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Erin Kelly, Ph.D.
Deputy Minister, Environment and Natural Resources
Government of Northwest Territories
PO Box 1320
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Yellowknife, NT X1A 2N2

10 November 2022

Dear Ms. Kelly:

Subject: DDMI Caribou Zone of Influence Analysis Plan

Diavik Diamond Mines (2012) Inc. (DDMI) is pleased to submit its Caribou Zone of Influence (ZOI) Analysis Plan to the Government of Northwest Territories Environment and Natural Resources (GNWT-ENR) for review. This submission is to meet Condition 1 of the GNWT-ENR Minister's July 15, 2022 letter regarding DDMI's Tier 3 Wildlife Management and Monitoring Plan.

If you have any questions regarding the attached submission, please contact the undersigned at kofi.boa-antwi@riotinto.com or Kyla Gray (867-445-4922; kyla.gray@riotinto.com) at your convenience.

Yours sincerely,

Kofi Boa-Antwi
Superintendent, Environment

Cc: Kari VanGeffen, GNWT-ENR
Kathy Unger, GNWT-ENR
Lara Mountain, GNWT-ENR

Attachment: Diavik Caribou Zone of Influence Analysis Plan

DIAVIK DIAMOND MINES (2012) INC.

TECHNICAL MEMORANDUM

DATE 28 October 2022

Reference No. 21452119-2409-TM-Rev1-5000
DIAVIK WORK PLAN No. 698
DIAVIK PO No. 3104601458

TO Kofi Boa-Antwi
Diavik Diamond Mines (2012) Inc.

FROM Daniel Coulton and John Virgl

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CARIBOU ZONE OF INFLUENCE ANALYSIS PLAN

1.0 INTRODUCTION

The approved Tier 3 Wildlife Management and Monitoring Plan (WMMP) for the Diavik Mine, operated by Diavik Diamond Mines (2012) Inc. (DDMI), requires zone of influence (ZOI) monitoring for caribou (DDMI 2022) that refers to guidance provided by the Zone of Influence Technical Task Group (ZOITTG 2021). Condition 1 of the WMMP approval requires the proposed approach for this analysis be provided to the Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT-ENR) for review prior to commencing this analysis and reporting (GNWT-ENR 2022). This document provides the proposed ZOI analysis approach for review to meet Condition 1.

The Zone of Influence Technical Task Group guidelines (ZOITTG 2021) recommend that caribou ZOI analyses consider statistical methods that can detect how caribou habitat selection changes as distance from disturbance changes, such as segmented regression (e.g., Johnson and Russell 2014, Boulanger et al. 2021), binned distance intervals (e.g., Polfus et al. 2011, Plante et al. 2018), generalized additive models (e.g., Fortin et al. 2013), or polynomial regression (e.g., Johnson et al. 2005). The ZOITTG (2021) provides an example that follows the approach of Boulanger et al. (2021), which the GNWT has also referenced to DDMI as the approach to use. As such, WSP Golder and DDMI requested that the GNWT-ENR provide the statistical code used to estimate ZOIs in Boulanger et al. (2021) with the intention of WSP Golder applying Boulanger et al.'s segmented regression methods to estimate annual ZOI at the Diavik-Ekati mine complex (i.e., Diavik and Ekati mines). The GNWT-ENR did not provide access to the statistical code; thus, WSP Golder proposes to use binned distance intervals (e.g., Polfus et al. 2011, Plante et al. 2018) to estimate annual caribou ZOI for DDMI's 2022 Wildlife Management and Monitoring Report (WMMR). The binned distance interval approach ('the approach') is presented below.

2.0 PROPOSED ANALYSIS APPROACH

As discussed in a virtual meeting with DDMI and GNWT-ENR (29 August 2022), the approach will consider telemetry data from collared Bathurst caribou, available from November 2006 to 31 December 2022 and provided by the GNWT-ENR. Older telemetry data will not be considered as part of the approach because Boulanger et al. (2021) determined that telemetry data from 1996 to 2006 are insufficient to generate annual ZOI estimates. Beverley/Ahiak collar data will be included since they have also interacted with Diavik (WSP Golder 2022a).

The approach will consider guidelines established by the ZOITTG (2021) and methods available in the scientific literature (e.g., Polfus et al. 2011, Plante et al. 2018, Boulanger et al. 2021), and is partitioned into four main steps:

- caribou seasonal range estimation;
- base habitat model extrapolation;
- zone of influence modelling; and
- post-hoc comparisons.

