15 August 2024

To: James Hodson;

Re: Barren-ground caribou movement and habitat selection analyses from telemetry data Report

Burgundy Diamond Mines Ltd. (Burgundy; Arctic Canadian Diamond Company Ltd.) is pleased to provide the Barren-ground caribou movement and habitat selection analyses from telemetry data for Ekati Diamond Mine Wildlife Effects Monitoring for your record.

This report addresses concerns about the effect of the Ekati Diamond Mine on caribou behaviour when the animals are within 30 km of the mine roads and mine infrastructure (including things like open pits, camps, waste rock storage areas, and settling ponds). More specifically, this report is a detailed analysis of radio-collar location data to examine the responses of caribou to mines and mine roads after accounting for the distribution of waterbodies, eskers, landcover categories (mostly vegetation types), and insect abundance.

After contributions from the workshop held on April 11, 2024, and subsequent discussions with the Government of the Northwest Territories, the Independent Environmental Monitoring Agency, and the Tłı̨chǫ Government to address comments received on the Online Review System, Burgundy addressed these comments and is now providing the final submission of the report on Barren-ground caribou movement and habitat selection analyses from telemetry data. Burgundy sincerely thanks everyone involved for their contributions to this report.

Burgundy trusts that you will find this information to be clear and informative. Please contact the Adam Scott at Adam.Scott@burgundydiamonds.com or undersigned William Liu at William.Liu@burgundydiamonds.com if you have any comments or questions.

William Liu

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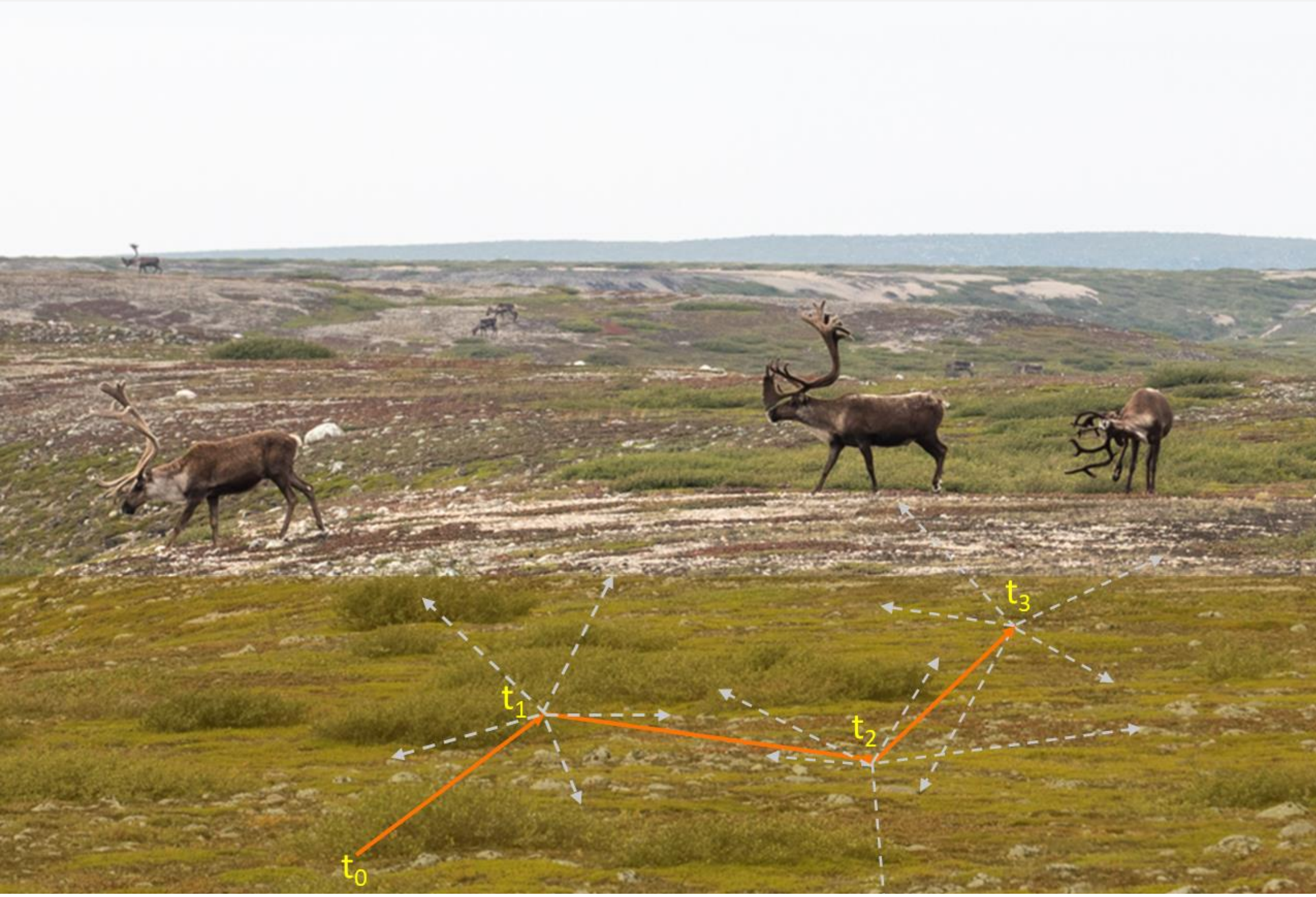

Barren-ground caribou movement and habitat selection analyses from telemetry data

Ekati Diamond Mine Wildlife Effects Monitoring

July 2024

Project No.: Arctic 22-04

PARAGON WILDLIFE RESEARCH AND ANALYSIS

Barren-ground caribou movement and habitat selection analyses from telemetry data

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Project No.: Arctic 22-04

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PLAIN LANGUAGE SUMMARY

The Wildlife Effects Monitoring Plan for the Ekati Diamond Mine that was in effect from 2017 to 2023 included a number of different monitoring and mitigation programs. One of those programs was a commitment to provide funding for the Government of the Northwest Territories' radio-collaring program for the Beverly and Bathurst caribou herds. Arctic Canadian Diamond Company Ltd. made a commitment to use the resulting data to examine the effects of the Ekati Diamond Mine on caribou behaviour.

This report addresses concerns about the effect of the Ekati Diamond Mine on caribou behaviour when the animals are within 30 km of the mine roads and mine infrastructure (including things like open pits, camps, waster rock storage areas, and settling ponds).

In 2021, the Independent Environmental Monitoring Agency (IEMA) summarized some of the movement data from the Beverly and Bathurst herds for animals within 30 km of the Ekati Diamond Mine and raised some questions requiring more detailed examination. The questions of interest were about local effects of mines and mine activity on caribou behaviour: essentially, how do caribou respond in time periods of less than a day to mining activities when caribou are close enough to sense the effect of the mine (for example, by sound, sight, scent, vibrations). The potential area around the Ekati and Diavik diamond mines where caribou might respond to sensory disturbances is large, and separate measurements for potential disturbances at each location in the area do not exist. Instead, the distance from the nearest point along a mine road and the nearest point to mine infrastructure was measured for every caribou location within 30 km. While the analyses can identify when animals preferred to be close to the mine (positive response to the mine) or avoided the mine (negative response to the mine), they do not tell us what specifically caused any of the observed responses.

Caribou are known to have seasonal preferences for habitat features. Earlier studies on the Beverly and Bathurst herds and on other migratory caribou have suggested or shown that roads, mine infrastructure, and mining activity can affect how caribou behave. This report is a detailed analysis of radio-collar location data to examine the responses of caribou to mines and mine roads after accounting for the distribution of waterbodies, eskers, landcover categories (mostly vegetation types), and insect abundance.

As responses may be different in different seasons and may be different for male and female caribou, the movements were examined separately for each sex in each season. The Beverly and Bathurst herds were initially considered for separate analyses, but the results supported combining data from the two herds.

The time period and the area included in the study

The goal was to understand caribou habitat selection and movement behaviour in short time intervals, so the years included in the study began with the winter of 2015-2016 when radio-collar locations collected once every 8-hours became available throughout the year for both the Bathurst and Beverly herds.

The radio-collar locations showed the large ranges used each year by the Beverly and Bathurst herds and those areas guided the selection of the study area. To define the regional study area, the ranges of both herds were considered and the area chosen is shown in Figure 1. The 212,000 km^2 area contains over 90% of all Bathurst herd locations collected between December 2015 and December 2022 and nearly 70% of Beverly herd locations for the same time period.

