July 14, 2017

WHALE TAIL COMMITMENT 8

Meadowbank Mine and All-weather Access Road Caribou Zone of Influence Assessment

Submitted to:
Agnico Eagle Mines Limited

REPORT

Report Number: Doc127_1658927.3100.3130

Table of Contents

1.0 INTRODUCTION

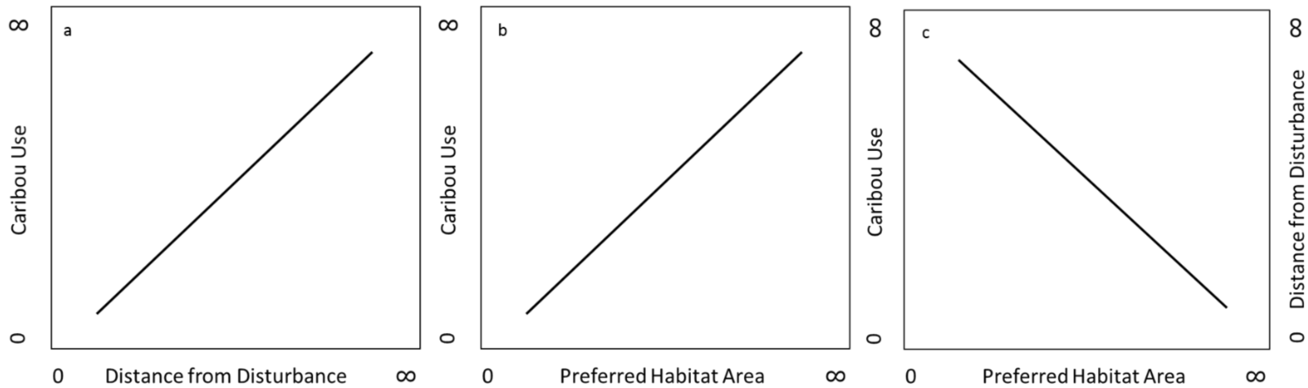
Animals should distribute themselves across space and time in accordance to resources that maximize fitness (i.e., survival and reproduction) (Fretwell and Lucas 1970; McLoughlin et al. 2006). Hence, animals should show preference for these resources and match the distribution of resource quality. Animals use sensory cues, such as taste, sight, and smell from the environment to guide decisions about which habitats and patches to use and experience to increase fitness. When animals encounter new environmental stimuli they may alter their perception of fitness risk based on previous experience in the same habitat or patch. This concept forms the ecological basis of sensory disturbance from development, where the new development stimuli represent the introduction of lights, smells, noise, infrastructure, and the presence of people to the landscape. In turn these stimuli are predicted to alter (reduce) the habitats and patches animals choose to use even though past experience indicates they are beneficial to occupy. The spatial extent of change in habitat use (animal distribution) is regarded as a zone of influence (ZOI) and is unknown for many animals and developments. At the population scale, ZOI effects may have the potential to alter the carrying capacity of the landscape and connectivity of resource use.

During the April 28 to May 2, 2017 Technical Session for the Whale Tail Project (Project), additional summary of caribou encounters with development ZOIs and residency time within ZOIs was requested by the Kivalliq Inuit Association (KivIA) and the Government of Nunavut (GN). Agnico Eagle Mines Limited (Agnico Eagle) made a commitment (number 8) to provide this analysis for the Beverly, Ahiak, Lorillard, and Wager Bay caribou herds on their spring, fall, and winter seasonal ranges. The following methods describe the approach used to assess a caribou ZOI for the Meadowbank Mine and Meadowbank All-weather Access Road (AWAR).

2.0 METHODS

Theoretically, geometric principles (e.g., πr^2) predict that caribou use of habitat would be positively correlated with the area associated with increasing distance from development (Figure 1a). This is because the area available for use increases with distance from disturbance. Thus, evaluating caribou habitat use (or caribou use) as a function of proximity to development alone is inherently biased by increasing availability of space. In a natural setting (i.e., no development influence) and no competition for resources, it would be expected that caribou use should be proportional to the amount of preferred habitat (Figure 1b). The amount of preferred habitat may also be positively correlated with distance from development because there is more area where it can occur. Without standardizing use to be conditional on the spatial amount and distribution of preferred habitat (or available area), one might incorrectly conclude that more common caribou presence (or abundance) away from development is evidence of avoidance when it may really be a function of habitat availability. To sufficiently predict avoidance requires a significant interaction between caribou use and preferred habitat availability (Figure 1c), and should indicate lower use than preferred habitat availability based on how preferred habitat is distributed relative to development. Failure to detect a significant interaction means that the relationship between caribou use and preferred habitat is similar across distances, and that the y-intercept has changed by a systematic factor such as time, across the range distances. This type of result does not necessarily support an avoidance hypothesis.

Figure 1: Predictions of Caribou use Relative to the Amount of Available Area (a), Preferred Habitat Area (b), and the Interaction Between Development Proximity and Preferred Habitat Selection Assuming an Avoidance Response (c)



2.1 Collar Data

Since 1996, satellite telemetry has been used to describe movements of numerous barren-ground caribou herds across their annual ranges. For many of the herds in Nunavut and the Northwest Territories, initially as few as four transmitting collars were deployed in 1996, after which time the number of collars has varied among years (Golder 2017). In general, the caribou satellite data were based on a duty cycle that varied from approximately every 7 days to every 1 day, and became more frequent during more recent years.

Starting in 2006, transmitters were also programmed to transmit at 1-day intervals to better describe post-calving movements. In 2009, the frequency of locations was increased to approximately every three hours during the summer to autumn period. When multiple locations were obtained for an individual caribou during a single day, the best location each day was used as classified by on-board collar software.

To support the analyses requested by KivIA and GN, the GN committed to provide Agnico Eagle with collar data for the Ahiak, Beverly, Lorillard, and Wager Bay caribou herds. On behalf of the GN, Caslys Consulting Ltd. (Caslys) provided collar location data for the Ahiak (2008 to 2017), Lorillard (1998 to 2017), and Wager Bay (1999 to 2017) herds and seasonal range definitions (Table 1). Data for the Ahiak and Beverly herds provided by GN were incomplete and required a separate request of Beverly caribou herd and pre-2008 Ahiak herd collar data from the Government of the Northwest Territories (GNWT). The GNWT provided the Beverly and Ahiak collar data on June 23, 2017.

Table 1: Seasonal Range Length for the Ahiak, Beverly, Lorillard and Wager Bay Caribou Herds Considered in the Assessment

Herd	Spring (days)	Fall (days)	Winter (days)
Ahiak	Apr 6 to Jun 12 (67)	Sep 22 to Dec 15 (115)	Dec 16 to Apr 5 (110)
Beverly	Apr 10 to Jun 5 (56)	Sep 12 to Dec 15 (125)	Dec 16 to Apr 9 (114)
Lorillard	Apr 5 to May 28 (53)	Sep 22 to Dec 15 (115)	Dec 16 to Apr 4 (109)
Wager Bay	Apr 1 to May 29 (58)	Sep 22 to Dec 15 (115)	Dec 16 to Mar 31 (105)

Inspection of the raw collar data indicated sources of error. Some of the same individuals were assigned to more than one herd (Beverly/Ahiak and Ahiak) and different individuals were assigned to the Ahiak herd by GN and GWNT for the same years. To remedy these issues only Ahiak data from the GNWT data were used because it was complete in temporal extent. For individuals assigned to more than one herd, the first herd assignment was maintained and duplicates were removed (i.e., the locations of the same individuals assigned to two herds). Finally, all individuals assigned to Beverly/Ahiak by the GNWT were assigned to “Beverly” to satisfy the requested analysis on the Beverly caribou herd.

