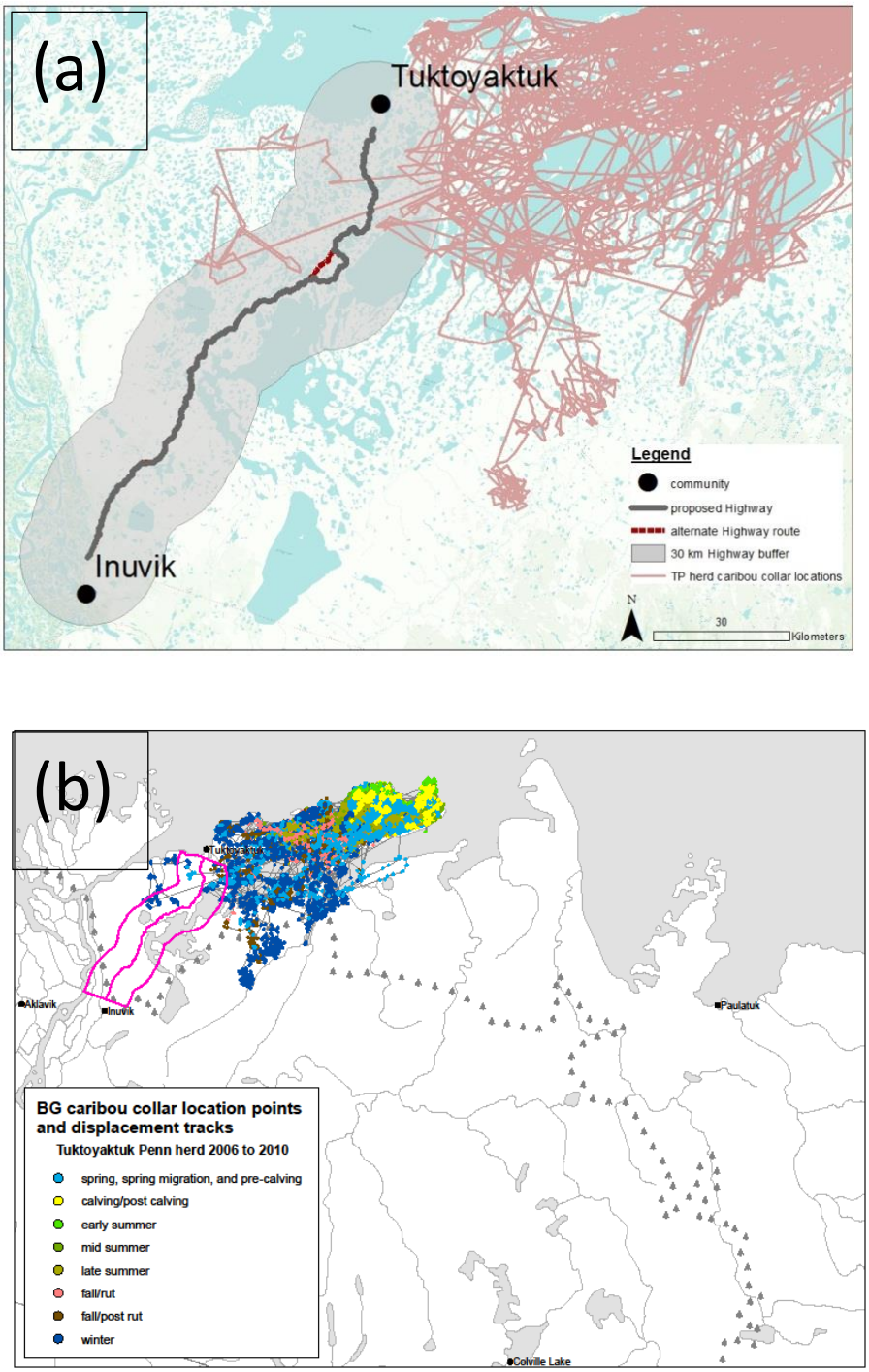

FIGURE 2: ENR's barren-ground caribou collar data from the Tuktoyaktuk Peninsula (TP) herd between 2005 – 2010 within the area of the proposed Inuvik to Tuktoyaktuk Highway. Collar data shown is from all seasons (year-round). (b) Seasonal locations and movement tracks for 2005 – 2010. This figure includes data up to October 2010.