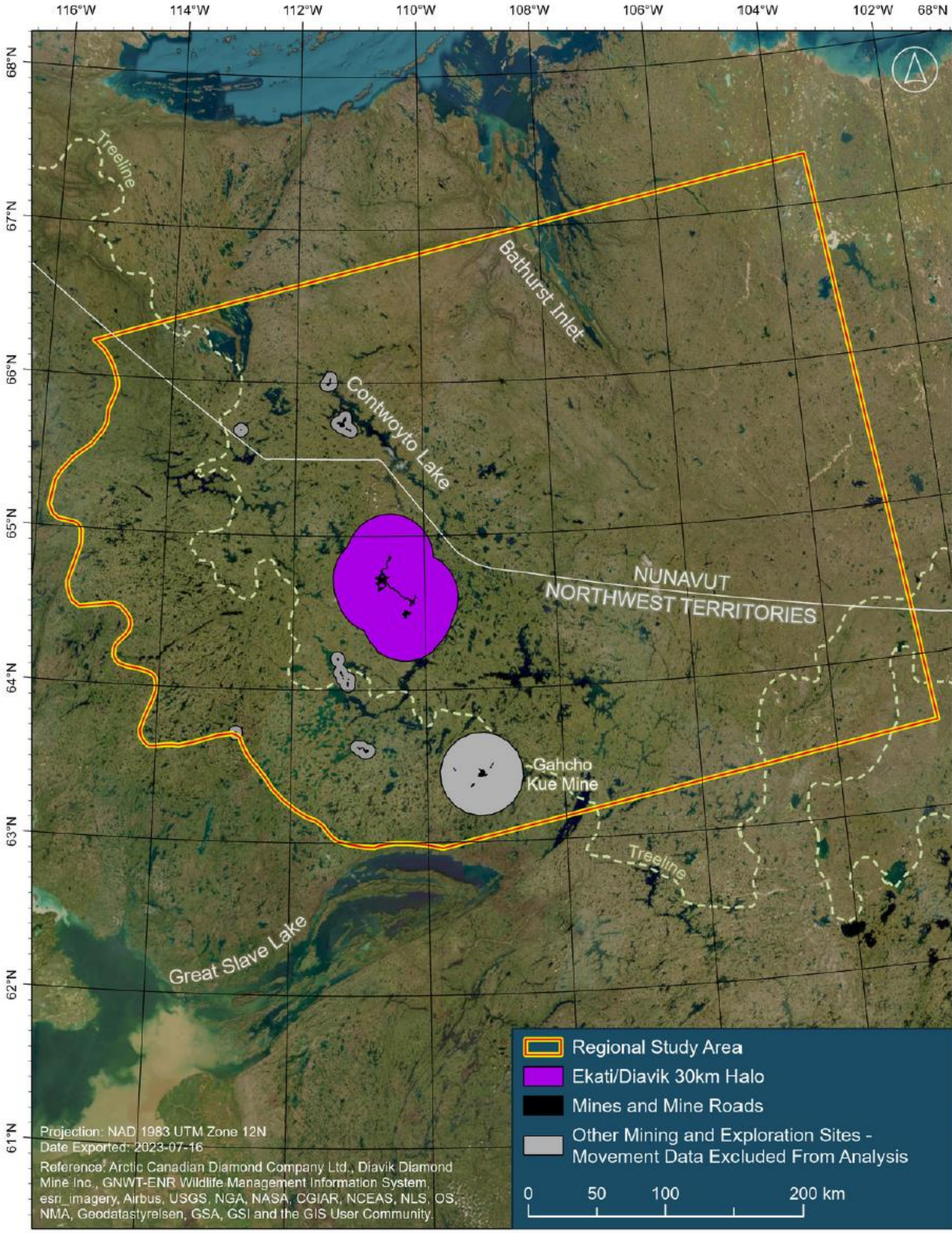

Figure 1: The areas containing caribou locations used in the analyses.

Understanding caribou habitat use when they are far from mines

Before trying to understand the effects of the Ekati and Diavik diamond mines on caribou behaviour, caribou locations were first used to determine how animals responded to natural environmental features when there were no mines nearby.

The locations from near the Gahcho Kué Diamond Mine and other mining and exploration sites (within the grey shapes on Figure 1) were excluded completely, while locations from within 30 km of the Ekati and Diavik diamond mines (the purple shape on Figure 1, the "Ekati/Diavik 30 km halo") were kept separate. All of the other locations from inside the regional study area were used to examine caribou habitat selection by each sex in each season when they were more than 30 km away from the mines.

Overall, there was a general pattern for caribou to prefer to be within about 1.3 km of a body of water, but not right next to it. In most seasons, both male and female caribou chose locations with higher amounts of tussock graminoid tundra and shrubs within 100 m. Of the seven seasons examined separately for males and females, all but one (female summer) showed that caribou made decisions about where to move over an 8-hour period using habitat information from the area within 100 m of their location as well as other habitat information within distances up to 4.0 km away (the farthest distance examined).

Predicting how caribou will select habitat when they are close to mines

Using the knowledge learned from how caribou responded to natural features away from the mines, the natural landcover features within 30 km of the mines were used to predict the value of the habitat to caribou if there were no mines present. When mapped, relative habitat value can be seen to differ across the study area near the mines, and also to differ between male and female caribou (Figure 2).

Testing how caribou change their 8-hour movement behaviour when they are close to mines

Caribou locations from within the Ekati/Diavik 30 km halo were used to test if the predictions were correct, or if caribou habitat selection was affected by how close the location was to the mine roads or the mine infrastructure. Like the other analysis, this was done separately for each season for male and for female caribou. Calving season and post-calving season were not included for this analysis because there were too few locations recorded near the mines in those seasons. For most seasons of the year, analysis of locations collected 8-hours apart showed that both male and female caribou selected habitat the same way they did in the large regional study area – there was no difference in habitat selection related to how close they were to mine roads or mine infrastructure. The habitat predicted to be selected based on caribou behaviour in the regional study area was strongly selected.

In the same analyses, the data were tested to see if how far a caribou moved in 8 hours depended on how close it was to a mine road or other mining infrastructure. For most of the year (early December to the beginning of June [winter and spring migration] and again from mid-August to mid-October [late summer and pre-rut]) there was no difference in how far female caribou moved that was related to how close they were to the mine or mine roads. The same lack of movement response was also true for male caribou in late summer and pre-rut.

In summer (early July to mid-August) and the rut (the last half of October) both male and female caribou moved shorter distances when they were closer to mine infrastructure. The length of movement steps was also shorter near mine features for females after the rut and for males from mid-April to early June (spring migration). The only season where the response was specifically to mine roads was for male caribou, who increased their movement step length when they were near mine roads in the winter.

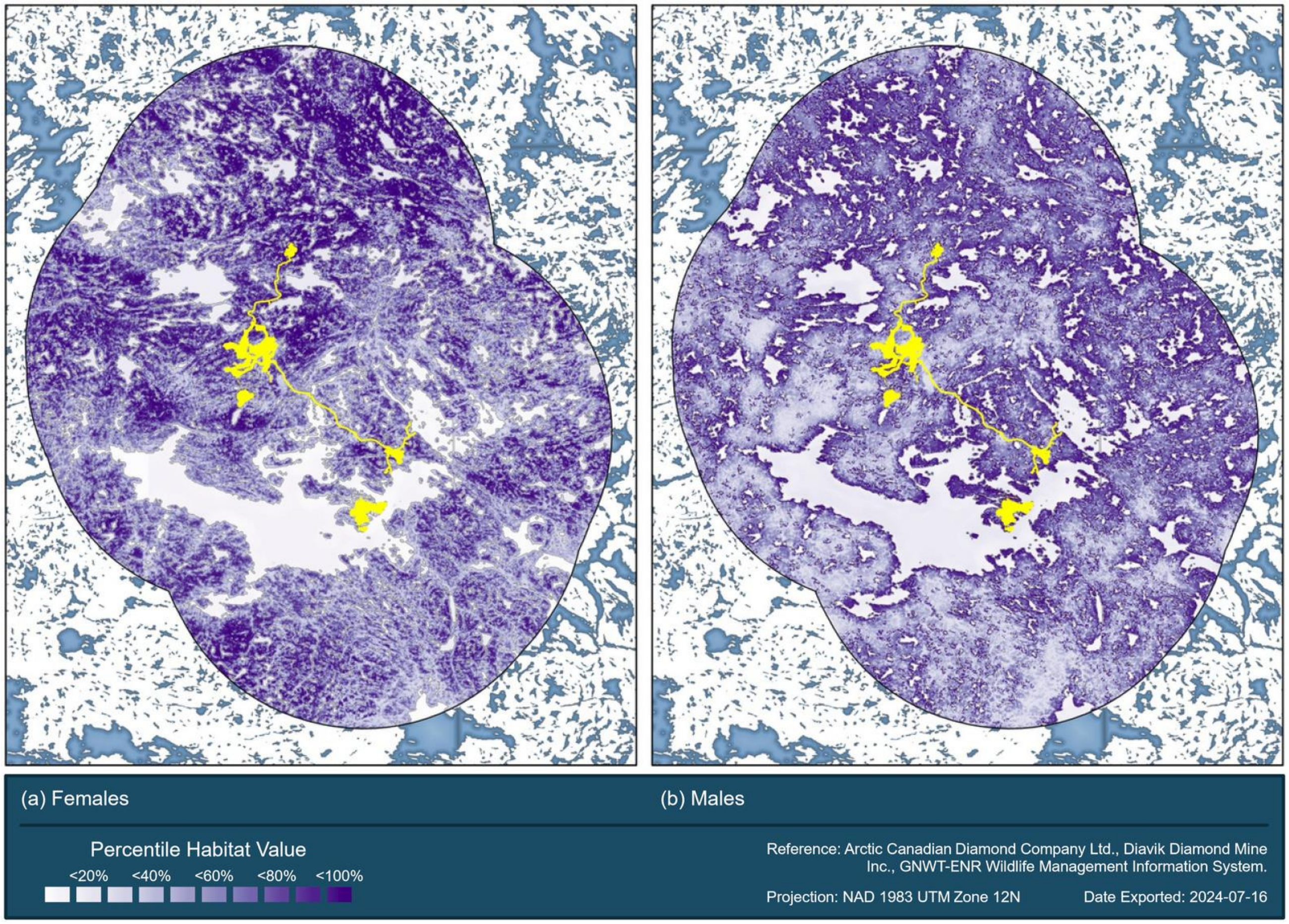

Figure 2: The predicted late summer habitat value in the Ekati/Diavik 30 km halo for female caribou (left-hand panel) and male caribou (right-hand panel).

How caribou respond to habitat and mines when they make 1-hour movements

Starting in 2017 (Bathurst herd) and 2018 (Beverly herd) locations were collected every hour when a radio-collared caribou was within about 30 km of the mines. These were the same animals that provided the locations 8-hours apart, but when they were close to the mines they produced locations that allowed 1-hour movement and habitat selection to be determined.

Overall, the results of the analysis of 1-hour caribou behaviour were weaker than the results from 8-hour behaviour analyses. When locations are only 1-hour apart, animals have less to choose from – the habitats they have available to them are closer together than when they have 8-hours between locations. As seen in the results of 8-hour interval habitat selection, analysis of locations collected 1-hour apart showed that both male and female caribou selected habitat the same way they did in the large regional study area – there was no difference in habitat selection to indicate that caribou were avoiding good habitat when it was closer to mine roads or mine infrastructure.