For each herd, the number of collared caribou-years for individuals that intersected the regional study area (RSA; defined by a 50 km radius around the Meadowbank Mine and AWAR), and the temporal extent of collar data provided by GN and GNWT are presented in Table 2. The number of collar-years available to evaluate seasonal ZOIs for Ahiak and Beverly herds are inadequate. For spring and winter seasons there are no baseline occurrence of collared caribou within 50 km of the Meadowbank Mine and AWAR, and there are two or no collar-years for the fall season. This suggests a low degree of interaction with the Meadowbank Mine and AWAR by these herds. Any effects detected for the Lorillard and Wager Bay herds would overestimate effects on the Ahiak and Beverly herds.

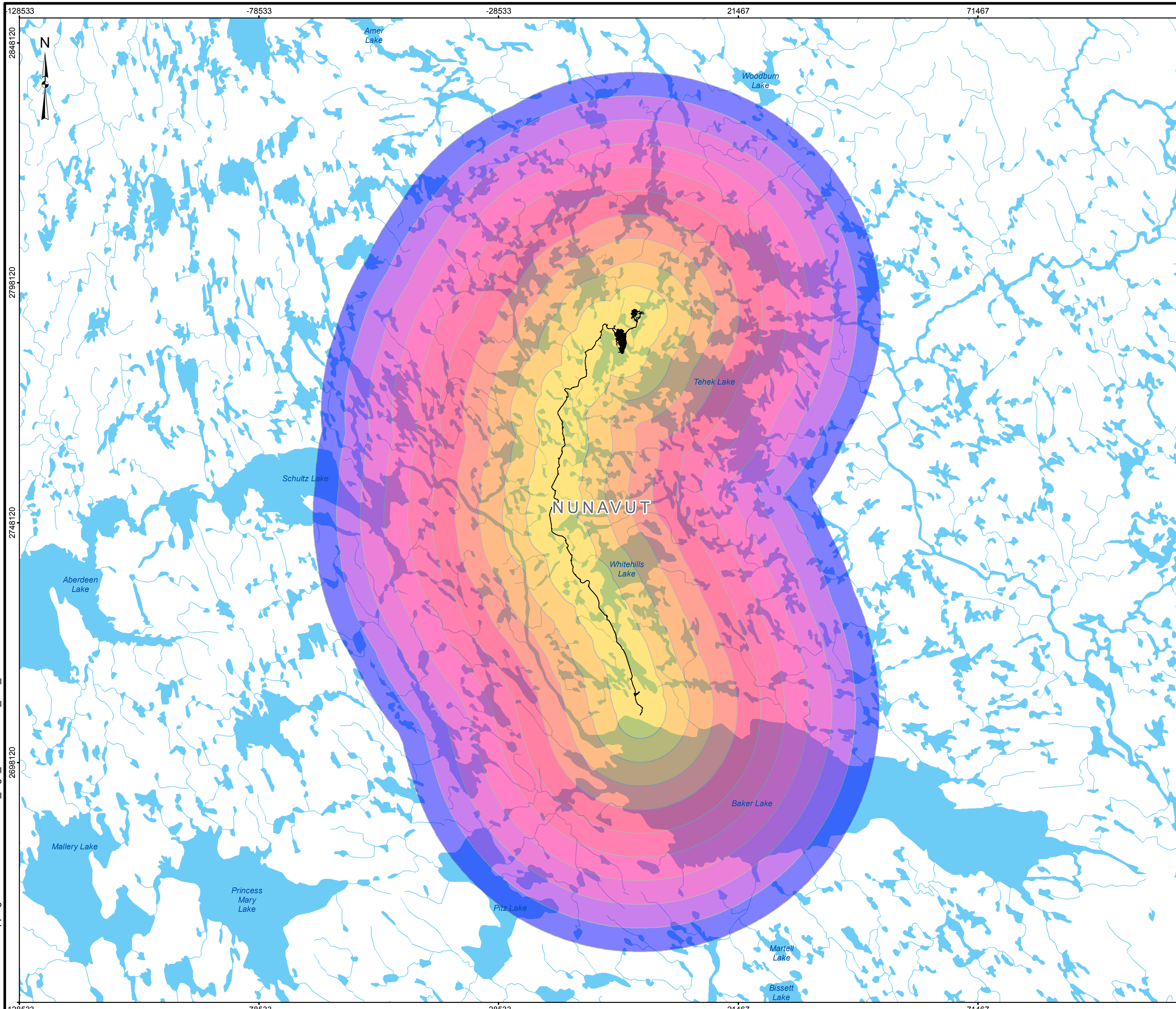
Table 2: Caribou Collar-Years Available Among Herds, Seasons and Phases (Baseline and Development) in the Regional Study Area

Herd	Spring		Fall		Winter		Year Range
	Baseline	Development	Baseline	Development	Baseline	Development	
Ahiak	0	1	2	2	0	1	2003 to 2017
Beverly	0	1	0	0	0	0	1997 to 2017
Lorillard	3	29	23	29	10	5	1998 to 2006, 2011 to 2017
Wager Bay	2	8	12	7	13	1	1999 to 2006, 2009 to 2013, 2015 to 2017

Note: Collar data for Lorillard and Wager Bay herds provided by Caslys Consulting Ltd., May 5, 2017. Collar data for Beverly and Ahiak herds provided by the Government of the Northwest Territories, June 23, 2017.

A similar problem is likely to occur with Lorillard and Wager Bay herds for the spring and winter seasons because there are five or less caribou-years contributing to either baseline or development phases (Table 2). The combined Lorillard and Wager Bay data for fall have the largest and most similar caribou-years available for baseline and development effects estimation. The Lorillard and Wager Bay collared caribou data for the spring, fall and winter seasons were carried forward for ZOI analysis without specifying herd-level effects (i.e., herd data were pooled). Although no statistical analyses were completed for Ahiak and Beverly herds, collar data from all caribou herds by ZOI distance buffer (or ZOI buffer) area are shown graphically for each response variable (see below) in Appendix A.

Within a GIS platform, movement paths were created per animal and year by joining segments (distance intervals or partial movement paths) of successive locations. Because the frequency of satellite collar locations has increased during the last eight years, the number of segments between successive locations for each animal has also increased. Sequential 5 km buffer areas (e.g., 5 km, 10 km, 15 km…50 km) within the RSA were created around the Meadowbank Mine and AWAR (Figure 2). Each buffer represents a hypothetical ZOI.