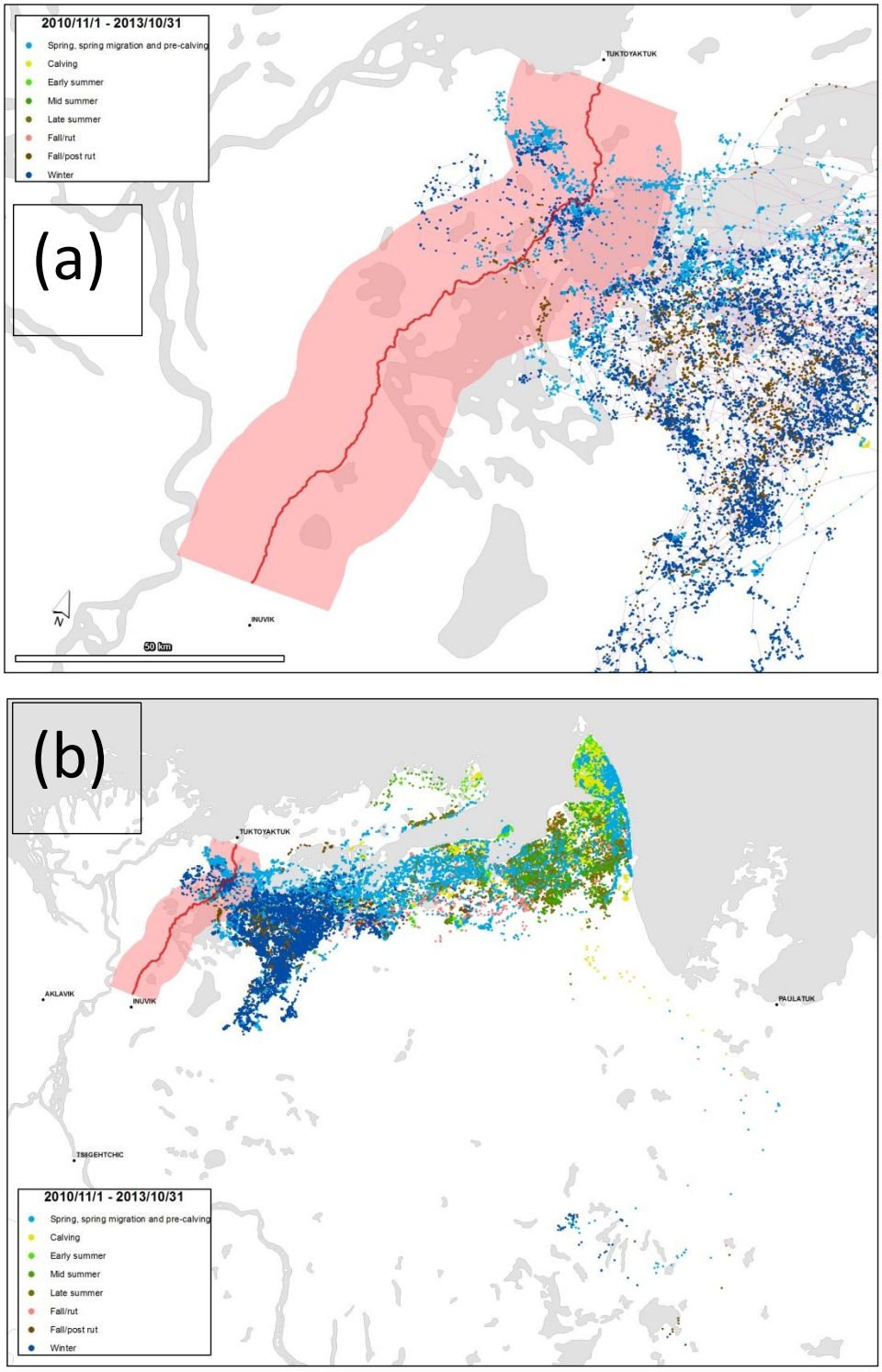

FIGURE 3: ENR's barren-ground caribou collar data from the Cape Bathurst (CB) herd between Nov 2010 – Oct 2013 within the area of the proposed Inuvik to Tuktoyaktuk Highway. (a) Zoomed into highway corridor (b) Seasonal locations and movement tracks for entire range.