Overall effects of mine roads and mine infrastructure on habitat selection by caribou

When their 8-hour movements were examined, male caribou avoided habitat closer mine infrastructure in the summer; however, their 1-hour movement preferences in summer were to be closer to mine infrastructure. Eight-hour interval analyses showed that male caribou preferred habitat closer to mine infrastructure during the rut. There were no other selection or avoidance responses to habitat near mine roads or infrastructure observed for male caribou in any season at either the 1-hour or 8-hour movement scale.

Combined with 8-hour results, female habitat selection was to avoid habitat near mine infrastructure or roads at both 1-hour and 8-hour movement scales in winter, and at one scale but not the other in every other season except the rut. Female caribou 1-hour interval habitat selection included a preference for habitat closer to mine roads during summer and the rut.

Effect of encountering mines on total seasonal movement distance and delays in seasonal range arrival

Regardless of their individual pathways and movement patterns, caribou that spend time near the Ekati and Diavik diamond mines are not typically travelling farther than animals that do not encounter the mine complex. Some comparisons (11%) of seasonal travel by each sex in each herd showed longer travel distances when the mining complex was encountered by caribou, but more comparisons (17%) showed shorter seasonal pathways; the remaining 72% of season/sex/herd combinations showed no effect of mine encounter on total travel distance in the season.

One of the characteristics of barren-ground caribou is that they use different ranges in different seasons. To address a concern that encountering the Ekati and Diavik diamond mines might delay movement across the landscape, the arrival times on each seasonal range were compared with whether or not the animal had spent time in the 30 km halo around the mines. There was no evidence that indicated animals were delayed from arriving at their next seasonal range on time after encountering the Ekati and Diavik diamond mines in the previous season.

EXECUTIVE SUMMARY

The objective of this study was to determine the effects of the Ekati Diamond Mine on fine-scale behaviour of Beverly and Bathurst herd caribou. The availability of telemetry location data at scales of less than 24-hour intervals defined the study period as 2016 to 2022. In the study period, data were collected every 8-hours throughout the range of both herds. Additionally, 1-hour interval data collection within an area of approximately 30 km around the Ekati and Diavik mines began with spring migration in 2017 for the Bathurst herd, and with spring migration in 2018 for the Beverly herd. The 8-hour and 1-hour time intervals were adopted as the coarser- and finer-scales for habitat selection analyses.

Habitat selection analyses were conducted in two stages. To begin, data collected on an 8-hour interval within the region, but outside the influence of development, were analyzed with step selection functions. These initial analyses revealed the importance of characterizing habitat at a variety of distances around each location. Tussock graminoid tundra, waterbody area, and shrub landscapes were important landcover types identified in step selection functions; together these three landcover types dominate the area within 30 km of the Ekati and Diavik mines.

The step selection functions were then used to predict relative habitat selection value from landcover distribution within 30 km of the two mines. In this way, behaviour of animals removed from the effects of development was used to predict habitat selection that might be expected if development was not present. The relative habitat selection values predicted from step selection functions were combined with the caribou location data from inside the 30 km buffer and used to assess the effect of the proximity of mine infrastructure and mine roads on seasonal habitat selection and movement step lengths by caribou of each sex.

For 8-hour interval behaviour, the selection of habitat cells within the 30 km buffer was significantly related to the relative habitat value predicted for them for 12 of 14 sex by seasons. Further, habitat selection was not related to distance from mining features – relative habitat selection value did not diminish when locations were closer to mine roads or other infrastructure. While proximity to mining features was included in 12 out of 14 top models from 8-hour interval integrated step selection analyses, there were only 7 models with significant interactions including distance-from feature. In 6 of 7 cases, including summer and rut for both sexes, results showed that caribou made shorter movements when they were closer to mining features. In 7 of 14 cases, including late summer and pre-rut for both sexes, there was no significant effect of distance from mining feature on step length.

The same models and same equations used to predict relative habitat values for the 8-hour interval analyses were used to analyse 1-hour interval behaviour. The individual records in the data sets differed for the two time intervals. Using case probability for model evaluation, the 1-hour iSSA top models had poor predictive accuracy. As observed in 8-hour interval analyses, the selection of habitat cells within the geofence area around the mines was significantly related to the relative habitat value predicted. In the 1-hour analyses results this relationship was observed in every sex by season. There were only two interaction terms with significant coefficients among the 14 top models, indicating an absence of support for distance-from-feature effects on step length and selection of habitat cells.

Analyses were also conducted to evaluate the effects of proximity to mines on seasonal caribou movement. Specifically, exposure to the 30 km buffer around the Ekati and Diavik mines was examined for its effect on total seasonal movement path length and on delayed arrival in the seasonal range for the next season. In 26 of 36 comparisons (independent for each herd by sex by season) there were no differences in total seasonal movement path length related to how long an animal had been within 30 km of the Ekati and Diavik mines. Of the remaining 10 results, four showed longer movement paths related to increased residency within 30 km of Ekati and Diavik, while the other six showed shorter

movement paths associated with increased time near the mines. There were no seasons in which any level of exposure to the 30 km buffer around the Ekati and Diavik mines resulted in caribou arriving late to the next seasonal range. The results did not generally support concerns of exposure to diamond mining infrastructure and roads yielding deflected, longer movements by caribou, nor delays in range-scale movements.

ACKNOWLEDGEMENTS

This project was initiated and managed by Tommy Thorsteinsson and Harry O'Keefe of Arctic Canadian Diamond Company Ltd. This report was prepared for Arctic Canadian Diamond Company Ltd. by Paragon Wildlife Research and Analysis Ltd. (Paragon). James Rettie (Paragon) led the project and collaborated on analyses with Robert Rempel of FERIT Consulting and Laurie Ainsworth of PhiStat Research & Consulting. Mapping was completed by Daniel Phalen.

Proprietary spatial data used in this report were provided by: Arctic Canadian Diamond Company Ltd. (mine and mine road footprints); Diavik Diamond Mines Inc. (mine footprint); and the Government of the Northwest Territories Department of Environment and Natural Resources - Northwest Territories Wildlife Management Information System (exploration and development layer).

The Government of the Northwest Territories Department of Environment and Natural Resources provided all barren-ground caribou radio-collar locations through its Northwest Territories Wildlife Management Information System.

Don Russell of the CircumArctic Rangifer Monitoring and Assessment (CARMA) network kindly provided daily insect harassment index values for the period of the analyses.

Suggested citation for this report:

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ACRONYMS AND ABBREVIATIONS

AIC	Akaike's Information Criterion
AUC	Area under the curve
BCRP	Bathurst Caribou Range Plan
BIC	Bayesian Information Criterion
BRT	Boosted regression tree
CARMA	CircumArctic Rangifer Monitoring and Assessment network
CRMP	Caribou Road Mitigation Plan
GF112N	Geofence 112 North
GIS	Geographic Information System
GNWT	Government of the Northwest Territories
GNWT-ENR	Department of Environment and Natural Resources of the GNWT
GPS	Global Positioning System
ha	hectare
IEMA	Independent Environmental Monitoring Agency
iSSA	integrated Step Selection Analysis
km	kilometre
LSL	Landscape Scripting Language
m	metre
mm	millimetre
NTS	National Topographic System
NU	Nunavut
NWT	Northwest Territories
PRHSV	Predicted Relative Habitat Selection Value
RSA	Regional Study Area
RSF	Resource Selection Function
RSS	Relative Selection Strength
SSF	Step Selection Function

UD	Utilization Distribution
UTC	Coordinated Universal Time
UTM	Universal Transverse Mercator
WEMP	Wildlife Effects Monitoring Plan
VIF	Variance Inflation Factor
ZOI	Zone of Influence

GLOSSARY

Animal-season	A period of a single season in a single year for a single animal. Data collected in each animal-season were considered independent in the analyses in this report.
Available locations	Geographic locations generated during analyses that represent plausible alternative end points for each real movement step that each caribou took. In step selection functions and integrated step selection analysis, the analytical processes employed in this report, a set of 5 available locations were generated for each real location acquired for each radio-collared caribou.
Delayed arrival	For the purposes of characterizing an animal's movement over a period of time, the delayed arrival of an individual in a seasonal range was defined as the number of days between the first telemetry location recorded for the individual in the season and the first location recorded for the individual within the 90% utilization distribution (UD) seasonal range.
Ekati/Diavik halo	A geographic area defined as being within 30 km of the area occupied by the Diavik and Ekati mine infrastructure and mine roads in 2021. In the 8-hour interval habitat selection analyses, data from within this area were separated from data in the broader regional study area. This is the geographic area used for 8-hour analyses of the effects of mine features on caribou behaviour. The spatial extent of the Ekati/Diavik halo is similar to GF112N described below.
Extent	See "Spatial extent" and "Temporal extent" below.
Geofence 112 North (GF112N)	A geographic area defining the limits of 1-hour telemetry data analysed in this report. Three geofence areas were established by GNWT-ENR to increase the frequency of telemetry location acquisition from radio-collars near areas of human disturbance. Geofence 112 includes the area around the Ekati and Diavik mines. In this report data were restricted to the portion of geofence 112 north of 64°12' North latitude. GF112N is the geographic area used for 1-hour analyses of the effects of mine features on caribou behaviour. The spatial extent of GF112N is similar to the Ekati/Diavik halo described above.
Grain	The spatial area or temporal period associated with individual observations in an analysis. Its potential upper and lower limits are set by covariate data resolution (at the finest level) and by spatial and temporal data extents (at the coarsest level). Functionally, the analyst will choose one or more grains between the upper and lower limits. Ecologically, animals may simultaneously respond to covariates measured at different grains.