LEGEND

WATERCOURSE

MEADOWBANK MINE AND ALL-WEATHER ACCESS ROAD

WATER BODY

MEADOWBANK MINE DISTANCE ZONE

5 km

10 km

15 km

20 km

25 km

30 km

35 km

40 km

45 km

50 km

REFERENCE

1. BASE DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

DATUM: NAD 83 PROJECTION: CANADA LAMBERT CONFORMAL CONIC

25 0 25

KILOMETRES

PROJECT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED:
MEADOWBANK DIVISION
WHALE TAIL PIT PROJECT

TITLE

SEQUENTIAL ZONE OF INFLUENCE BUFFER AREAS AROUND MEADOWBANK MINE AND ALL-WEATHER ACCESS ROAD

Golder Associates

PROJECT		1658927	FILE No.	
DESIGN	DC	29 Jun. 2017	SCALE AS SHOWN	REV. 0
GIS	JE	07 Jul. 2017	**FIGURE 2**	
CHECK	DC	07 Jul. 2017		
REVIEW	JV	07 Jul. 2017		

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The Kivalliq Ecological Land Classification Atlas was used to identify the availability and distribution of seasonally preferred habitats in the RSA. The land cover types considered to be preferred by caribou in the analysis are presented in Table 3 and were based on results of resource selection function (RSF) models of Bathurst collared caribou (Johnson et al. 2005; Golder 2016) and experienced opinion. For the fall season, forb tundra was included because forbs and mushrooms offer an alternative forage to lichen for caribou. Wet graminoid was also added as a spring preferred habitat. In spring, caribou migrate across frozen lakes to reach calving areas and wet graminoid habitat is found in the areas adjacent to lakes. Because caribou select similar habitats during winter and spring, these seasons were combined. To our knowledge, there are no RSF results available to describe habitat preferences for the caribou herds under consideration in the current analysis. It is unknown how well habitat selection described for one barren-ground caribou herd can be broadly applied to other herds but this represents the best information available. The area of preferred habitat occurring in each ZOI distance buffer was standardized by dividing by the associated area of each ZOI buffer. This provided an index of seasonal preferred habitat concentration associated with each ZOI buffer.

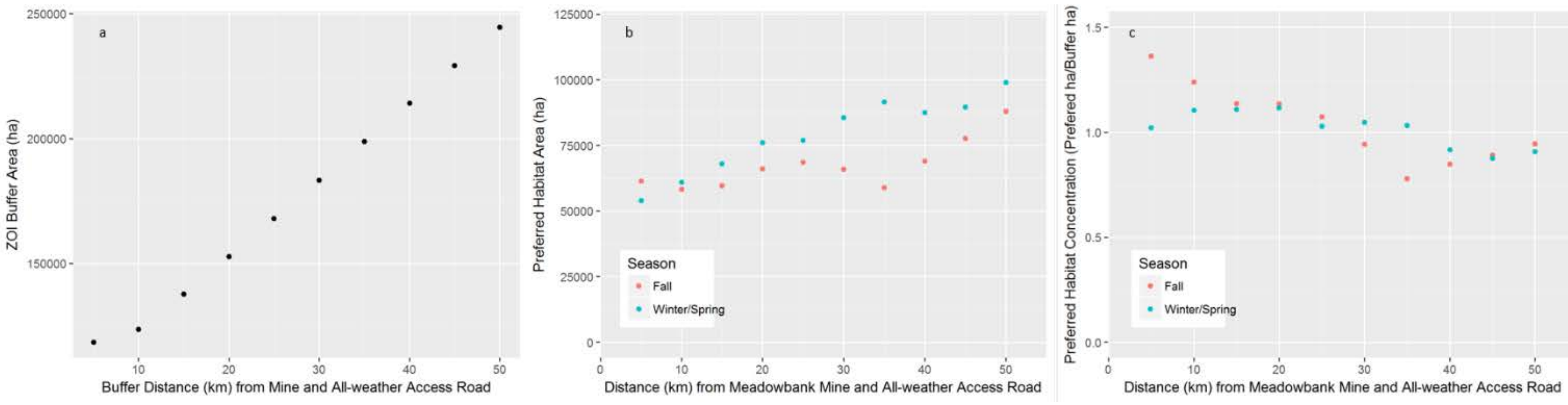
Table 3: Seasonal Preferred Habitats Considered in the Analysis

Season	Land Cover[a]	Source
Fall	Graminoid/Heath Tundra	Johnson et al. (2005)
	Heath tundra	
	Heath upland	
	Heath upland/rock complex	
	Lichen Tundra	
	Graminoid tundra	
	Forb tundra	experienced opinion
Winter/Spring	Heath tundra	Golder 2016
	Lichen tundra	
	Shrub tree complex	
	Tree	
	Tree lichen complex	
	Water (frozen lakes)	
	Wet graminoid	experienced opinion

[a] Kivalliq Ecological Land Classification Atlas.

As expected the available area in each ZOI distance buffer significantly increased ($r = 0.99$, $P < 0.01$) with distance from the Meadowbank Mine and AWAR (Figure 3a). The absolute amount of fall and winter/spring preferred habitats also increased (Figure 3b). Relative to the absolute available area, the concentration of preferred seasonal habitats has a significant negative association with distance from the Meadowbank Mine and AWAR for fall ($r = -0.88$, $P < 0.01$) and spring/winter ($r = -0.80$, $P < 0.01$) (Figure 3c). In other words, there is significantly more per unit area of preferred seasonal habitats closer to the Meadowbank Mine and AWAR than at further distances.

Figure 3: Spatial Distribution of Available Area (a) and Seasonal Preferred Habitat Area (b) and Preferred Habitat Concentration (c) in the Regional Study Area



Spearman correlation was used to validate whether caribou locations showed a significant positive association with standardized preferred habitat. This was accomplished by summing and standardizing the number of baseline collar locations across herds by ZOI buffers and comparing values of standardized preferred habitat in each of the ZOI buffer areas (n = 10 buffer areas). A significant positive association was detected for winter (r = 0.78, P = 0.01) but not for spring (r = -0.02, P < 0.52) and fall (r = 0.28, P < 0.21). Because standardized winter preferred habitat was the only preferred habitat index supported by location data, the standardized seasonal preferred habitat variable was not used in statistical models and was replaced by ZOI distance buffer. Inclusion of both ZOI buffer and standardized seasonal preferred habitat concentration variables would cause redundancy in models because they are highly autocorrelated.

Caribou collar location data from the Lorillard and Wager Bay (and Ahiak and Beverly [Appendix A]) herds within the RSA were intersected with the hypothetical ZOI buffers and habitat layers and assigned to baseline (pre-2007) and development (2007 to 2017) phases. The distribution of habitat use by caribou was measured using two response variables. This included the number of individual collared caribou present and the amount of time spent by individual caribou in each of the hypothetical ZOI buffers for the spring, fall and winter seasonal ranges (based on location dates). The two variables were standardized as proportions. For example, if two collared caribou were present in the RSA and one was present in the 5 km ZOI buffer then the proportion of use (or occurrence) assigned to this ZOI buffer was 0.5 (1 divided by 2). This calculation was repeated for each ZOI buffer through time. When no caribou occurred in the RSA, the value for each ZOI buffer was set at zero. Standardizing occurrence as a proportion of total collared caribou observed controlled for the varying number of collared caribou in each herd through time. The proportion of collared caribou occurrence in each ZOI buffer area was then divided by the proportion of ZOI buffer area relative to the RSA. This standardized the proportion of caribou occurrence to unit area to avoid bias from the increasing amount of available area with increasing distance from the Meadowbank Mine and AWAR (Figure 2a).

For each individual caribou, the amount of time spent in each ZOI buffer was measured as the duration of movement paths in that ZOI buffer relative to the total time the animal resided in the RSA. By standardizing the response, each individual contributed to the mean value equally by accounting for the within caribou variation in amount time spent in the RSA. Similar to occurrence, amount of time in each ZOI buffer was standardized to the proportion of ZOI buffer area (i.e., ZOI buffer area relative to RSA). A negative binomial distribution was assumed for this analysis.