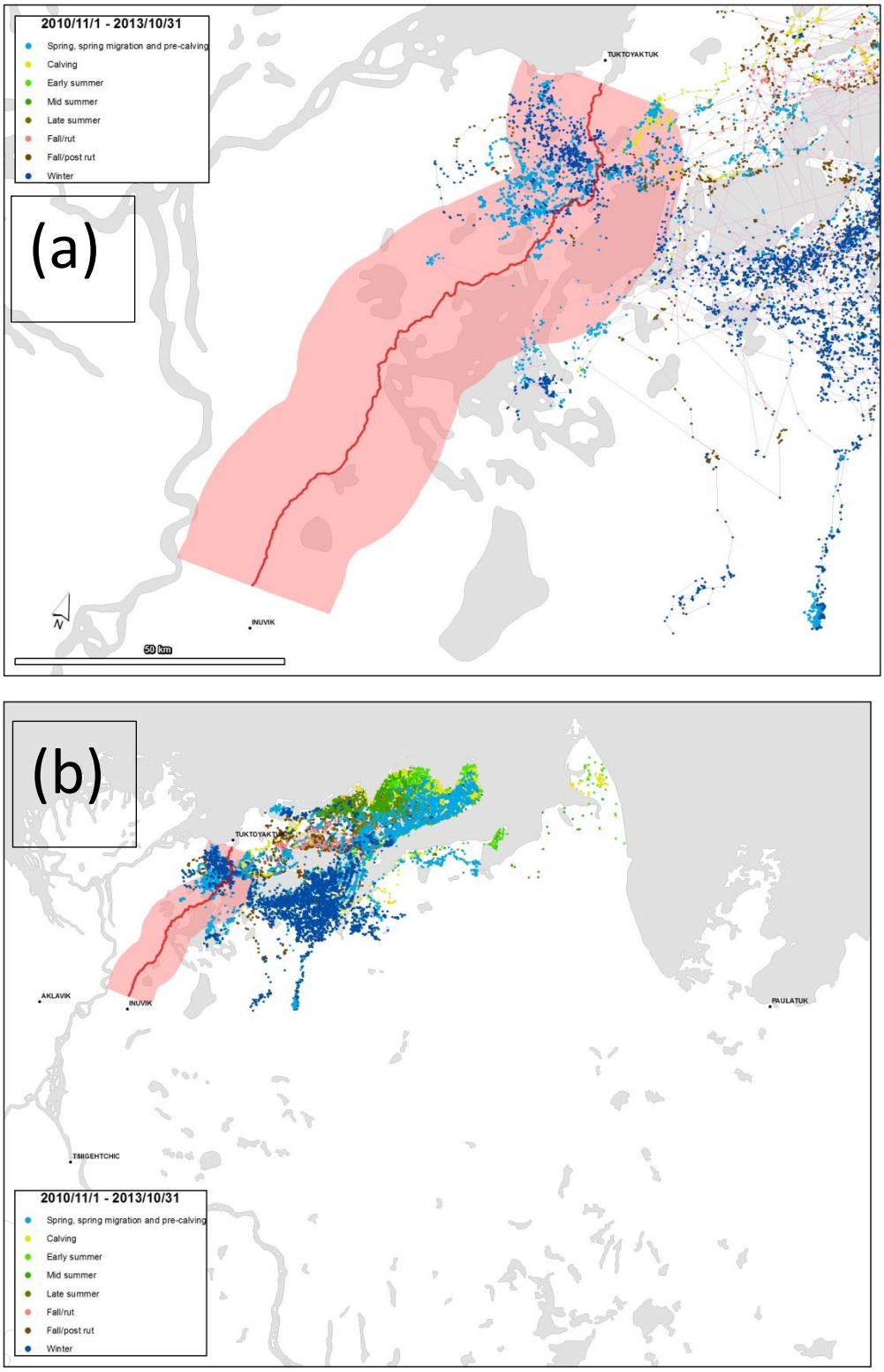

FIGURE 4: ENR's barren-ground caribou collar data from the Tuktoyaktuk Peninsula (TP) herd between Nov 2010 – Oct 2013 within the area of the proposed Inuvik to Tuktoyaktuk Highway. (a) Zoomed into highway corridor (b) Seasonal locations and movement tracks for entire range.

Hypotheses to be tested:

Caribou movement, habitat use, habitat selection, and mortality (from harvest and other sources) will be assessed before highway construction. This information will form the baseline conditions from which it will be determined:

- If there is an area of reduced use near the highway during and after construction, and if so, what the size of this area is (i.e., the ZOI).
- If caribou cross the highway at a higher rate of travel than they would cross over un-disturbed areas.
- If caribou are less likely to cross the highway.
- If rates of caribou mortality are higher within the RSA during and after highway construction (i.e., because of vehicular crashes, increases in harvest pressure, etc.).
- If mitigations and management actions meant to minimize highway impacts on caribou are effective.

Information on covariates such as dust accumulation on vegetation in the proximity of the highway, traffic volume, vegetation types, and seasonal abundance will also be collected to test potential mechanisms driving the ZOI, if it exists.

***Note**: Future work may include aerial surveys and camera work near the road during construction and operation if the analysis of collar data reveals that there are not enough collared caribou near the highway to test the predictions outlined above (see Boulanger et al. 2012).*

Methods:

A total of forty-six GPS/satellite collars were placed on caribou from the Cape Bathurst and Tuktoyaktuk Peninsula herds in March 2012. These collars provide three locations daily. Ten of the deployed collars were equipped with a geofence, allowing more data to be collected if the caribou move into the area of the proposed road (one location every hour). Due to concerns from the Tuktoyaktuk HTC, additional GPS collars will only be deployed in conjunction with subsequent caribou population estimate survey work. The next deployment is set for spring 2015, in preparation for summer 2015 population updates for the Cape Bathurst and Tuktoyaktuk Peninsula herds.

Statistical methods – movement and distribution

The effect of the highway on the movement and distribution of Cape Bathurst and Tuktoyaktuk Peninsula herds will be primarily assessed in two ways. First, displacement of caribou from highway areas will be tested for and estimated using a combination of piecewise regression methods and resource selection function analyses

(Boulanger et al. 2012). This analysis will include covariates listed above including seasonality, to determine if they are potential mechanisms causing displacement from the highway, if this occurs. Second, multi-state models (Hestbeck et al. 1991, Boulanger et al. 2004b, White et al. 2006) will be used to test whether the construction of the highway influences probabilities of caribou movement across the highway, and if proximity to the highway affects caribou survival rates.

If enough mortality data exists, it may be possible to develop a mortality-based RSF model that predicts areas of highest risk (Nielsen et al. 2004, Nielsen et al. 2006), which can be used to identify key areas for mitigation (e.g., lower speed limit zones). The mortality-based RSF can use data from mortalities of both collared and non-collared animals

Proposed Schedule/Budget for 2012/13 and beyond:

The following table provides cost estimates and approximate timing of field work and analysis of data necessary to monitor the effects of the highway corridor on caribou. ENR covered costs for March 2012 deployment of collars with geofencing and for the data acquisition costs to date. Unless additional collaring is required and approved, the costs for this work will be covered by ENR as part of regular caribou monitoring. Costs for data analysis related to the road will be covered by DoT funding.