Habitat	The set of resources and risk conditions at each location in environmental space. The resources and risks vary for each species and are likely influenced by other factors such as season, sex, and reproductive status. Habitat is approximated by the set of environmental covariates measured and included in an analysis. However, the full suite of relevant resources and risks are rarely known or measured at all appropriate spatial and temporal extents and resolutions.
Habitat selection	The process through which individual animals differentially use habitats relative to their availabilities. Typically determined through comparison of habitat attributes at available locations and used locations.
Predicted relative habitat selection value	See the definition of relative habitat selection value below. The relative habitat selection value was predicted (PRHSV) for each 3.1-ha hexagon cell in the Ekati/Diavik 30 km halo and used as a covariate in analyses of 1-hour movement data inside GF112N and analyses of 8-hour data inside the Ekati/Diavik 30 km halo. The PRHSV was calculated separately for each sex by season based on SSF results.
Regional Study Area	The spatial extent of environmental and caribou location data included in analyses of 8-hour movement and habitat selection. The first stage of analyses was based on data within the regional study area, excluding data both within the Ekati/Diavik halo (described above) and within buffers around some other select development features.
Relative habitat selection value	The exponentiated result when a selection function is applied to the covariates in a discrete cell (e.g., a 3.1-ha hexagonal unit as used in the analyses reported here). The habitat selection value is relative to the values of other cells, rather than being an absolute likelihood that a cell will be selected by an animal. It was determined separately for each sex by season.
Relative selection strength	A measure of the influence of an individual covariate on the relative habitat selection value. The relative selection strength (RSS) is calculated as the exponentiated coefficient of a covariate in a resource selection equation. It is interpreted as the difference in likelihood of use between two resource units (3.1-ha cells in our analyses) when the covariate of interest differs by one unit and all other covariates are held constant for the two units.
Resolution	How finely a resource unit is measured: the minimum spatial or temporal unit of data (e.g., pixel size of raster data; fix-interval of telemetry locations; frequency of updated measurement of environmental covariates).
Scale (of selection)	The size of a geographic space or the length of a period of time. In the context of habitat selection, it is generally accepted that selective behaviour may differ when examined over finer or coarser scales. The spatial and temporal scales are linked: behaviour occurring over larger areas is likely to occur over longer periods of time, and vice versa.

Selection analysis	An analytical process used to characterize preferential use or avoidance of environmental features by an animal. In this report selection analyses were based on mixed effects Poisson models for each sex by season. In this report it is referred to generically as habitat selection analysis or specifically as step-selection function (SSF) or integrated step-selection analysis (iSSA).
Selection function	Any model (typically including environmental covariates) that yields the relative probability of an animal using a location (a 3.1-ha hexagonal unit in the case of the analyses presented here).
Spatial extent	The entire geographic area represented by a data layer or an analysis.
Temporal extent	The entire time period represented by a data set or an analysis.
Total movement pathway	For the purposes of characterizing an animal's movement over a period of time, the total movement pathway was defined as the sum of the length of straight-line steps implied by the sequence of 8-hour interval telemetry locations for the individual.
Used locations	Geographic locations obtained via telemetry from radio-collared caribou.
Utilization Distribution (UD)	The UDs described in this report represent the seasonal distribution of caribou in each year – separately for each sex in each herd. Based on telemetry data.

1. INTRODUCTION

The Ekati Diamond Mine and its surrounding mining leases are located approximately 200 km south of the Arctic Circle and 300 km northeast of Yellowknife, Northwest Territories (NWT; Section 2.1 below)). The mine is situated within the Exeter Lake, Koala, Lac de Gras, and Lac du Sauvage watersheds at the headwaters of the Coppermine River drainage basin, which flows north to the Arctic Ocean. It is also within the annual ranges of the Bathurst and Beverly herds of migratory barren-ground caribou (*Rangifer tarandus groenlandicus*).

The 2017 Ekati Diamond Mine Wildlife Effects Monitoring Plan (WEMP, Golder 2017), including the Caribou Road Mitigation Plan (CRMP), was applied site-wide at the Ekati Diamond Mine to the end of the study period in 2022. The Ekati WEMP program included a commitment by Arctic Canadian Diamond Company Ltd. to provide funding to the Government of the Northwest Territories Department of Environment and Natural Resources (GNWT-ENR) for radio-collaring programs and to incorporate radio-telemetry data in its assessment of the effect of the Ekati Diamond Mine on barren-ground caribou.

In a recent report on caribou movement prepared for the Independent Environmental Monitoring Agency (IEMA), Poole et al. (2021) described movement attributes of barren-ground caribou relative to the Ekati Diamond Mine. Their review was limited to movement of female caribou that came within 30 km of mine infrastructure, examining movement speed, turning angles, time spent in concentric distance buffers around the mine infrastructure, and crossings of two of the mine roads. They included a qualitative assessment of habitat but recognized that more thorough analyses would likely provide a better understanding of the relationship between caribou movement and ecological covariates. The summary concluded that fine-scale movement step-lengths and turning angles were affected by proximity to Ekati Diamond Mine infrastructure and its operations.

Arctic Canadian Diamond Company Ltd. identified two broad objectives that to address through formal analyses:

- to conduct detailed analysis of caribou telemetry data to identify and evaluate the movement of caribou through the mine site; and
- to conduct analyses that will contribute to the body of knowledge utilized by the GNWT and others to manage the herd.

This document reports on Arctic Canadian Diamond Company Ltd.’s analyses to address their commitments, and to respond to the concerns raised by Indigenous Governments, regulators, and others regarding the potential effects of the Ekati Diamond Mine on fine-scale behaviour of caribou. The analyses reported here used telemetry data from the Bathurst and Beverly herds to examine the effects the Ekati Diamond Mine has on caribou behaviour in the vicinity of the mine. Habitat selection is always a scale-dependent process, as available habitat is context-dependent. Locations that an animal may select are constrained to what is within the area that the animal may encounter over the time interval of selection, given its movement abilities and its established behaviour. That selective behaviour may be measured over any time interval of interest (e.g., annual, seasonal, sub-seasonal, daily, etc.). The spatial and temporal resolution of telemetry location data for the Beverly and Bathurst herd caribou was set by GNWT-ENR as one location (with approximately 10-m accuracy; E. DiMarco – Telonics, personal communication March 15, 2023) every 8-hours throughout the range of both herds, increasing to one location every 1-hour when animals were within specific geographic areas near development – areas that include a buffer of approximately 30 km around the Ekati Diamond Mine. Those temporal resolutions (1-hour and 8-hour) were adopted to define the two relatively fine scales of analyses in this report.

Animal movement and habitat selection are linked to each other and to ecological attributes including topography, vegetation communities, and human disturbance (Passoni et al. 2021). For that reason, the analytical approaches for this project were step-selection analyses to model movement steps in relation to ecological covariates (Thurfjell et al. 2014, Passoni et al. 2021) including land cover classes, insect harassment indices, and proximity to mine infrastructure and mine roads.

1.1 Objectives

The broad questions addressed in this report are:

1. Are there effects of the Ekati Diamond Mine on fine-scale barren-ground caribou behaviour?
2. At what scale do the effects occur?
3. Are effects specific to different seasons or sexes? and
4. What is the magnitude of the effects?

Important variables of interest for these analyses were identified with input from Indigenous Governments, regulators, and IEMA. They included landcover types, mine roads, other mine infrastructure, insect harassment, sex, season, herd, and year. Future work may include other factors.

To address those key questions, the analyses in this report sought to remove the confounding effects of differential distribution of habitat. While Boulanger et al. (2012, 2021) attempted to address the effects of habitat availability on caribou distribution, this report includes explicit habitat selection analyses spatially separated and independent from the effects of development to provide seasonal step selection functions (SSFs) for each sex . In the iterative development of a set of sex by season SSFs, multiple grains of habitat were measured to characterize used and available locations rather than relying on a default assumption of the importance of habitat within a specific distance of a point.

The SSFs were used to predict relative habitat selection values in proximity to the Ekati and Diavik mine, providing controls for relative habitat selection value independent of the influence of distances from mining infrastructure and activities. Having accounted for relative habitat selection values, the analyses at the 8-hour interval scale then moved forward to address the role of proximity of mine infrastructure and mine roads on caribou behaviour. The integration of habitat selection, movement behaviour, and behavioural responses to mine roads and infrastructure was considered to be a detailed, ecologically sound approach to examine the effects of industry on caribou.

Data collected at 1-hour intervals were used for finer scale analyses, though the data acquisition frequency was limited to areas close to the mines, precluding the ability to provide 1-hour interval predictions for habitat selection absent of mining influence.

Additionally, the analyses in this report test the season-specific effect of exposure of caribou to the area within 30 km of the Ekati and Diavik mines on:

5. Total distance moved within the season; and
6. Delay in arrival time on the next seasonal range.

Given the proximity of the Diavik Diamond Mine to the Ekati Diamond Mine and the reported distances of effects on caribou distribution (zones of influence [ZOIs]: Boulanger et al. 2012, 2021; Poole et al. 2021) the analyses in this report include both the Ekati and Diavik mines and their roads and other infrastructure; no attempt was made to separate the effects of the individual mines on caribou.

2. METHODS

This report examines behavioural responses of caribou to infrastructure and roads at the Ekati and Diavik diamond mines at two different scales. At the coarse scale, 8-hour interval data were used to characterize habitat selection by each sex in each season throughout the ranges of the Beverly and Bathurst caribou herds. The results of those analyses were used to predict relative habitat selection values within approximately 30 km of the two mines where movement characteristics, and proximity to mining features were used to examine responses of caribou to the mines, while accounting for predicted relative habitat selection values. Analyses of the effects of development on behaviour were conducted separately on 1-hour and 8-hour interval data. It was not possible to predict relative habitat selection value for 1-hour interval data in the absence of mining effect, as 1-hour interval data were not collected except in proximity to human developments; consequently, predicted relative habitat selection values from 8-hour interval data were also used for 1-hour analyses of effect.