In the absence of a covariate indexing the distribution of preferred seasonal habitat, baseline data on caribou occurrence and amount of time in ZOI buffers was assumed to follow the distribution of preferred habitat on the landscape because Meadowbank Mine and the AWAR were not present. An avoidance ZOI requires the detection of a significant interaction between distance and development phase, with a unique positive slope for the caribou response variables. A full-factorial design of season by ZOI buffer (i.e., distance as a categorical variable) would generate 61 model parameters and would be unlikely supported given the number of collar-years available (i.e., sample size is approximately two animals per number of model parameters). Instead ZOI buffer distance was treated as an integer and linear regression was used to statistically evaluate whether patterns in the response variables are consistent with the ZOI prediction.

Candidate models were used to assess changes in the distributions of standardized occurrence and amount of time in ZOI buffers relative to the explanatory variables temporal phase (baseline versus development), season, and ZOI distance buffer (or distance). Descriptions of candidate models, assumptions and inferences are provided in Table 4. Akaike's Information Criterion, corrected for small sample size (AICc; Burnham and Anderson 2002), was used to evaluate the relative support for candidate models, where the model with lowest AICc score provides the most parsimonious fit (i.e., most plausible explanation) to the data. For candidate models with a phase variable, baseline was set as the reference parameter (i.e., the y-intercept). As described in Table 4, detection of a ZOI is conditional on a significant interaction between the phase variable and distance. Visual examination of the pattern was used to determine whether the interaction indicates lower caribou occurrence or the amount of time in ZOI buffers for the development phase relative to baseline phase and in which ZOI buffer(s) this pattern is observed. A significant interaction may also occur if occurrence or amount of time spent in ZOI buffers is higher during the development phase but this pattern does not support an avoidance effect. An intercept-only model was also considered as a benchmark of explanatory value, where models with some explanatory value will have greater relative support than the intercept-only model. All statistical analyses were completed using linear models in R (RDCT 2016).

Table 4: Candidate Models Evaluating Indirect Effects to Caribou by Meadowbank Mine and All-weather Access Road

Model	Assumptions	Inference
Phase*Distance*Season	Baseline differs from development by distance and season	Significant interaction between phase and distance requires further evaluation for negative effect adjacent to infrastructure during application
Phase*Distance	Baseline differs from development by distance No differences among seasons	Significant interaction between phase and distance requires further evaluation for negative effect adjacent to infrastructure during application
Phase*Season	Baseline differs from development by season No difference among distances	Seasonal occurrence in RSA varies through time No distribution effect from Mine or AWAR
Season	Distribution varies by season Baseline and application phases are similar Distances are similar	Occurrence in RSA varies seasonally No difference among baseline and development phases or distances (no distribution effect from Mine or AWAR)
Intercept-only	Distribution is constant over space and time	No difference among phases, distance (no effect from Mine or AWAR), or seasons

* denotes an interaction term between explanatory variables

If a statistically significant interaction between the explanatory variables development phase and distance variables is supported, then ZOI buffer area estimates were compared to determine whether a ZOI showing avoidance is present. The ZOI extent was inferred qualitatively from sequential buffer areas (distances) where development phase selection is statistically less (i.e., 95% confidence intervals [CI] do not overlap mean values) than the baseline phase through pair-wise comparison of baseline versus development estimates for the same distance. This type of comparison is analogous to the quasi-piecewise regression approach used by Boulanger et al. (2012), which sequentially evaluates one distance unit at a time. Importantly, detected differences that did not occur sequentially with distance do not provide strong and sufficient evidence for a ZOI. A pattern of avoidance should be consistently present at closer proximities to sensory disturbance to support an avoidance hypothesis. For example, if caribou occurrence during the development phase is lower at 20 km than the baseline phase but similar at 5 km, 10 km or 15 km buffer areas, then inferring a 20 km ZOI would not be supported biologically, given that the magnitude of sensory disturbance should be greater closer to sources of noise, dust, lights and smells.

3.0 RESULTS

Model selection results for standardized occurrence and amount of time spent in ZOI buffers by pooled Lorillard and Wager Bay caribou are presented in Table 5. Results for caribou occurrence indicate that the model of a three-way interaction between phase, distance and season variables has the lowest AICc score and provides the best fit to the data relative to other candidate models. Three models ranked higher than the null (intercept-only) model and, therefore provide some explanatory value. The top model indicates that phase differences in spatial patterns of standardized occurrence differ between baseline and development phases and among the fall, spring, and winter seasons for Lorillard and Wager Bay caribou.

For standardized amount of time in ZOI buffers, results indicated that the model with a three-way interaction between phase, distance and season variables had the lowest AICc score and provides the best fit to the data relative to other candidate models. Two models ranked higher than the intercept-only model and therefore provide some explanatory value. The top model indicates that the amount of time Lorillard and Wager Bay collared caribou spend in the ZOI buffers varies between baseline and development phases and by season.

Table 5: Model Selection Results Evaluating Variation in Caribou Use and Duration

Response Variable	Model name	Log likelihood	K	ΔAICc	AICc weight
Standardized Occurrence in each ZOI buffer	Phase*Distance*Season	-1323.0	13	0.0	0.9
	Phase*Season	-1331.3	7	3.9	0.1
	Season	-1352.7	4	40.5	0.0
	Null	-1363.4	2	58.0	0.0
	Phase*Distance	-1362.5	5	62.3	0.0
Standardized Amount Time in each ZOI buffer	Phase*Distance*Season	-1873.6	13	0.0	1.0
	Phase*Distance	-1896.6	5	29.9	0.0
	Null	-1902.4	2	35.5	0.0
	Season	-1902.2	4	39.1	0.0
	Phase*Season	-1901.5	7	43.6	0.0

* denotes an interaction term between explanatory variables.

Regression coefficients for the most parsimonious models for occurrence and amount of time spent in ZOI buffers are presented in Table 6. For the top-ranked model of caribou occurrence, the intercept, phase, phase by winter, and phase by distance by winter interactions were statistically different from zero. All other coefficients were not significant. For top-ranked model of standardized amount of time, the regression coefficients for the intercept, phase, distance, phase by distance, and phase by winter and phase by distance by winter interactions were statistically different from zero. All other coefficients were non-significant. Distance-based estimates of caribou occurrence and amount of time spent in ZOI buffers are presented in Figures 4 and 5.