Each analysis step is described in further detail below.

2.1 Caribou Seasonal Range Estimation

Seasonal ranges for the Bathurst herd will first be delineated for four seasons of interest (spring [1 May – 14 June], post-calving [15 June – 31 August], autumn/rut [1 September – 31 October], and winter [1 November – 30 April]) using a 95% kernel density estimate (Virgl et al. 2017, Boulanger et al. 2021), for each year of the study period, resulting in up to 51 annual-seasonal ranges (i.e., 17 years × 4 seasons/year). Prior to range estimation, all telemetry data will be screened to remove erroneous locations and duplicate records, and to identify missing information. Annual-seasonal ranges will be reviewed to determine the degree of overlap with the Diavik-Ekati mine complex and to screen out ranges that are predicted to have negligible interactions (i.e., no potential ZOI estimate) between caribou and the mine complex. Each annual-seasonal range will be screened and included in the ZOI analyses if the range contains both Diavik and Ekati mines and at least 90% of the study area (i.e., the 2012 aerial survey study area). For example, if the post-calving range for a given year does not completely contain the Diavik-Ekati mine complex, then no ZOI analysis would be completed. The intent is to not confound detecting a change in distribution with a lack of exposure to sensory disturbance from the Diavik-Ekati mine complex. All annual-seasonal ranges that comply with these thresholds will be considered for ZOI analyses, which are described below in further detail.

2.2 Base Habitat Model Extrapolation

The ZOITTG guidelines (2021) recommend that as part of ZOI analyses, telemetry data be used to derive a base habitat model (e.g., resource selection function [RSF]) that accounts for natural variation in caribou distribution. Boulanger et al. (2021) used telemetry data for collared Bathurst caribou to estimate a RSF (i.e., base habitat model) to account for habitat selection around the Diavik-Ekati mine complex. The approach proposed here will extrapolate Boulanger et al.'s (2021) base habitat model to the temporal boundary of analysis (i.e., November 2006 - December 2022).

Specifically, Boulanger et al.'s (2021) base habitat model was applied for summer to early winter (i.e., 15 July – 30 November), 2009 to 2017, but excluded a large portion of the winter season (i.e., 1 December – 30 April) when caribou more recently have a higher likelihood of occupying the Lac de Gras area and therefore being influenced by the Diavik-Ekati mine complex (Golder 2018, 2019, 2020, 2021; WSP Golder 2022b). Telemetry data available from November 2006 to December 2008 and January 2018 to December 2022 will also be included in the analysis. Thus, Boulanger et al.'s (2021) base habitat model will be extrapolated for the four seasons described in Section 2.1 and broader temporal boundary, under the assumption that it can be used to predict caribou habitat selection for these differing seasonal boundaries and temporal window (i.e., 2006–2022). It is also assumed that the base habitat model reflects selection by Beverley/Ahiak caribou. Habitat and temporal data will be acquired from public repositories to extrapolate the Boulanger et al. (2021) base habitat model, including habitat data summarized in Table 1 and the CircumArctic *Rangifer* Monitoring and Assessment (CARMA) data (Russell et al. 2013). Following methods described in Boulanger et al. (2021), telemetry data will be used to constrain habitat available to caribou within the vicinity of the Diavik-Ekati mine complex and annual-seasonal ranges will be used to assign the binary 'in range' temporal covariate to telemetry locations (Table 1 from Boulanger et al. 2021). Seasons will also be assigned to telemetry locations based on the conditions described in Section 2.1 above. Using the base habitat model beta coefficients summarized in Table A4 of Boulanger et al.'s (2021) Supplementary Information, spatial data (Table 1), and temporal covariates, relative caribou habitat selection will be predicted within available habitats, for up to four seasons each year.