2.1 Regional description

The region containing the study area is the Coppermine River Upland Ecoregion of the Taiga Shield Ecozone in the south and west, and two ecoregions of the Southern Arctic Ecozone: the Garry Lake Lowland in the east; and the Takijua Lake Upland which stretches from the margin of Bathurst Inlet to west of Lac de Gras, including the Ekati and Diavik diamond mines. Much of the surface of the Takijuaq Lake Upland is unvegetated rock outcrops of the Canadian Shield (Ecological Stratification Working Group 1996). Soils in the ecoregion are predominantly Cryosols and permafrost is continuous and deep across the region (Ecological Stratification Working Group 1996). The mean summer and winter temperatures are +6°C and -26°C, respectively, and annual precipitation is between 200 mm and 300 mm. Low Arctic shrub tundra dominates the study area with boreal forest-tundra transition in the Taiga Shield to the west. The vegetation communities are further discussed in Sections 2.5 and 3.4 below.

Besides caribou, large mammals in the region include grizzly bears (*Ursus arctos*), wolves (*Canis lupus*), wolverine (*Gulo gulo*), muskoxen (*Ovibos moschatus*), and moose (*Alces alces*).

2.1.1 Ekati Diamond Mine

The Ekati Diamond Mine is located in the Northwest Territories, approximately 200 kilometres (km) south of the Arctic Circle and 100 km north of the tree line on the tundra (Figure 2-1). The Diavik Diamond Mine is situated on an island in Lac de Gras approximately 30 km south-southeast of the Ekati Main Camp (Figure 2-2).

The local terrain near the mine is characterized by boulder fields, tundra, wetlands, eskers, and numerous lakes with interconnecting streams. There are more than 8,000 lakes within the 266,300 hectare (ha) claim block. While extreme winter temperatures dominate the majority of the year, there are generally four months (June through September) that experience daytime temperatures above freezing.

The Ekati mine began construction in 1997 and opened in October 1998. During the period of the study the following developments occurred at the Ekati Diamond Mine:

- The Misery Road power distribution line construction began in September 2014. The final portion of construction occurred between March 3, 2016 and the completion of construction on August 2, 2016 - during the period defined for analyses in this report;

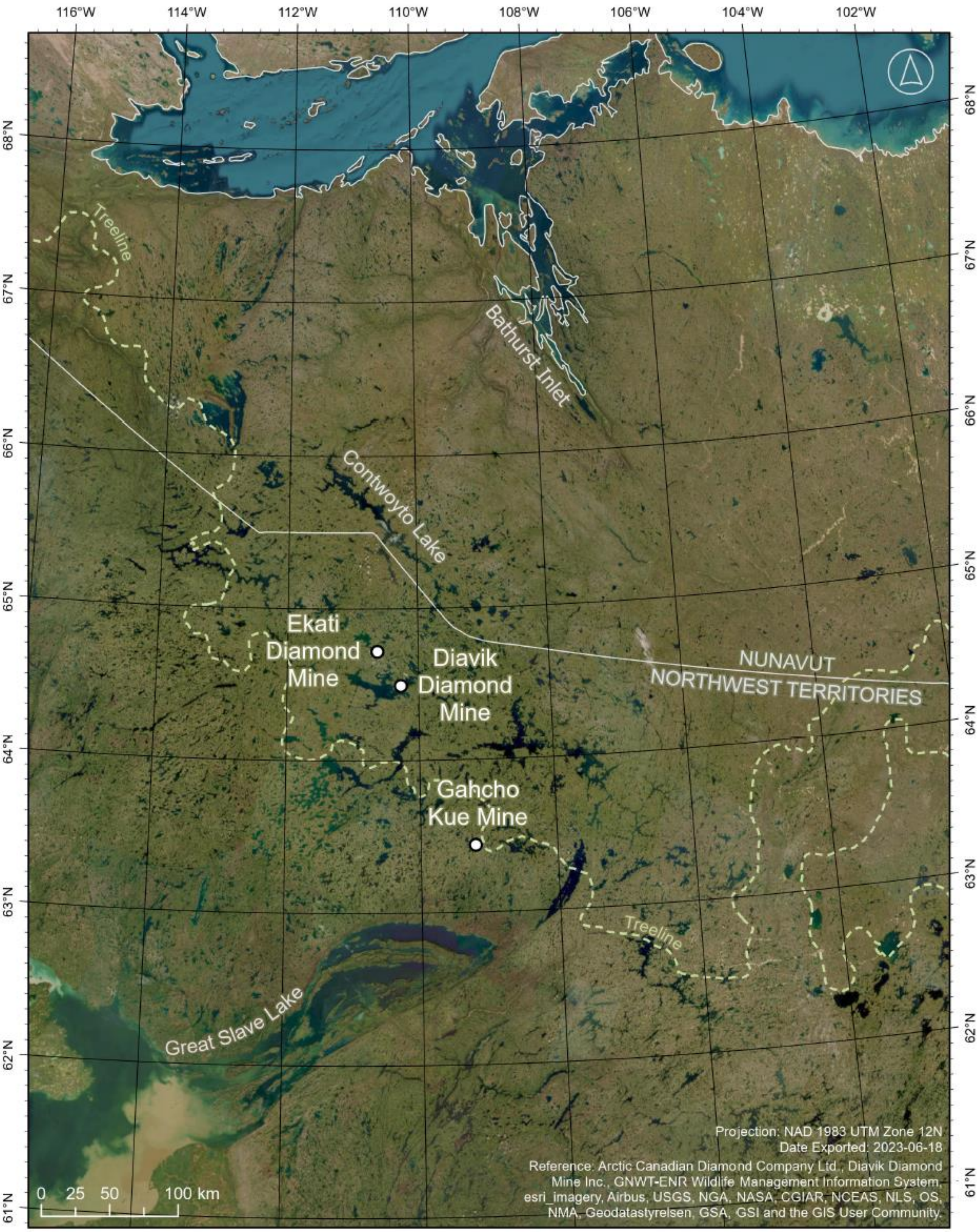

Figure 2-1:
Ekati Diamond Mine Location

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PARAGON WILDLIFE RESEARCH AND ANALYSIS

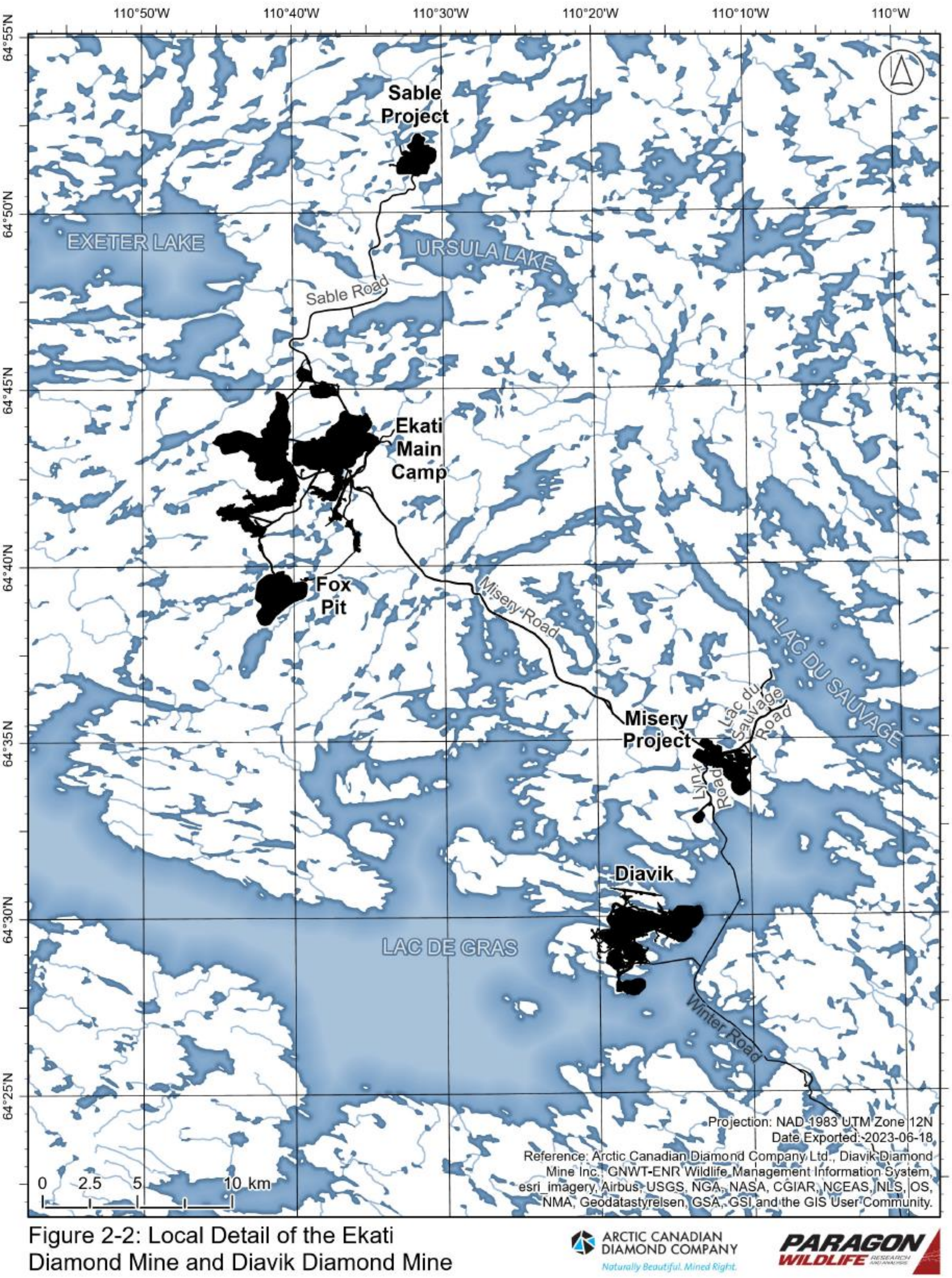


Figure 2-2: Local Detail of the Ekati Diamond Mine and Diavik Diamond Mine

- The portion of Sable Road from km 2.8 to 19.8 was under construction during 2016, with construction completed on September 30, 2016;
- The Lac du Sauvage Road was built in 2017, with completion on October 10, 2017;
- Operations were suspended at the Ekati Diamond Mine from March 20, 2020 until December 31, 2020 and the mine was in care and maintenance;
- Dewatering of Point Lake occurred between June 10, 2022 and October 1, 2022. During this period a pipeline was in place on top of the Lac du Sauvage Road and Lac du Sauvage Spur Road between Point Lake and Lac du Sauvage. For reference, Point Lake was approximately 2 km northeast of the Misery Project, 650 m east-southeast of the Lac du Sauvage Road.