Table 6: Model Selection Results Evaluating Linear Fits to Variation in Caribou Use and Amount Time of ZOI Buffers

Response Variable	Effect	Estimate	SE	t-value	P-value
Standardized Occurrence in each ZOI buffer	**Intercept[(a)]**	**6.30**	**0.79**	**7.92**	**<0.01**
	Phase	**2.38**	**1.18**	**2.01**	**0.04**
	Distance	0.02	0.03	0.84	0.40
	Season (spring)	-2.29	1.54	-1.49	0.14
	Season (winter)	1.48	1.15	1.29	0.20
	Phase*Distance	-0.05	0.04	-1.21	0.23
	Phase*Season (spring)	3.31	1.98	1.67	0.09
	Phase*Season (winter)	**-9.88**	**1.87**	**-5.29**	**<0.01**
	Distance*Season (spring)	0.05	0.05	0.94	0.35
	Distance*Season (winter)	-0.06	0.04	-1.49	0.14
	Phase*Distance*Season (spring)	-0.06	0.06	-1.00	0,32
	Phase*Distance*Season (winter)	**-0.19**	**0.06**	**3.17**	**<0.01**
Standardized Amount Time in each ZOI buffer	**Intercept[(a)]**	**-0.60**	**0.15**	**-4.02**	**<0.01**
	Phase	**0.58**	**0.20**	**2.87**	**<0.01**
	Distance	**0.02**	**0.01**	**4.01**	**<0.01**
	Season (spring)	0.10	0.42	0.24	0.81
	Season (winter)	**0.48**	**0.25**	**1.94**	**0.05**
	Phase*Distance	**-0.02**	**0.01**	**-2.80**	**<0.01**
	Phase*Season (spring)	0.06	0.46	0.14	0.89
	Phase*Season (winter)	**-5.07**	**0.88**	**-5.74**	**<0.01**
	Distance*Season (spring)	-0.01	0.01	-0.24	0.81
	Distance*Season (winter)	-0.01	0.01	-1.85	0.06
	Phase*Distance*Season (spring)	-0.01	0.01	-0.15	0.88
	Phase*Distance*Season (winter)	**0.13**	**0.02**	**5.86**	**<0.01**

* denotes an interaction term between explanatory variables.

[(a)] The phase variable value of baseline was set to be the reference (i.e., y-intercept value).

Statistically significant results shown in bold.

Figure 4: Predictions of Standardized Caribou Occurrence (± 95%CI) by Season and Phase Based on the Top-model in Table 6

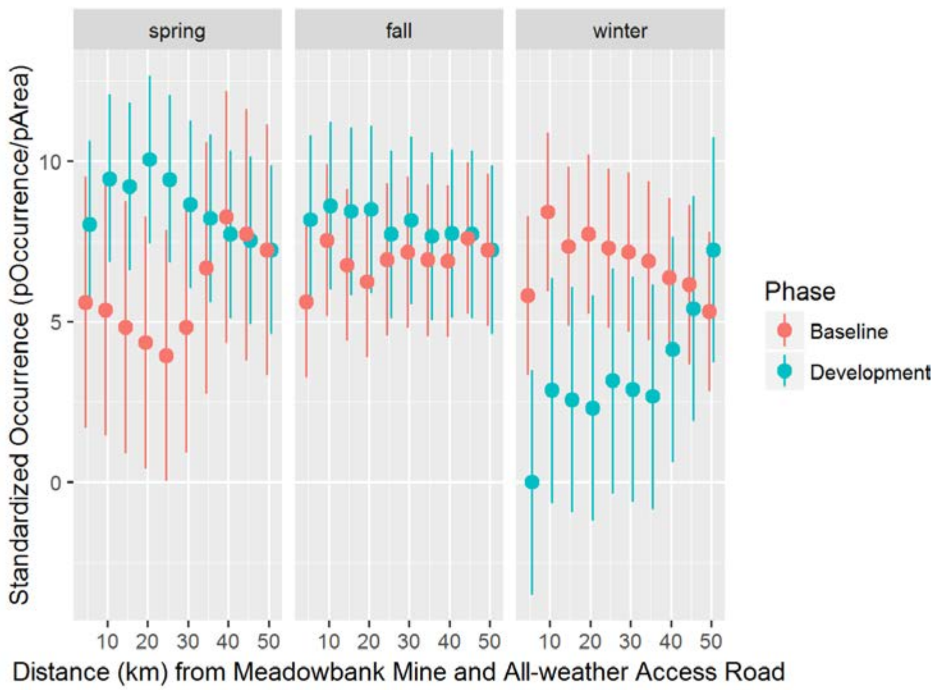
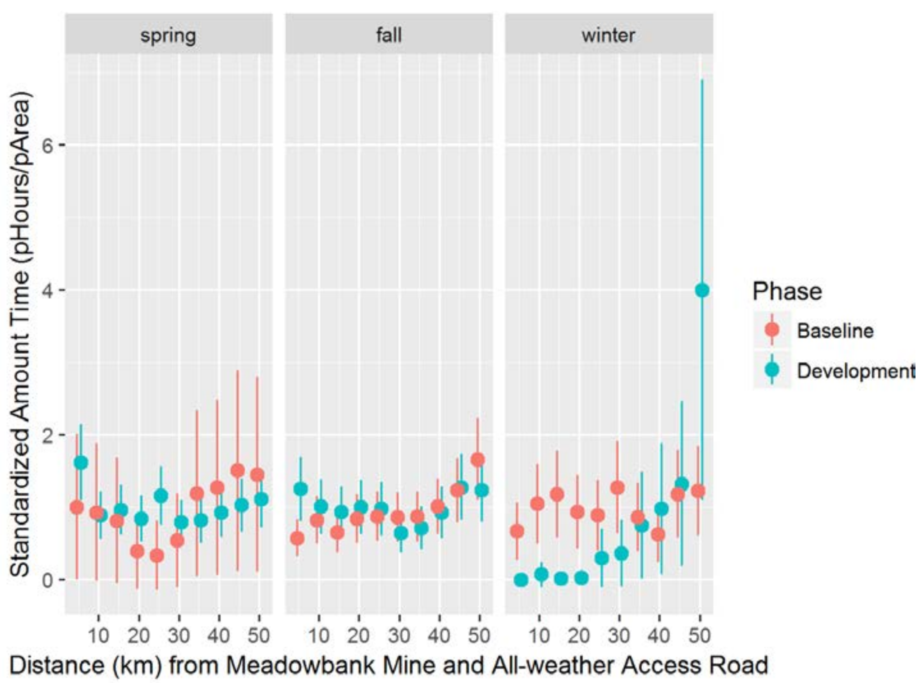


Figure 5: Predictions of the Standardized Amount Time Caribou Spend (± 95%CI) by Season and Herd and Phase Based on the Top-model in Table 6



Spring and Fall Seasons

For spring and fall seasons, distance-based patterns indicate that caribou occurrence and amount of time in ZOI buffers is similar or higher for the development phase than during baseline (Figure 4 and Figure 5). Patterns for fall and spring suggest pooled Lorillard and Wager Bay caribou did not alter their distribution or behaviour to avoid Meadowbank Mine and the AWAR. Because there was no evidence supporting that caribou avoided Meadowbank Mine and AWAR in spring or fall, no pair-wise comparisons were completed for these seasons. The results also indicate that the variation in response variables is higher during the baseline phase of the spring season, which is likely a result of the smaller and unbalanced number of collar-years available (Table 2).

Winter Season

In contrast to the observed patterns for spring and fall, caribou occurrence and amount of time in ZOI buffers during winter indicate development phase values were lower near the Mine and AWAR, suggesting seasonal-specific avoidance relative to baseline (Figure 4 and Figure 5). Thus, qualitative pair-wise comparisons of differences between mean values of baseline and development phases by hypothetical ZOI buffer areas were completed.

Caribou occurrence and amount of time in successive ZOI buffers during the development phase appears to be significantly less through the 35 km and 30 km buffers, respectively, and similar thereafter based on the degree of overlap of 95% CIs with mean values. Similar to the spring baseline, the variation in caribou occurrence during the baseline and development phases is large and is likely partially related to the low number of collar-years in the RSA during winter (Table 2). Also, the amount of variation in residency time during the development phase increases with distance, which is in contrast to what would be expected if more caribou were spending more of their time at further distances. The duration of collard caribou that resided in the RSA during winter in the development phase ranged from 54 to 2,438 hours, so there is a high degree of individual-level heterogeneity in time of occupancy of the RSA among the few individual caribou observed. The large amount of variation is not surprising given that five collared caribou contributed six caribou-years during this phase and season (Table 2).