Fiscal Year	ENR Cost (K)	DOT Cost (K)	Description (Bold specific to Road)[5]
2012/13	$100		Collar pick up, data acquisition (population estimate)
2013/14	$160	**$15**	Collar pick up, possible fall collar deployment, data acquisition, **analysis of historic and current location data, analysis of optimal collar number for WEMP, exploration of other approaches for monitoring highway impacts (e.g., aerial surveys) and preliminary report**
2014/15	$230	**$10**	Collar pick up, purchase and deployment; data acquisition and **annual report**
2015/16	$150	**$20**	Collar pick up, data acquisition, **analysis and interim report** (population estimate)
2016/17	$110	**$10**	Collar pick up, data acquisition, **analysis and annual report**
2017/18	$230	**$20**	Collar pick up, purchase and deployment, data acquisition, **analysis, and interim report**
2018/19	$140	**$10**	Collar pick up, data acquisition, **analysis and annual report** (population estimate)
2019/20	$110	**$10**	Collar pick up, data acquisition, **analysis and annual report**
2020/21	$110	**$10**	Collar pick up, data acquisition, **analysis and annual report**
2021/22	$100	**$40**	Collar pick up, data acquisition, **final analysis, and report of results**

3.ii. Barren-ground grizzly bears and wolverine

Rationale:

Grizzly bears were assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2012 as a species of Special Concern in Canada. Canada is currently consulting on listing grizzly bears under the federal *Species at Risk Act*. Low recruitment and reproductive rates[6], as well as concern over the vulnerability of grizzly

[5] Based on a three-year life expectancy for GPS/satellite collars.

[6] Northern barren-ground grizzly bears have been shown to have low recruitment rates compared to other terrestrial mammals. Mean age of female bears' first reproductive episode is 8.1 years of age; and litter sizes are small (averaging two cubs per litter), with a reproductive interval averaging three years between litters (McLoughlin et al. 2003). A study looking at grizzly bears in the NWT and Nunavut showed an average 74% survival rate for the first year of life (McLoughlin and Messier 2003).

bear populations and their range to increasing human presence, provide further rationale for including barren-ground grizzly bears in the ITH WEMP.

Grizzly bears occur throughout the RSA (**FIGURE 5**), with the northern half of the proposed highway corridor occurring within grizzly bear denning areas identified in community conservation plans (Tuktoyaktuk CCP 2008). Construction occurring during winter months provides the greatest potential for disturbance to denning bears, particularly females with cubs. Summer construction will happen outside of the normal denning period. Normal highway use post-construction is anticipated to create a loss of functional habitat close to the highway (i.e., a ZOI). It is also expected that grizzly bears will select den sites away from the highway. The physical presence of the highway, along with traffic travelling on it, may be a physical barrier to movement until bears become habituated to its presence.

Wolverines are an important furbearer species in the ISR. Traditional Knowledge (TK) and harvest data confirm that wolverines utilize the RSA. COSEWIC has assessed the status of the western population of wolverine in Canada as Special Concern. In the NWT, wolverines are ranked as Sensitive by the NWT General Status Ranking Program and are slated for assessment by the NWT Species at Risk Committee in 2013. The inclusion of wolverine in the WEMP is based on this status, their low tolerance to human disturbance, and concern over how the proposed highway may result in increased mortality of the species.

Wolverines may use the area within the RSA less than expected during and after construction as a result of noise from construction activity, camps, and vehicle traffic. Alternatively, wolverines may be attracted to camps, cabins, or construction activities associated with the highway if waste and odours are not properly managed. Grizzly bears may be attracted to these areas for similar reasons. Destruction of nuisance or problem carnivores during highway construction is a concern, although the implementation of the Inuvik to Tuktoyaktuk highway WPP should reduce the potential for defence-of-life-and-property (DLP) kills.

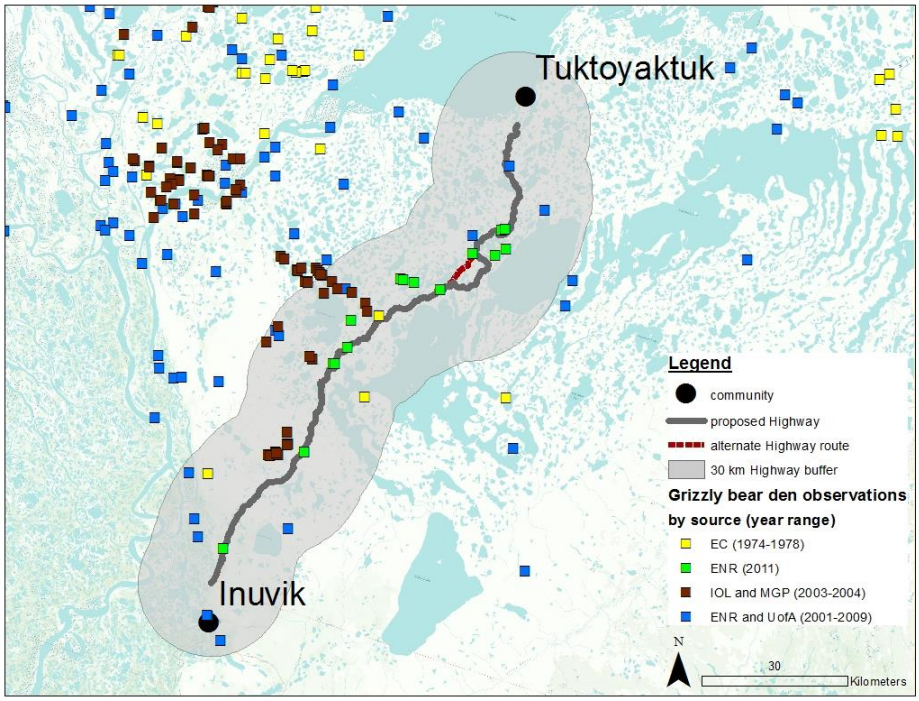

FIGURE 5: Observed grizzly bear denning sites within the area of the proposed Inuvik to Tuktoyaktuk Highway and the time period within which the den was observed. Sources for data are Environment Canada (EC); Environment and Natural Resources, GNWT (ENR); Imperial Oil (IOL); Mackenzie Gas Pipeline project (MGP); and the University of Alberta (UofA).