2.2 Data projection for analyses in this report

Environmental data layers used in the analysis were projected to Canada Atlas Lambert (EPSG:3978) as calculation of area-based statistics and linear edge require an area-based projection. Universal Transvers Mercator (UTM) and Lambert are commonly used area-based projections. The Canada Atlas Lambert projection (EPSG:3978) was selected as multiple UTM zones are included in the study area and the Canada Atlas Lambert projection is commonly used in map production in Canada.

Caribou location data were provided as latitude/longitude (WGS84/CRS4326), and these were also transformed to Canada Lambert to properly overlay with the environmental data, and as area-based projection is necessary for calculating movement distance in metres (m).

Source: NAD83 / Canada Atlas Lambert - EPSG:3978

2.3 Caribou location data

Radio-collars were first deployed on female Bathurst herd caribou in 1996 and on males in 2015. The earliest data for the Beverly herd were from radio-collars deployed on female caribou in 2006; available data for male caribou began in 2015. The number of radio-collars on each sex from each herd varies annually, depending on mortalities, collar failure, and operational decisions regarding collar deployment. The location fix rate (the frequency of locations being obtained for each individual) has also varied over time. Within each time period these factors dictate the number of locations available per animal, per season, and per herd.

Each radio-collared caribou is assigned to a herd by GNWT-ENR based on its range use, a classification that GNWT-ENR reviews annually – retroactively reassigning animals to different herds if the animal changed the calving ground it used.

All caribou location data used in this report were acquired from radio-collars using a global positioning system (GPS) to determine the locations. Location dates and time were received and stored in Coordinated Universal Time (UTC) and all analyses were conducted based on UTC time, i.e., without correction to local time.

Spatially, the telemetry locations have been used to define the extent of the ranges used by each herd over time. The location-fix rates set by GNWT-ENR determined the finest temporal resolution possible for examinations of movement and other behavioural patterns.

2.3.1 Geofence delineation and effect on data collection

Beginning with radio-collars deployed in early 2016, the GNWT-ENR began collecting location data on 1-hour intervals when caribou were within pre-defined geographic areas, areas referred to as being "geofenced". One of those geofenced areas (geofence 112) included an approximately 30 km buffer around the Ekati and Diavik mines and the Ekati Mine roads (Section 2.7.2).

2.3.2 Telemetry data screening

- Following receipt of data from GNWT-ENR, the following screening steps were applied:
- Each location was assigned a code for the season in which it was collected; season dates being specific to the herd to which the animal was assigned in the GNWT database (Section 2.4.1);
- Data were then screened to remove duplicate locations from the same animal at the same time on the same date;
- As large sets of remotely acquired data have the potential to include GPS location data that are incorrect, the next step was to screen data for outliers – locations that are likely to be incorrect. Data were screened for outliers using a combination of techniques of Bjørneraas et al. (2010, as employed by van Beest et al. [2013]) and those of Keating (1994). These techniques use one or more of: interval movement speed; turn angle between two steps; absolute distance and equivalence of distance of adjacent movement steps; and comparison with the distribution of those values against the entire set of movement steps in the data set over the same time interval;
- To determine the distribution of time intervals between locations for each animal, data were next examined for time of data collection and the time interval between sequential locations, with the minimum interval set at 56 minutes;
- After cleaning the data to remove location duplicates, movement outliers, and data from short time intervals, the data were summarized by time of data collection, inter-location time interval, and years of data availability for different time intervals between locations; and
- Data were then reduced to the range of years and location acquisition times when adequate and comparable data were available to address the project objectives.

2.4 Seasonal caribou ranges

2.4.1 Season delineation

Nagy (2011) delineated 12 seasons for each barren-ground caribou herd in the NWT. Nagy's seasons (Nagy 2011 p. 92) were as short as 12 to 14 days for the calving, post-calving, and rut seasons (Table 2-1). In previous analyses of NWT barren-ground caribou data (e.g., Caslys 2016; GNWT 2019; Poole et al. 2021) some of Nagy's seasons were combined to yield between 5 and 9 seasons for analyses. In early years, data collection was as infrequent as one location every 5 to 7 days. The post-2015 data for the Bathurst and Beverly herds and used in the analyses in this report included multiple locations per animal per day. The sets of seasons and season dates adopted for these analyses appear in Table 2-1. Winter data spanned periods from December of one year to April of the following year (Table 2-1); the winter data for each animal were retained as a set for analysis and nominally assigned to the analysis year corresponding to the January to April period (e.g., data from December 2017 to April 2018 were assigned to the nominal 2018 analysis year).

Table 2-1: Season dates used in this report for the Bathurst and Beverly barren-ground caribou herds

Season	Bathurst Herd[1]	Length in days	Beverly Herd[1]	Length in days
Winter	December 1 to April 19	140	December 16 to April 9	115
Spring migration	April 20 to June 1	43	April 10 to June 5	57
Calving	June 2 to June 16	15	June 6 to June 19	14
Post-calving	June 17 to June 28	12	June 20 to July 8	19
Summer	June 29 to August 17	50	July 9 to August 12	35
Late Summer	August 18 to September 6	20	August 13 to September 11	30
Pre-rut	September 7 to October 16	40	September 12 to October 20	39
Rut	October 17 to October 31	15	October 21 to November 3	14
Post-rut	November 1 to 30	30	November 4 to December 15	42

[1] *Season dates follow Nagy 2011 (p. 92).*

2.4.2 Seasonal range utilization distribution (UD) analyses

Seasonal ranges were estimated at the herd level, using 90% fixed kernel utilization distributions (90% UDs) as recommended and employed in previous studies (e.g., Fieberg and Kochanny 2005; Börger et al. 2006; van Beest et al. 2013). For each herd, the sex-specific UDs were estimated for each season in each year from data pooled across animals using the package adehabitatHR in the R statistical package (R Core Team 2022). Data for each winter spanned two calendar years: winter began in December and ended the following April.

The use of kernel density estimators to delineate seasonal ranges is dependent on the quantity of data (i.e., number of locations), the underlying spatial grid used in the analyses and the smoothing factor that affects the size and shape of UDs based on known locations of animal use; consistency in spatial grid and smoothing factors used for UDs is necessary for comparability among years and among seasons. A 500 m grid was used for all UD analyses and the ad hoc approach (Kie 2013; Morellet et al. 2013; Bastille-Rousseau et al. 2015; Newton et al. 2017) was used to determine the best smoothing parameter for each herd; in the initial stage, smoothing parameters were varied iteratively in 1,000 m increments for each female seasonal range in each year in each herd to determine the minimum value needed to yield a single contiguous 90% UD. Following the initial analyses for each seasonal range, the herd-specific median of the smoothing parameters for all female seasonal 90% UDs in all years was selected and applied prior to the recalculation of all UDs (all seasons, all years, and each sex) for each herd.

2.4.3 Location data screening for seasonal range delineations

In addition to considerations of UD estimation parameters it is important that there be a relatively equal weighting in the amount of available data. To give each animal equal weight in pooled-animal UD analyses, each individual radio-collared animal must provide a similar, ideally identical, number of locations to the data set within a season (Börger et al. 2006). Prior to confirming methods for range delineation available location data were screened and summarized for abundance and distribution of data through the season and across animals. This was conducted in two steps:

- Morellet et al. (2013) (i) reduced the number of locations per animal to match the coarsest time interval in data collection (e.g., one location per animal per day or one location per animal per 12 hours); and (ii) set a minimum number of locations per animal for inclusion in the data set for range analysis. For the purpose of delineating seasonal ranges in this study, the Beverly and Bathurst herd data were screened to produce a subset of the data with a single location per animal per day.

- Within the single-location-per-day subset, summaries of the number of locations per animal per season per year were generated. Following established principles for screening data (van Beest et al. 2011; Morellet et al. 2013; Avgar et al. 2015; Nicholson et al. 2016) the animal by season by year summaries were screened for a minimum number of locations in a season; animals whose data sets contained the minimum or greater were retained and included in the analyses, locations from other animals were removed. The minimum threshold for inclusion was one location per day on at least 75% of days in a season.

2.5 Landcover and associated data layers

Spatial analyses of caribou behaviour require detailed information on environmental variables that reflect ecological value at the spatial and temporal scale associated with animal location data. Previous works on barren-ground caribou in the study area have reported the various importance of vegetation communities, eskers, water, topography (elevation, slope, aspect), human development, and insect harassment (Johnson et al. 2005; Witter et al. 2012; Boulanger et al. 2012, 2021; Dominion Diamond 2014; Golder Associates 2014, 2016; ERM 2021). Available environmental data were examined for relevant detail, and against the spatial and temporal extent and resolution for this study.