Table 1: Spatial Habitat Data Required to Extrapolate the Boulanger et al. (2021) Base Habitat Model

Spatial Data	Covariate	Potential Source(s)
Land cover classification	Bedrock-boulder	▪ Land Cover Map of Northern Canada ▪ Earth Observation for Sustainable Development (EOSD) land cover classification ▪ 1:250 000 National Topographic Data base maps from Natural Resources Canada
	Moss-lichen	
	Tundra	
	Tussock	
	Sedge wetland	
	Low shrub	
	Tall shrub	
	Treeline herb	
	Forest	
	Esker	
	Water	
Normalized difference vegetation index (NDVI)	NDVI	▪ United States Geological Survey (USGS)

2.3 Zone of Influence Modelling

Predicted relative habitat selection, resulting from the extrapolation of Boulanger et al.'s (2021) model, will be used to compare observed caribou use (i.e., number of caribou telemetry locations) to predicted caribou use (based on the base habitat selection model) at various distances from the Diavik-Ekati mine complex for each year and selected season (Plante et al. 2018). If observed use is lower than predicted use at a particular distance from the mine complex, this will indicate avoidance by caribou. If observed use is higher than predicted use, this will indicate selection by caribou. The ZOI will be inferred as the distance at which habitat use is no longer influenced by disturbance (e.g., relative selection ratios switch from negative to positive; Plante et al. 2018).

Binned distance intervals will be calculated from the Diavik-Ekati mine complex (e.g., 1, 2, 3 km from mine complex) and will be biologically informed by caribou movement rates and the distribution of caribou with respect to the mine complex. For instance, ZOITTG guidelines (2021) indicate that if there is little variation in distribution of caribou relative to distance from mine complex, ZOI estimates will be imprecise and likely non-significant. Thus, distance categories will be informed based on the smallest distance interval where there is still a reasonable sample size of caribou locations for modelling and estimating ZOIs. Approval Condition 2 indicates that annual ZOI estimates should be reported for all intervening years in which an adequate sample is achieved (GNWT-ENR 2022). Model convergence will be interpreted as an adequate sample to generate a ZOI estimate.

2.4 Post-Hoc Comparisons

The ZOITTG (2021) recommends that natural and anthropogenic covariates be considered and/or included in caribou ZOI analyses. Post-hoc comparisons between the magnitude of annual-seasonal ZOIs and annual-seasonal indices of mine activity, including the number of full-time equivalents (FTEs), total material moved (TMM), fuel consumption, length of roads, and number of active open pits (Table 2), will be used to meet this recommendation. FTEs have been used previously as an index of mine activity and/or sensory disturbance to caribou and are positively correlated with number of flights (Golder 2017). Thus, FTEs will be used as a surrogate covariate for aircraft flights and people in camp (Table 2). Total material moved is assumed to be correlated with blasts, traffic levels, and fugitive dust deposition.

Post-hoc comparisons between the magnitude of annual-seasonal caribou ZOIs and natural factors that may be related to variation in ZOI estimates and/or caribou distribution will also be considered. Comparison will be made using correlation analysis. Proposed indices of natural factors include snow depth, snow melt rate, freeze-thaw events, drought, and insect harassment, to be selectively applied to applicable seasonal ZOI estimates. Consideration of these explanatory variables (i.e., indices of mine activity and natural factors) and their relationship with ZOIs is also a requirement of Condition 2 from ENR for approval of the 2021 WMMP. Snow melt rate, freeze-thaw events, snow depth, drought and insect harassment are all derived from the Modern Era Retrospective Analysis for Research and Applications (MERRA) dataset that overlaps with the Bathurst annual range (Russell et al. 2013). The approach assumes these MERRA variables will be provided by January 2023.

Table 2: Natural and Anthropogenic Covariates Proposed for Post-Hoc Comparisons

Covariate* [Surrogate]	Source
Anthropogenic	
Aircraft flights[a] [FTEs]	DDMI[b], ACDC[c]
Blasts[a] [TMM]	
Dust deposition [TMM]	
Fuel consumption[a]	
Full-time equivalents (FTEs)	
Total length of roads (km)	
Number of active open pits	
Total material moved (TMM)	
Traffic levels[a] [TMM]	
Natural	
Drought index	CARMA MERRA[d] (Russell et al. 2013)
Snow melt rate	
Freeze-thaw events	
Snow depth	
Insect harassment	

* Covariate data availability to be confirmed with ACDC.

a) Recommended for inclusion and/or consideration by the ZOITTG (2021).

b) DDMI = Diavik Diamond Mines (2012) Inc.

c) ACDC = Arctic Canadian Diamonds Corporation.

d) CircumArctic *Rangifer* Monitoring and Assessment (CARMA) Modern Era Retrospective Analysis for Research and Applications (MERRA).

3.0 CLOSURE

We look forward to working with DDMI and the GNWT on this project and we trust this analysis plan provides sufficient information for review. Please feel free to contact us if you have any questions and comments concerning this plan.