After the highway is opened, additional mortalities may occur if wolverines and bears that are attracted to any ungulate kill sites near roads are themselves hunted or trapped. Ungulate kill sites would occur if future harvesting of caribou or other species occurs along the highway or because of animals killed by vehicles. Direct mortality associated with vehicle collisions is expected to be a rare event. Attraction versus avoidance of the highway may be assessed by determining how wolverine and grizzly bear distribution in the RSA changes with highway construction and use.

To get a better understanding of the impact of the highway on direct mortality in the RSA, DLP kills, harvest data, and other incidental mortality data (vehicle collisions, etc.) will be tracked before, during, and up to five years after highway construction. This information will be used to determine if any actions, such as harvest management along the highway, are necessary. This is part of the ENR's current ongoing monitoring program (see Methods for further details).

Hypotheses to be tested:

Grizzly bear and wolverine distribution, abundance, and harvest mortality will be assessed before construction of the highway. This information will form the baseline conditions from which it will be determined:

- If there is a change in bear denning frequency within or near the RSA during and after construction.
- If there is an area of reduced use near the highway during and after construction, and if so, what the size of this area is (i.e., the ZOI)*.
- If rates of grizzly bear and wolverine mortality within the RSA are higher during and after highway construction (i.e., because of vehicular mortality, increased harvest pressure, or removal of problem bears or wolverines).
- If there are fewer grizzly bears and wolverines in the RSA compared to adjacent areas during and after highway construction.
- If bears and wolverine are less likely to cross the highway*.
- If bears and wolverine cross the highway at a higher rate of travel than they would cross over un-disturbed areas*.
- If mitigations and management actions meant to minimize impacts of the highway on bears and wolverine are effective.

Information on covariates such as dust accumulation on vegetation in the proximity of the highway, traffic volume, seasonality, vegetation types, and seasonal abundance would also help to test potential mechanisms driving the ZOI, if it exists.

***NOTE**: Adequately addressing starred (*) hypotheses may require the use of GPS collars for both species. GPS collars or some other monitoring tool may be needed to address predictions related to wolverines.*

Methods:

DNA hair snagging – there are a variety of ways in which the abundance, distribution and movements of grizzly bears and wolverines can be monitored in the RSA and adjacent areas. Hair snagging is currently the preferred option based on feedback received from the Tuktoyaktuk HTC. DNA collected from sites within the RSA and adjacent areas can potentially be used to determine grizzly bear and wolverine density, distribution and movements before, during, and up to five years after highway construction (see Mulders et al. 2007, Poole et al. 2001 and Rescan 2012 for more information).

Grizzly bear hair snag programs typically take place during summer when bears are active. Wolverine hair snagging programs typically take place during spring when there

is snow cover. However, due to concerns about a potential increase in wolverine hunting pressure from use of the spring hair snag stations to locate wolverine tracks, the wolverine study will not be conducted at this time of year.

Summer 2013 will be used as a pilot year to determine whether the hair snagging program will be able to test the predictions outlined above and if grizzly bear study design is also adequate to assess the abundance and distribution of wolverine. The pilot year should provide an indication of the number of grizzly bears using the study area and how many of those individuals are likely to interact with the highway based on where they are detected within the survey grid. The rates of detection for each species (i.e. the number of individuals detected and how many times they are detected over the course of the sampling period) will provide an indication of whether this approach will provide sufficient data to meet the objectives of the monitoring program. Depending on results, different approaches to monitoring bears and wolverine may need to be considered and/or parts of the WEMP may need to be dropped.

Distribution, movements, and mortality:

DNA hair snagging will be used to determine if there is a shift in the distribution of grizzly bear and possibly wolverine during and after construction of the highway, and if the highway contributes to grizzly bear and wolverine mortality and changes in population trends within the RSA. The **preliminary** study design, subject to refinements based on power analysis by a statistician, involves establishing a grid over the RSA above treeline and adjacent areas. The central portion of the study area was chosen to maximize the number of years of baseline data that could be collected before construction takes place, given that construction is scheduled to begin at either end of the highway for the first two seasons of construction.

The grizzly bear survey grid consists of 93 10 km x 10 km cells, extending from the tree line north to Tuktoyaktuk including the existing Access Road 177, and to the west to include the Mackenzie Delta/Richards Island as a reference area (**FIGURE 6**). Previous work (Edwards 2009) suggests that grizzly bear home ranges in this reference area are small enough that these individuals are unlikely to be affected by disturbance from the highway, incur increased mortality or be attracted to the highway. Monitoring stations consisting of a tripod of wooden posts covered in barbed wire and supplied with a scented lure placed within each of the grid cells. Within each grid cell, tripods are placed in areas of high quality grizzly bear habitat to increase the likelihood of detections.

Repeated samples of the survey grid in years before and after construction can be used to test whether grizzly bear density varies spatially as a function of distance from the

road, whether grizzly bear density varies over time, and if there is an effect of proximity to the road on the trend in density over time.

Hair samples will be collected over four sessions spaced 14 days apart starting in mid-June 2013 and running until mid-August 2013. Following the protocols established for monitoring of grizzly bears and wolverines at the diamond mines in the North Slave Region, collections are set to take place annually before and during construction and biannually during the operations phase (to be verified statistically; see Rescan 2012 for more information). Collected samples will be sent out for DNA analysis and results evaluated after each phase of the project.