2.5.1 Available landcover data layers considered

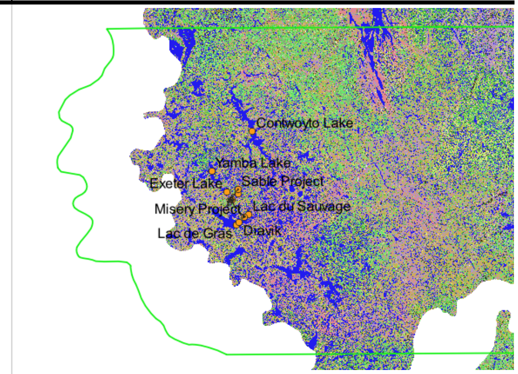
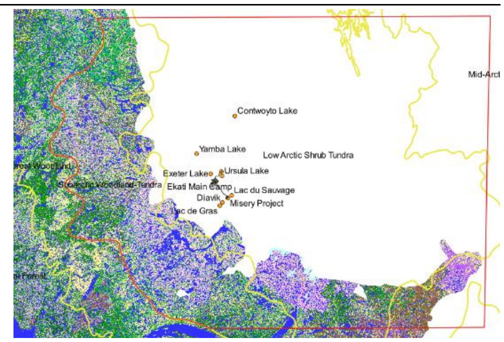
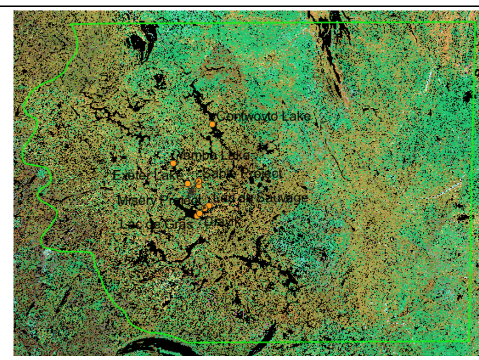
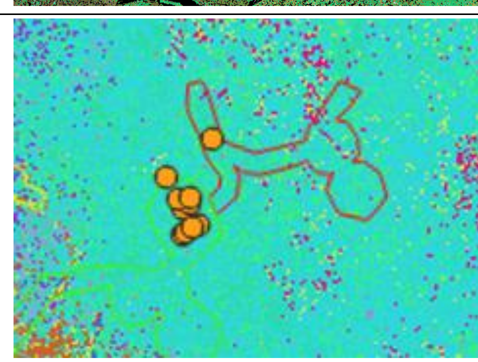
Five available landcover Geographic Information System (GIS) layers were considered (Table 2-2), nominally termed LC2009 (Olthof et al. 2009), EOSD (Wulder et al. 2003), LC2000-ETM+ (Olthof et al. 2005), CanLC2015 (Latifovic et al. 2017), and WKSS (Matthews et al. 2001). Layers were evaluated in terms of extent of coverage relative to the study area, focus and detail of the landcover classification relative to the Tundra and Woodland vegetation zones and known caribou habitat relationships, pixel size, and general impression of classification quality. A combination of LC2009 and EOSD data layers were used in two published studies incorporating caribou resource selection function (RSF) modeling by Boulanger et al. (2012) and Boulanger et al. (2021). The WKSS data layer was used to develop the first barren-ground caribou RSF in the region by Johnson et al. (2005) and was later used for RSF analyses by Dominion Diamond (2014) and for landcover classification by ERM (2021) in an examination of the methodology of Boulanger et al. (2012). In their analyses of the Bathurst herd winter RSF, Golder (2016) combined LC2000 data above the treeline with additional data sources in areas below the treeline.

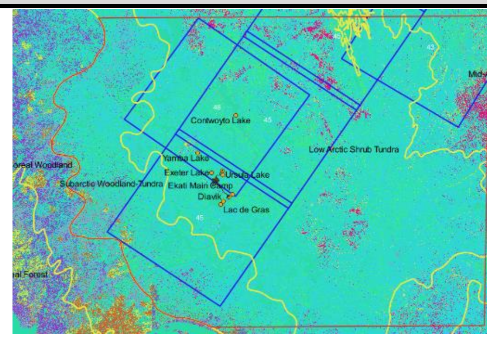
For this project, LC2009 was assessed as a high-quality mapping product, it covered the initially defined study area, had good spatial resolution (30 m), and sufficient classification detail for caribou RSF estimation in the Arctic Tundra vegetation zone (Table 2-2). LC2000 (ETM+) was considered the second choice in that it had appropriate spatial extent; however, it had lower spatial resolution (90 m) and more classes defined (43) than were likely to be accurately mapped. The unsupervised approach to classification LC2000 (ETM+) (which produced an initial group of 150 classes that were then labelled into 43 classes) led to the potential for higher classification error rates.

Following engagement with Indigenous Governments, regulators, and other project participants on September 15, 2022, the initial study area was extended further to the west into the Sub-Arctic Woodland Tundra, beyond the extent of LC2009 coverage. Consideration was given to retain LC2009 for the main portion of the study area (Arctic Tundra vegetation zone) and use either the EOSD or LC2000

(ETM+) classification for the Sub-Arctic Woodland Tundra portion of the study area in the western portion of the revised study area.

Table 2-2. Available landcover data layers that were considered, with comments on suitability.

Description and comments	Extent relative to study area
LC2009: 30 m raster; 15 classes. Circa-2000 Northern Land Cover of Canada. This dataset was generated to provide spatially and thematically consistent land and vegetation cover of Northern Canada above the tree line at medium (30 m) Landsat resolution. Nominally called LC2009 based on publication date. This classification had both good spatial and classification resolution for the Arctic Tundra vegetation zone but did not extend into the Boreal Forest & Woodland zone, which falls in the western portion of the study area. Olthof, I., R. Latifovic, and D. Pouliot. 2009. Development of a circa 2000 land cover map of northern Canada at 30 m resolution from Landsat. Canadian Journal of Remote Sensing 35:152-165.	
EOSD: 25 m raster; 37 classes. This mosaic created for the forested ecozones of Canada. The classification was focused on forested areas, and did not extend into the Arctic Tundra zone. Also, when overlayed, gaps occurred between the extents of this coverage and the LC2009 coverage. There is also a vector version created from a smoothed raster that provides even less spatial resolution. Wulder, M.A., J.A. Dechka, M.A. Gillis, J.E. Luther, R.J. Hall, A. Beaudoin, and S.E. Franklin, 2003; Operational mapping of the land cover of the forested area of Canada with Landsat data: EOSD land cover program. Forestry Chronicle 79:1075-1083.	
LC2000 (ETM+): 90 m raster; 43 classes. Circa 2000 Landsat ETM+ mosaic of northern Canada above the tree line. This map covered the extents of the study area, but was based on an unsupervised classification approach, which was of lower quality than the LC2009 product. Also, spatial resolution was 90 m versus 30 m for the LC2009. There were more classes than the LC2000 map, but accuracy is not well defined. Olthof, I., C. Butson, R. Fernandes, R. Fraser, R. Latifovic, and J. Orazietti. 2005. Landsat ETM+ mosaic of northern Canada. Canadian Journal of Remote Sensing 31:412-419.	
CanLC2015: 30 m raster; 19 classes. Canada Landcover 2015. Classification resolution above the tree line was very low, with most of the study area comprised of only 2 land cover classes. Latifovic, R., Pouliot, D., and Olthof, I. 2017. Circa 2010 Land Cover of Canada: Local Optimization Methodology and Product Development. Remote Sensing, 2017, 9:1098.	

Description and comments	Extent relative to study area
WKSS Map. 30 m raster; 22 classes. This map covered only a portion of the study area (blue lines), so was not considered further. Matthews, S., H. Epp, and G. Smith. 2001. Vegetation Classification for the West Kitikmeot/Slave Study Region. Final Report to West Kitikmeot/Slave Study Society. Yellowknife, NWT, Canada.	

2.5.2 Additional landcover and topography data layers

In addition to the raster based landcover data layer, covariates for elevation (m), slope (degrees), and aspect (degrees) were derived from the Canadian Digital Elevation Model (CDEM) mosaic (Natural Resources Canada 2013); aspect was later eliminated as a covariate in the absence of calculated values for parts of the study area. The CanVec 1:250,000 Series Hydrographic Features layer (Natural Resources Canada 2019) was used to determine waterbody areas (overwriting the water coverage included in the landcover layers) and land/water edge density. Eskers were derived from 1:50,000 National Topographic System (NTS) map layers for the regional study area (RSA; Section 2.7); esker polygons were created as 200 m (total width) polygons centred on the esker polylines on the NTS map layers. In all cases, data layers from NWT and NU were merged when necessary.

2.5.3 Resolution and multi-grain assessment of landcover covariates

Habitat selection analyses based on sets of telemetry point locations (rather than movement pathways) include various analytical frameworks to define available habitat based on telemetry locations. However, analytical methods do not specify the grains (the spatial scales of measurement) at which habitat covariates are best quantified to characterize locations in the used and available data sets; these are at the discretion of the analyst.

At minimum, the characterization of habitat associated with each location is limited by the spatial resolution of the covariate data sets (e.g., raster size). Telemetry locations are a sample of selective behavioural outcomes for the entire inter-location movement interval; in an area where habitat is characterized by multiple covariates, each location should be evaluated for its relationship not only to a set of covariates, but also to the grains of covariate measurement that are potentially relevant to decision making by wildlife. Rettie and McLoughlin (1999) recommended that in habitat selection studies, habitat be characterized following the examination of habitat associations defined at multiple radii around each location. The inter-location interval or movement rate, and the patch characteristics and arrangement of landcover types are expected to influence the appropriate size of buffers placed around each location to optimally describe its habitat characteristics (Rettie and McLoughlin 1999; Northrup et al. 2022). In an empirical example, Laforge et al. (2015) explored multiple grains of habitat measurement (based on concentric radii around each location) in their analyses of habitat selection by white-tailed deer (*Odocoileus virginianus*). They concluded that white-tailed deer habitat selection was best explained by a model where the grain of measurement was allowed to vary for each environmental covariate.