GOLDER ASSOCIATES Ltd.

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DWC/JAV/ca/ar

https://golderassociates.sharepoint.com/sites/140080/project files/6 deliverables/working/2409-tm-rev1-5000-zoi analysis plan/21452119-2409-tm-rev1-5000-zoi analysis plan 28oct_22 .docx

REFERENCES

Boulanger J, Poole KG, Gunn A, Wierzchowski J. 2021. Estimation of trends in zone of influence of mine sites on barren-ground caribou populations in the Northwest Territories, Canada, using new methods. Wildlife Biology wlb.00719. doi: 10.2981/wlb.00719.

DDMI (Diavik Diamond Mines (2012) Inc.). 2022. Diavik Diamond Mine Tier 3 Wildlife Management and Monitoring Plan, Version 1.3. October 2022.

Fortin, D., P-L Buono, A. Fortin, N. Courbin, C.T. Gingras, P.R. Moorcroft, R. Courtois, and C. Dussault. 2013. Movement responses of caribou to human-induced habitat edges lead to their aggregation near anthropogenic features. The American Naturalist 181:827-836.

GNWT-ENR (Government of the Northwest Territories, Department of Environment and Natural Resources). 2022. Conditional Approval of the Wildlife Management and Monitoring Plan for the Diavik Diamond Mine. July 15, 2022.

Golder (Golder Associates Ltd.). 2017. Analysis of Environmental Effects from the Diavik Diamond Mine on Wildlife in the Lac de Gras Region. Prepared for Diavik Diamond Mines (2012) Inc. by Golder Associates Ltd.

Golder (Golder Associates Ltd.). 2018. Diavik Diamond Mine 2017 Wildlife Monitoring Program. Prepared for Diavik Diamond Mines (2012) Inc. by Golder Associates Ltd.

Golder (Golder Associates Ltd.). 2019. Diavik Diamond Mine 2018 Wildlife Monitoring Program. Prepared for Diavik Diamond Mines (2012) Inc. by Golder Associates Ltd.

Golder (Golder Associates Ltd.). 2020. Diavik Diamond Mine 2019 Wildlife Monitoring Program. Prepared for Diavik Diamond Mines (2012) Inc. by Golder Associates Ltd.

Golder (Golder Associates Ltd.). 2021. Diavik Diamond Mine 2020 Wildlife Management and Monitoring Report. Prepared for Diavik Diamond Mines (2012) Inc. by Golder Associates Ltd.

Johnson, C.J., M.S. Boyce, R.L. Case, H.D. Cluff, R. Gau, A. Gunn, and R. Mulders. 2005. Cumulative effects of human developments on arctic wildlife. Wildlife Monograph 160:1–36.

Johnson CJ, Russell DE. 2014. Long-term distribution responses of a migratory caribou herd to human disturbance. Biological Conservation 177:52-63.

Plante S, Dussault C, Richard JH, Côté SD. Human disturbance effects and cumulative habitat loss in endangered migratory caribou. Biological conservation 224: 129-143.

Polfus JL, Hebblewhite M, Heinemeyer K. 2010. Identifying indirect habitat loss and avoidance of human infrastructure by northern mountain woodland caribou. Biological Conservation 144: 2637-2646.

Russell DE, Whitfield PH, Cai J, Gunn A, White RG, Poole K. 2013. Rangifer 33: 145-152.

Virgl JA, Rettie WJ, Coulton DW. 2017. Spatial and temporal changes in seasonal range attributes in a declining barren-ground caribou herd. Rangifer 37:31-46. doi 10.7557/2.37.1.4115.

WSP Golder. 2022a. Exploratory collared caribou movement analysis. Addendum to the Diavik Diamond Mine 2021 Wildlife Management and Monitoring Report. Prepared for Diavik Diamond Mines (2012) Inc. by WSP Golder. Edmonton, AB. June, 2022.

WSP Golder. 2022b. Diavik Diamond Mine 2021 Wildlife Management and Monitoring Report. Prepared for Diavik Diamond Mines (2012) Inc. by WSP Golder. Edmonton, AB. March, 2022.

ZOITTG (Zone of Influence Technical Task Group). 2021. Draft guidance for monitoring the zone of influence (ZOI) of anthropogenic disturbance on barren-ground caribou. Prepared by the Government of the Northwest Territories for the Zone of Influence Technical Task Group. January, 2021. Yellowknife, NWT, Canada.