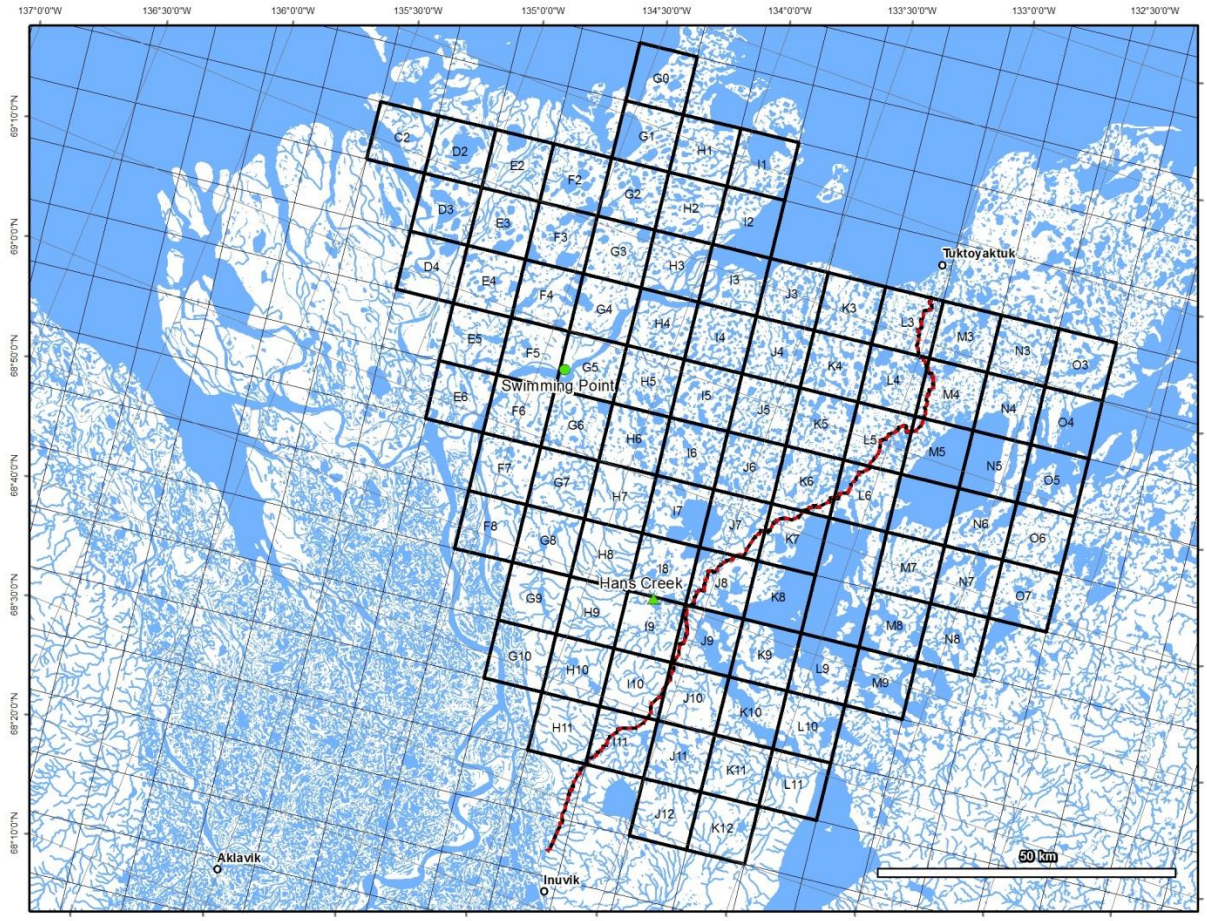

FIGURE 6: Summer 2013 grizzly bear DNA hair snagging grid. Each cell is 10 km x 10 km.

Statistical Methods

Spatially explicit mark-recapture methods (Efford et al. 2004, Efford et al. 2007, Efford 2011) will be used to model variation in grizzly bear and possibly wolverine density

caused by habitat types and test whether the highway results in spatial variation in density. Spatially explicit models allow the modelling of detection variation caused by the layout of posts and also allow covariates to test for the effect of the highway on grizzly bear and possibly wolverine density. In addition, it will be possible to derive a density estimate for each year of DNA sampling; however, the main emphasis of analyses will be the detection of variation in density caused by the addition of the highway. Open mark-recapture models will be used to estimate trends in grizzly bear and wolverine abundance (Pradel 1996, Boulanger et al. 2004a), and, if sample sizes permit, joint live-dead mark-recapture models (Barker and White 2001) that allow incorporation of mortality data will be used to estimate trends in adult survival.

Simulations will be used to optimize grid size and configuration relative to the highway, once results of the pilot year are available. For trend analysis, the main requirement will be that the study area size remains constant over time.

Potential alternative to DNA hair snags: GPS collars (requires approval from co-management partners)

Pending the results of the hair snagging pilot study, it may be determined that the use of GPS/satellite collars are more suited to evaluating the effects of the highway on grizzly bears and wolverine. If deemed necessary and approvals acquired, GPS/satellite collars would be deployed on grizzly bears and possibly wolverine in or near the RSA in May 2014. The collaring program would tentatively continue throughout and for up to five years after highway construction to determine the impacts of the highway on grizzly bear and wolverine movement and habitat use and selection.

These collars would be programmed to provide six locations a day in the active period and one location daily during hibernation. Depending on the performance of the caribou collars, grizzly and wolverine collars may be equipped with a geofence that allows more data to be collected if the bears move into the area of the proposed highway (one location every hour). Additional collars would be deployed to maintain the number of bears collared, likely in May 2016, May 2018, and May 2020.