4.0 CONCLUSIONS

The analysis evaluated whether caribou use (measured as two response variables) within 50 km of the Meadowbank Mine and AWAR have changed relative to baseline conditions using collared data from the pooled Lorillard and Wager Bay herds. Beverly and Ahiak collar data were considered but provided inadequate sample sizes for statistical analyses. Although collar data from these herds were insufficient to contribute to the analysis, the data indicate that there is likely little interaction between the Beverly and Ahiak herds and the Meadowbank Mine and AWAR, which was also identified in the ZOI encounter rate and residency study (Golder 2017). Thus, indirect effects from the Meadowbank Mine and AWAR would be influencing a small portion of the Beverly and Ahiak herds and infrequently. Should a greater degree of interaction be observed in the future, a future ZOI analysis could include Ahiak and/or Beverly collared caribou data but whether post-development patterns exhibit avoidance could not be referenced to baseline because there are insufficient baseline data.

The results indicated that caribou are not avoiding areas adjacent to the Meadowbank Mine and AWAR relative to baseline during the spring and fall seasons, which except for spring baseline, were the periods when collar presence in the study area was highest for Lorillard and Wager Bay herds. These results are generally consistent with other observations of caribou at the Mine site, which indicate that caribou are most frequently observed in the winter (44% of observations), fall (34% of observations), and spring (16% of observations).

These data are collected as part of the AWAR surveys. However, during the winter, pooled Lorillard and Wager Bay caribou occurrence and amount of time in ZOI buffers during the development phase was lower than baseline up to 35 km from the Meadowbank Mine and AWAR. Caribou occurrence and amount of time in the RSA during the winter was the lowest of any of the three seasons, which does differ from the AWAR observation data. Analysis of encounter rates and residency also indicated that the Meadowbank Mine and AWAR are currently outside of the winter range of Wager Bay caribou and at the periphery for the Lorillard herd (Golder 2017). Baseline variation in occurrence and the amount of time using habitats during winter may be due to low numbers of collared caribou and how much overlap there is between the study area and the seasonal ranges of Lorillard and Wager Bay caribou herds (Golder 2017). Caribou presence in the RSA may not be regular and depend on other climatic and biological factors that vary through time such as herd size (Virgl et al. 2017).

Overall, there is uncertainty in conclusions regarding caribou avoidance of the Meadowbank Mine and AWAR for both spring and winter, which is related to the low numbers of collared caribou interacting with the RSA during spring baseline (n = 5 caribou-years) and winter development phases (n = 6 caribou-years). Based purely on sample size, fall was the most likely season for detecting an effect with a moderate level of certainty. If caribou avoidance of Meadowbank mining activities was occurring, it would be expected to be evident in all seasons, but this was not the case. Considering the seasonal patterns in sample size and observed changes in response variables in this study, there does not appear to be strong evidence for indirect effects to caribou due to sensory disturbance from the Meadowbank Mine and AWAR.

Report Signature Page

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APPENDIX A

Seasonal Patterns of Standardized Occurrence and Amount Time Spent in the Meadowbank Mine and All-weather Access Road 50 km Study Area for the Ahiak, Beverly, Lorillard, and Wager Bay Collared Caribou

Figure A1: Mean (± SD) and Point Values of Seasonal Standardized Occurrence in the Meadowbank Mine and All-weather Access Road Regional Study Area of Collared Caribou from the Ahiak Caribou Herd, 2003 to 2017

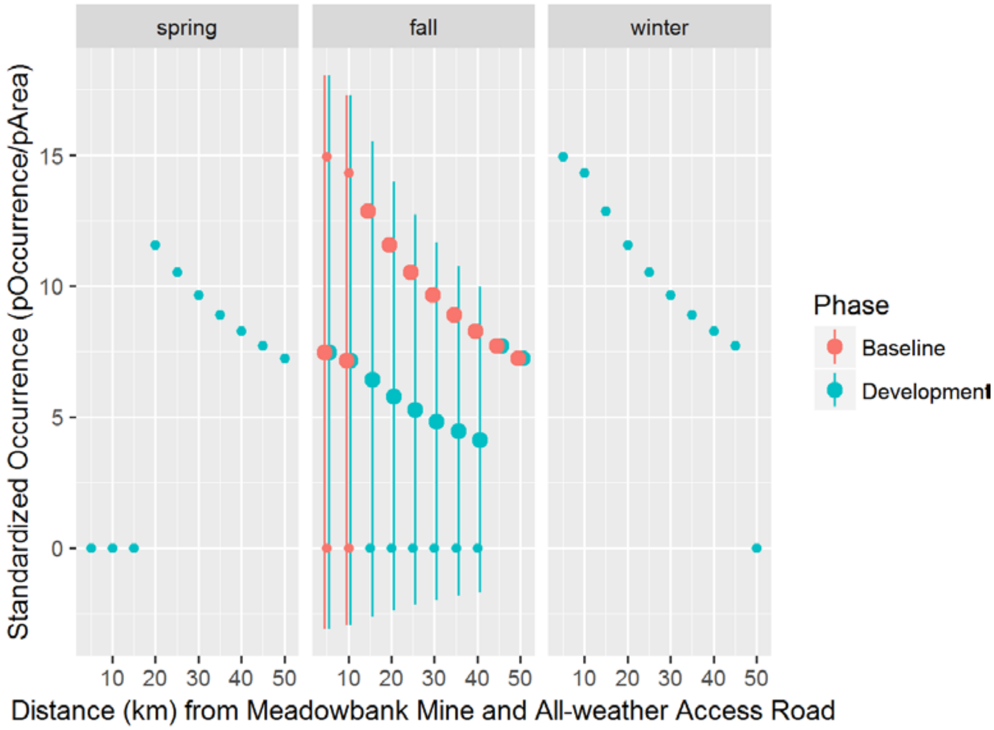


Figure A2: Mean (±SD) and Point Values of Seasonal Standardized Amount Time in the Meadowbank Mine and All-weather Access Road Regional Study Area of Collared Caribou from the Ahiak Caribou Herd, 2003 to 2017

Figure A3: Mean (± SD) and Point Values of Seasonal Standardized Occurrence in the Meadowbank Mine and All-weather Access Road Regional Study Area of Collared Caribou from the Beverly Caribou Herd, 1997 to 2017

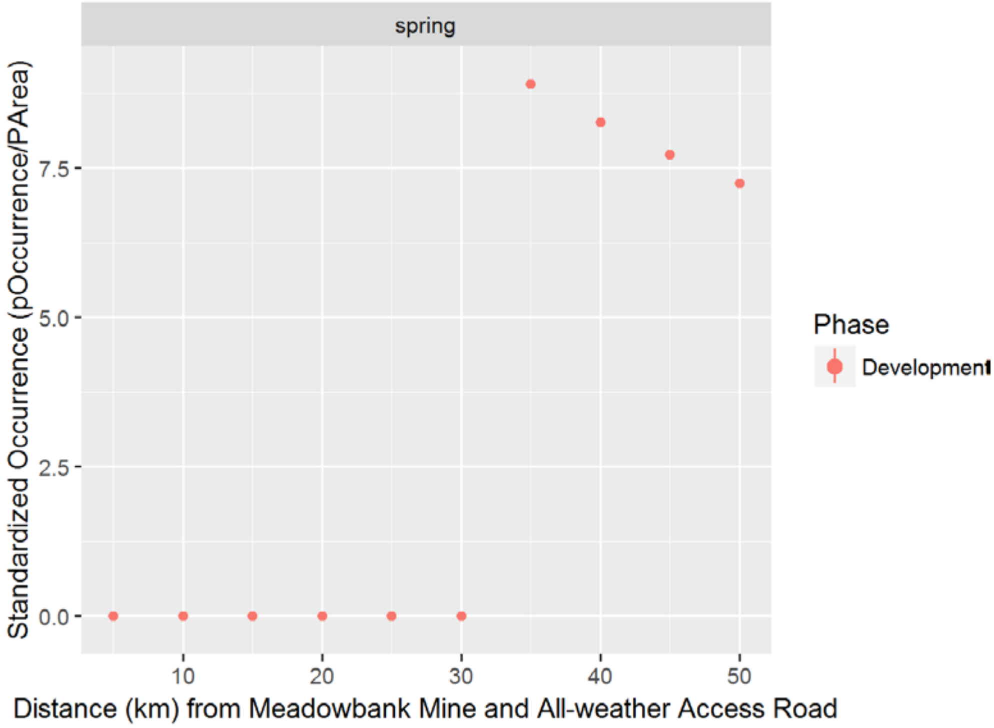


Figure A4: Mean (± SD) and Point Values of Seasonal Standardized Amount Time in the Meadowbank Mine and All-weather Access Road Regional Study Area of Collared Caribou from the Beverly Caribou Herd, 1997 to 2017

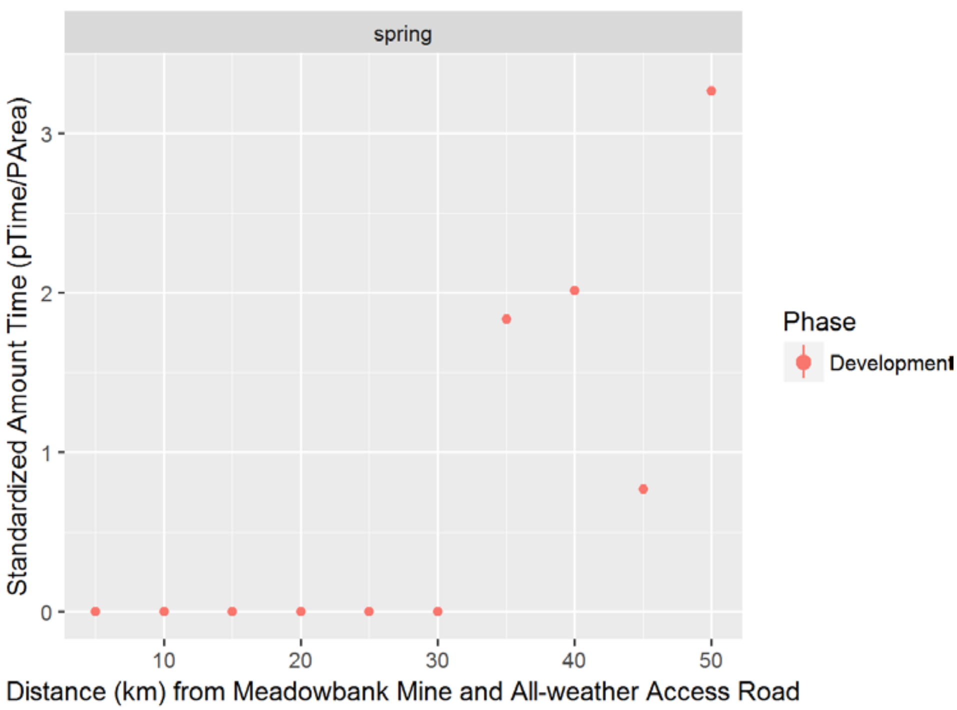


Figure A5: Mean (±SD) and Point Values of Seasonal Standardized Occurrence in the Meadowbank Mine and All-weather Access Road Regional Study Area of Collared Caribou from the Lorillard Caribou Herd

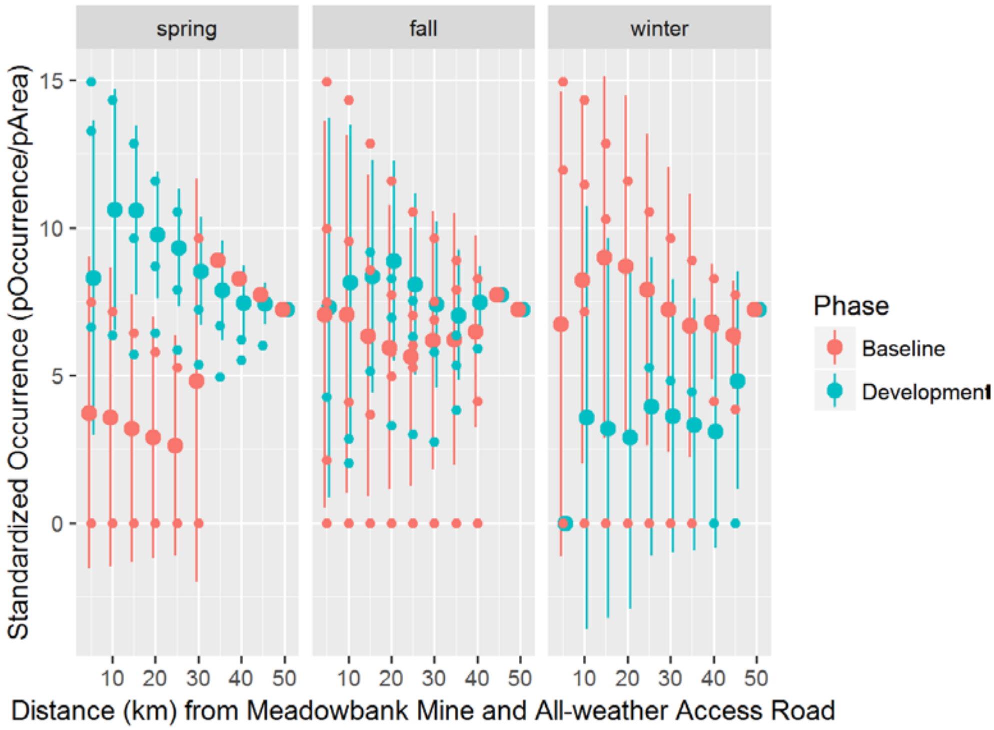


Figure A6: Mean (±SD) and Point Values of Seasonal Standardized Amount Time in the Meadowbank Mine and All-weather Access Road Regional Study Area of Collared Caribou from the Lorillard Caribou Herd, 1998 to 2017