Collar location data for any bears found near the highway corridor will be analysed using movement rate analysis and habitat selection analysis (RSFs). Collar tracks and locations from bears that were within or near the highway corridor before construction would be compared to tracks and locations during and up to five years after construction.

Statistical methods

As with caribou, resource selection function modelling and piecewise regression methods will be used to determine if ZOI exist around the highway area. In addition,

RSF analyses will focus on whether there are some areas where bears and/or wolverines are more likely to cross the highway due to habitat, topography, prey abundance (i.e. locations of collared caribou) and if it is possible that traffic volume influences crossing (Graham et al. 2010).

Den Surveys:

Specific impacts of highway construction and use on grizzly bear denning will be determined via fall and spring aerial den surveys of the RSA before, during, and up to 5 years after highway construction. This information will be used to avoid denning bears during winter work. It will also provide location information for bears residing in the area for spring capture work if required.

Additional summer den surveys may be carried out by contractors or wildlife monitors for evidence of denning at granular stockpiles prior to their use during winter construction. These surveys are covered under the WPP.

Mortality:

As ENR records for grizzly bear harvest in the study area go back to the late 1980s, harvest locations post construction will be compared to historic grizzly bear harvest data to look at changes in the distribution of the harvest. Levels of DLP kills and other types of mortality pre, during, and post construction will be monitored. There is mandatory reporting of grizzly bear mortalities in the ISR.

Existing sources of data will be analysed to identify changing patterns of wolverine harvest relative to the highway during the pre-construction, construction, and up to five years after construction phase. ENR's wolverine carcass collection program has been collecting data on sex, age, and harvest since 2004/2005 and is an ongoing program that can be used to track this information into the operation phase of the project. Further baseline information can be provided by the Inuvialuit Harvest Study which recorded location and numbers of wolverine harvested in the ISR from 1988 to 1999.

Statistical methods

If enough mortality data exists, it may be possible to develop a mortality-based RSF model that predicts areas of highest risk (Nielsen et al. 2004, Nielsen et al. 2006), which can be used to identify key areas for mitigation (e.g., lower speed limit zones). The mortality-based RSF can use data from mortalities of non-collared (and if approved) collared animals.

Proposed Schedule/Budget for 2012/13 and beyond:

The following table provides cost estimates and approximate timing of field work and analysis of data necessary to monitor the effects of the highway corridor on bears and wolverine based on a DNA study. Study design may need to be altered based on the initial pilot year.

Fiscal Year	Cost (K)	Details
12/13	$12	fall denning survey
13/14	$395*	Spring denning survey, statistical analysis of historic location data and optimal number of collars, statistical assistance with design of pilot DNA study, pilot DNA project, DNA analysis and preliminary report, fall denning survey
14/15	$395	Spring denning survey, pilot DNA project, DNA analysis and preliminary report, fall denning survey
15/16	$25	spring and fall denning surveys of winter work areas
16/17	$395	DNA project, spring and fall denning surveys
17/18	$25	Spring and fall denning surveys
18/19	$395	DNA project, spring and fall denning surveys
19/20	$25	Spring and fall denning surveys
20/21	$395	DNA project, spring and fall denning surveys
21/22	$65	Spring and fall denning surveys, final data analysis, and report

***Note** – Estimates for carnivore work will need to be adjusted if the collar approach is approved for both wolverines and grizzly bears.

3.iii. Wolves

Rationale:

Wolves are an important furbearer species in the ISR and traditional knowledge and harvest data confirm that wolves utilize the RSA and proposed highway corridor. Wolves are ranked as *Stable* by the NWT General Status Ranking Program and typically display high resilience to harvest and other pressures. However, attraction of wolves to gut piles of other species harvested near the highway might predispose them to increased levels of mortality due to additional hunting and trapping pressure. This prediction will be tested via GNWT's existing regional wolf harvest monitoring program.

Although wolf den surveys were included in an earlier version of the WEMP, preliminary field surveys conducted in June/July 2013 indicate that these components should be dropped from the WEMP because it will be difficult to find enough dens in the RSA to test impact predictions.

Hypotheses to be tested:

- If wolf mortality is higher within the RSA during highway construction and use.
- If mitigations and management actions meant to minimize highway impacts on wolf harvest are effective.

Methods:

Patterns of wolf harvest: Existing sources of data will be analysed to identify changing patterns of wolf harvest relative to the highway in the RSA during the pre-construction, construction and post-construction phases. ENR's wolf carcass collection program has been collecting data on sex, age and harvest since 2006/2007 and is an ongoing program that can be used to track this information into the operation phase of the project. Further baseline can be provided by the Inuvialuit Harvest Study which recorded location and numbers of wolves harvested in the ISR from 1988 to 1999.

Proposed Schedule/Budget for 2012/13 and beyond:

Costs for monitoring wolf harvest will be covered off by ENR's existing monitoring programs.

3.iv. Habitat Loss

Direct habitat loss will be monitored using annually updated shapefiles of the project footprint (road alignment + borrow sources) provided to ENR by DOT. These shapefiles may be based on as-built plans, satellite imagery or aerial photos. The final footprint will be compared against predictions made in the draft EIS.

4. Staffing requirements

There is currently no capacity within the Inuvik region to undertake the wildlife work described in the WEMP and WPP or to actively participate on the Inuvik to Tuktoyaktuk Highway Corridor Working Group. It is recommended that a new position be created in the Inuvik region to deal with this capacity issues. This person will need to be a wildlife biologist with a strong background in environmental assessment, monitoring and management. A full time Person Year (PY) is recommended as opposed to external contractors because the wildlife programs and plans required for the Highway are multi-year, thereby benefiting from a devoted, continuous lead with a strong understanding of the co-management process in the Inuvik region. This position is not expected to be staffed until April 2014.

Proposed Schedule/Budget for 2014/15 and beyond:

The following table provides costs and approximate timing for a PY to conduct the wildlife work required for the Inuvik to Tuktoyaktuk Highway.

Fiscal Year	Cost (K)	Details
Annually 2014/15-2020/22	$135	Full time PY ($130K) at Pay Scale 18 plus $5K for computer upkeep, email access, supplies, etc.

5. Reporting Requirements

Updates on the implementation of the WEMP, including any changes to survey design, methodology, and preliminary results, will be reported by GNWT-ENR at bi-annual meetings (spring and fall) of the Inuvik-Tuktoyaktuk Highway Corridor Working Group led by DOT. Results from more in-depth statistical analysis of data will be either reported annually or within one year of the termination of specific components of the WEMP, as outlined in the proposed schedule and budget tables provided in the previous sections.

GNWT-ENR will report the results of spring and fall grizzly bear denning surveys to DOT prior to the onset of summer and winter construction activities. DOT will be responsible for communicating the survey results to their contractors.

GNWT-ENR will also advise DOT and HTC's of the timing and location of wildlife surveys before they are carried out, for the duration of the WEMP.

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7. Appendix A – Revisions Tracking Table

Note – this table only contains substantive changes to the scope of the WEMP, methodology used to test hypotheses, and budget projections. Minor edits to improve clarity of the text are not included.

Date	Version	Changes	Rationale
October 4, 2012	Discussion Draft 1	N/A	N/A
June 4, 2013	Discussion Draft 2	1. Introduction – Study area expanded to include cumulative effects study area to allow comparison of areas near the road and far from the road 2. Objectives – Added a note with caveat that ability to test predictions will depend on type of monitoring approach used and having sufficient wildlife data to test predictions. 3. i. Caribou – Methods – Change in the frequency and timing at which additional GPS collars will be deployed on caribou. Statistical methods – added greater detail about statistical analysis that will be used to test hypotheses. Proposed schedule/budget – Additional costs of data analysis required for the WEMP allocated to DOT. Additional year added (2020/21). ii. Barren-ground grizzly bears and wolverine – Grizzly and wolverine sections combined into one section. Hypotheses revised with additional notes to indicate which hypotheses may require use of GPS collars to test. Additional hypothesis to test if grizzly/bear wolverine abundance differs between areas near and far from the road. Methods: DNA hair snagging added as preferred method to assess changes in abundance and distribution of both grizzly bear and	Due to concerns from Tuktoyaktuk HTC, additional GPS collars will now only be deployed in conjunction with subsequent population estimate surveys (spring 2015) Changed based on concerns from the Tuktoyaktuk HTC about impact of collaring on grizzly.

		wolverine. Spring hair snagging program for wolverine dropped for time being. The summer sampling grid for grizzly will also be used to determine rate of wolverine detections. GPS collaring presented as an alternative pending results of pilot year of hair snagging. Added description of aerial grizzly bear den surveys. Statistical Methods – Added description of statistical analyses to be used for DNA hair snagging data. Added detail to statistical methods for analyzing GPS collar data and mortality data. Proposed Schedule/Budget – revised budget estimates to reflect costs of DNA hair snagging program iii. Wolves – added detail about analysis of wolf den survey data. Proposed schedule/budget – Cost for first year of den surveys revised based on using DNA project to look for dens. 4. Staffing Requirements – Added a section describing the need for ENR to hire a full time Person Year (PY) to be dedicated to implementation of the WEMP and to participate in ITH corridor working group, including proposed schedule and budget.	Spring wolverine hair snagging program dropped because communities were concerned that conducting this program in winter (the optimal time) would make wolverines more susceptible to harvest by local trappers Due to workloads, lack of ENR capacity in Inuvik region to undertake work described in the WEMP or to actively participate in ITH corridor working group.
July 2013	Discussion Draft 3	2. Objectives – Added monitoring direct habitat loss as the project progresses 3ii. Barren-ground grizzly bears and wolverine – revised budget estimates	Added to address EIRB recommendations R21 and R24. Funds are to conduct DNA based hair snagging surveys ($320K) and spring and fall grizzly bear den surveys ($25K), and include statistical

			assistance with survey design and data analysis ($50K). DNA hair snag surveys include collecting 2 years of baseline information (2013/14 and 2014/15 fiscal years) and subsequent surveys every 2 years up to and including 2020/21. Hair snags may collect both wolverine and grizzly bear hair so there is no additional cost to surveying wolverines. Den surveys will be conducted every year for the area scheduled to have winter work. Costs do not include a minimum of $25,000 of in-kind support to conduct the surveys (field work and organizing logistics).
		3.iii Wolves – this section has been removed.	Discussions with HTCs and preliminary surveys conducted in [June/July 2012] indicated that it will be difficult to find enough individuals in the Regional Study Area to test impact predictions.
		3.iv – Added methods for monitoring direct habitat loss as the project progresses	To address EIRB recommendations R21 and R24.
		4. Staffing Requirements – Budget for PY adjusted to remove cost for fiscal year 2013/14.	PY would likely not start until April 2014.
		5. Reporting requirements – new section added	To clarify expectations about what, how often and to whom aspects of the WEMP will be reported on.
Oct 2013	Working Document	1. Caribou movements	Update caribou movement maps before I-TH corridor working group meeting.