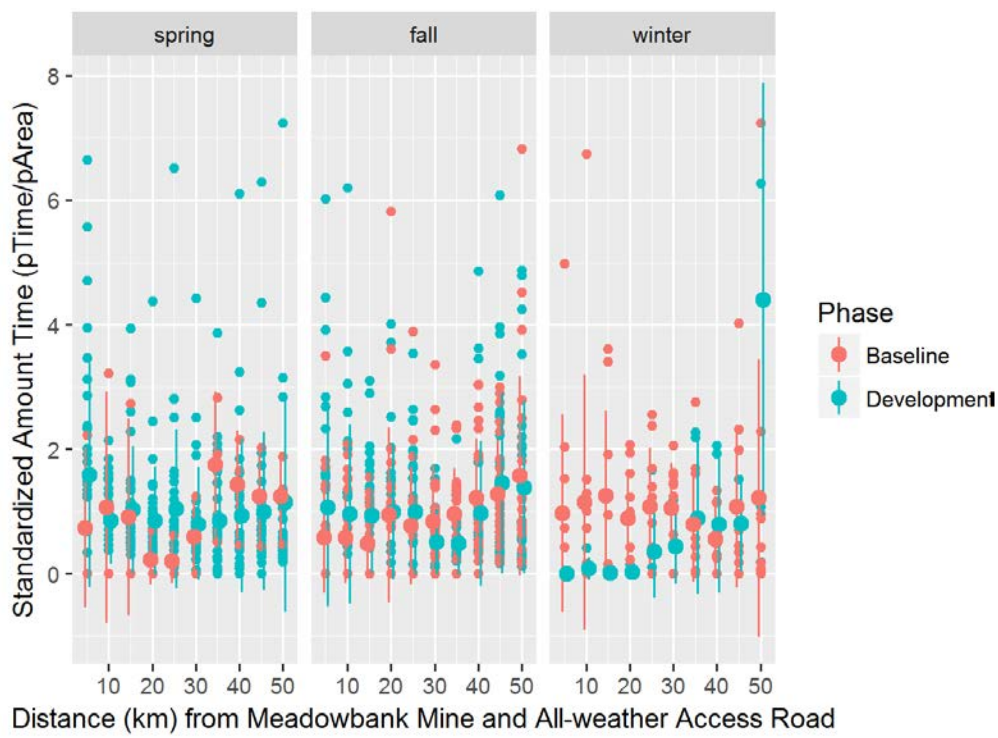


Figure A7: Mean (± SD) and Point Values of Seasonal Standardized Occurrence in the Meadowbank Mine and All-weather Access Road Regional Study Area of Collared Caribou from the Wager Bay Caribou Herd, 1999 to 2017

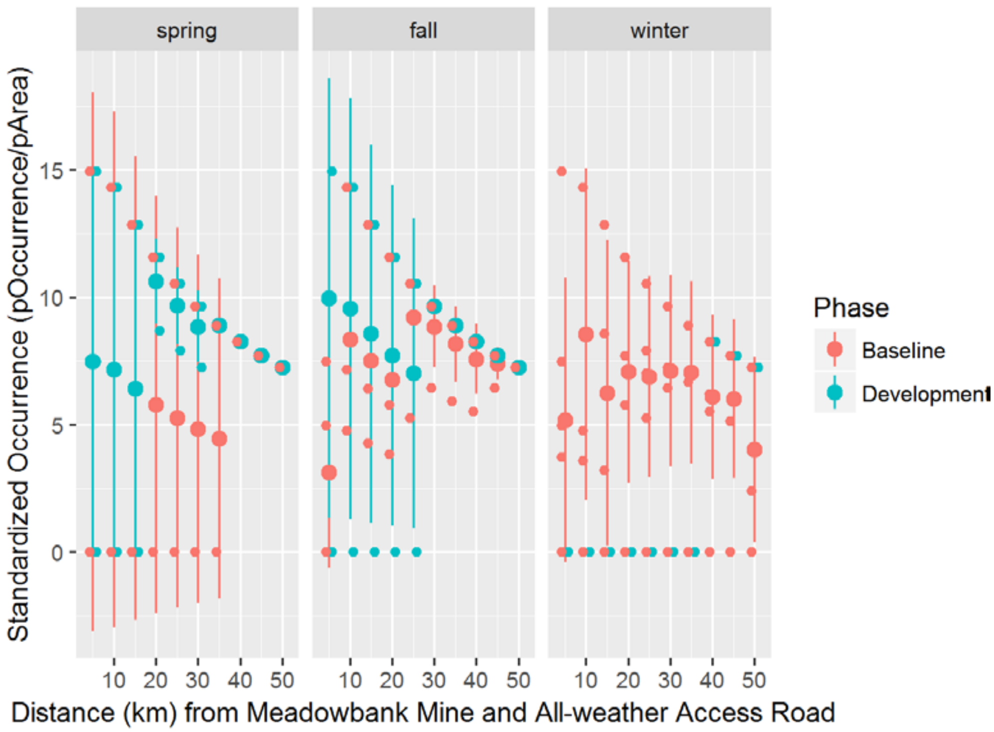
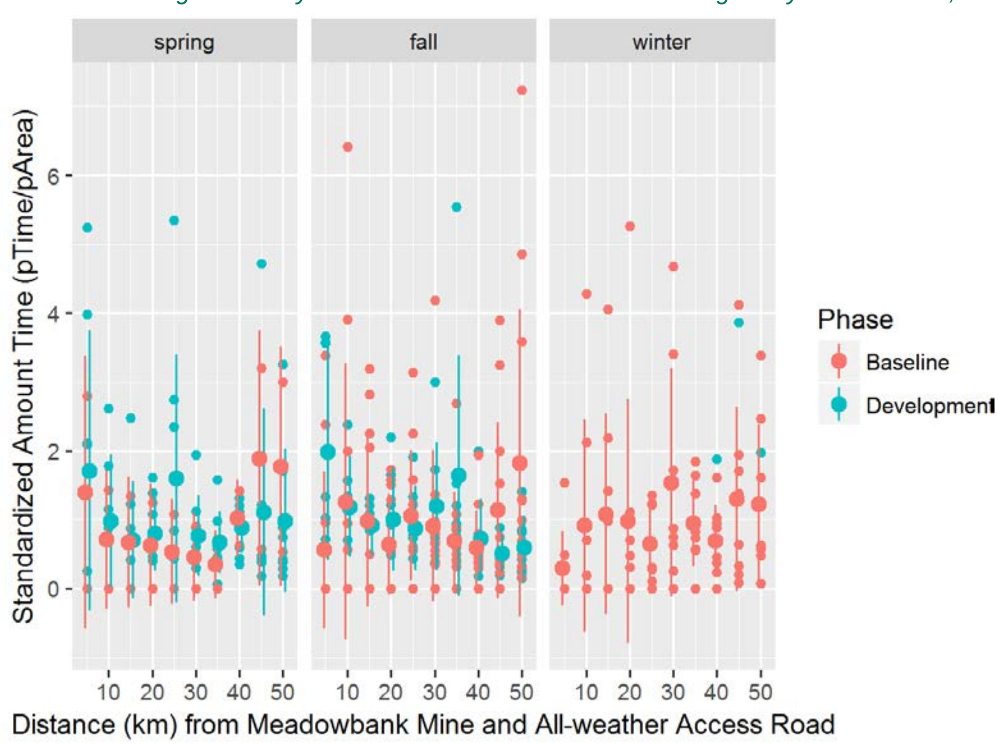


Figure A8: Mean (± SD) and Point Values of Seasonal Standardized Amount Time in the Meadowbank Mine and All-weather Access Road Regional Study Area of Collared Caribou from the Wager Bay Caribou Herd, 1999 to 2017



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