To facilitate spatial analyses, a 3.1-ha hexagon grid (approximately equal in area to a circle with 100 m radius) was superimposed on the regional study area (Section 2.7). Each topographic covariate and the proportional cover of each landcover covariate was determined for every 3.1-ha cell in the study area. The 3.1-ha cell was the landscape unit for habitat selection analyses. To examine the spatial extent around each location that influenced habitat selection in this study, landcover covariates were also measured for a range of spatial extents (i.e., multiple grains) centred on each 3.1-ha cell in the hexagon grid. Rather than generating new coarse-grain measures of covariates based on a moving window, spatial averaging was used to calculate values through the specialized GIS program LSL (Kushneriuk and Rempel 2011). For a large study area with 30 m raster coverage, LSL offered a computational efficiency that was orders of magnitude faster than raster-centred assessment. Beginning with 3.1-ha hexagon values, spatial averaging in LSL was used to generate measures of covariates at four different grain sizes, and record the nested set of measures for each cell in the 3.1-ha hexagon-based shapefile for the RSA. Exact dimensions of the coarser grain pseudo-hexagons are constrained by nesting from the base 3.1-ha hexagon; beyond 3.1-ha, the three grains were 58.9-ha, 524-ha, and 5137-ha. The LSL program employs a hierarchy of hexagons and offsets (for spatial averaging) to capture layer attributes within each hexagon (e.g., area and proportion of tundra, tussock, and water; Sections 2.5.1 and 2.5.2), as well as length and density of the edge between water and land (Section 2.5.2). An example of the LSL spatial averaging process from 3.1-ha grain to 5137-ha grain is illustrated in Figure 2-3.

The process produced a measurement for each covariate in a set of near-concentric nested hexagons and pseudo-hexagons centred on each 3.1-ha cell. This provided data to examine multiple grains of covariate measurement on habitat selection at each of the 1-hour and 8-hour movement interval scales. Published uses of LSL include developing and applying range specific resource selection functions for caribou in northern Ontario (Hornseth and Rempel 2016), developing an indicator of ecological integrity for songbirds (Rempel et al. 2016), and conducting scenario analysis of forest management options (Rempel et al. 2007). The program is also used in Ontario for mapping caribou Category 2 conservation habitat. Though they did not mix grains within models, Hornseth and Rempel (2016) conducted a study of caribou habitat selection in northern Ontario that compared habitat selection with a set of nested pseudo-hexagons ranging from 16 ha to 10,000 ha; they determined a 5,000-ha scale was almost always the best predictor.

Analyses in this study include multiple grains of measurement for most covariates and allow the analytical processes (Section 2.8) to identify the appropriate grains to describe ecological relationships. The implementation of multi-grain habitat characterization for each used and random location is described in Section 2.8.5. The analyses here most closely correspond to multi-variable multi-scale modelling as described by McGarigal et al. (2016, p. 1173) who recommended measuring covariates at multiple scales (i.e., multiple grains sensu Northrop et al. 2022), allowing data from different grains to compete in modelling processes, and identifying the optimal grain for each covariate.

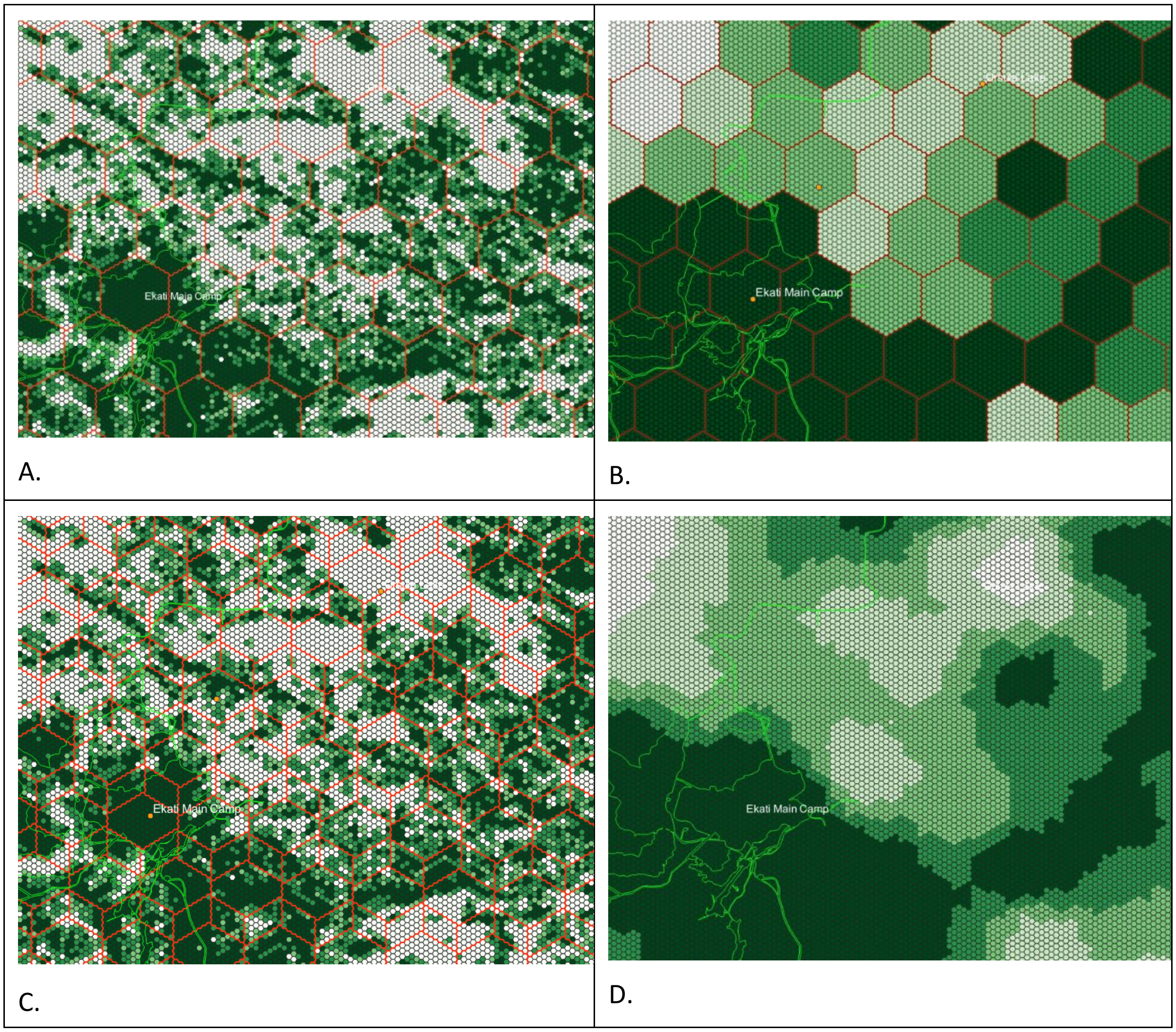


Figure 2-3. Illustration of spatial data capture and smoothing using LSL. A) Proportion tundra with 3.1-ha hexagons, where hexagons with higher proportions are darker green. 5137 ha pseudo-hexagons are overlayed in red; B) Average proportion of tundra within 5137 ha pseudo-hexagons, where values are transferred back to the 3.1-ha hexagon; C) Overlay of two 5137 ha pseudo-hexagons offsets in red; operationally, 12 offsets were specified at the 5137-ha grain. D) Average of the average offset values of tundra at the 5137-ha grain. Note how spatial averaging (smoothing) of the offsets compares to the result in B where no offset averaging is used. Note also the coarser grain at which D presents the information originally plotted in A.

2.6 Environmental covariates

2.6.1 Insect harassment indices

The CircumArctic Rangifer Monitoring Agency (CARMA) established five overlapping geographic regions for each of the Bathurst and Beverly ranges in which they calculate region-wide daily and cumulative harassment indices for oestrids (bot flies) and for mosquitoes. The CARMA harassment indices are based on remotely sensed weather variables from NASA's Modern Era Retrospective Analysis for Research and Applications (MERRA) dataset (Russell et al. 2013). CARMA's processing of the MERRA data largely relies on established relationships of insect abundance with temperature and wind speed and direction (Russell et al. 2013). While the five regions for each herd were based on historical seasonal distributions, they are effectively fixed polygons for which daily harassment index values have been determined. The 10 CARMA seasonal polygons ranged from 29,226 km^2 to 278,387 km^2, a spatial resolution between 1 and 10 million times larger than the 3.1-ha hexagon grid used to characterize study area attributes. After examination of annual cycles of CARMA's oestrid and mosquito harassment index values it was concluded that the potentially affected seasons during the 2016 to 2022 period were calving, post-calving, summer, and late summer.

The screened 8-hour-interval caribou location data (Section 2.3.2) for each sex of each herd for each of the four seasons of each year were independently intersected with the 10 CARMA regional polygons and the best fit between the caribou location data and the regional polygons was used to select the insect harassment data sets to use as covariate data for each sex and herd in each season of each year. The appropriate oestrid and mosquito daily harassment index values were appended to each 1-hour and 8-hour caribou step record (Section 2.8) in each data set for each of the four seasons with insect harassment.

The mixed effects Poisson model (Section 2.8) used for habitat selection in this report relies on comparisons of the characteristics of each real caribou movement step and a number of random steps beginning at the same location. In every instance, the insect harassment index values are identical for the actual (TRUE) movement step and the random (FALSE) movement steps. Consequently, neither oestrid nor mosquito harassment could be incorporated as a stand-alone covariate in models; instead, they were incorporated in interaction terms with landcover covariates. Given that the insect harassment covariates themselves did not differ between TRUE and FALSE steps, the interaction term was used to determine if landcover selection varied in response to insect harassment index values. Witter et al. (2012, p. 293) summarised insect relief terrain for reindeer and caribou as variously including eskers, areas of higher elevation, and coastal areas. Hagemoen and Reimers (2002) included snow patches, marshes, hilltops, ponds, and windy mountaintops as oestrid relief areas.

In analyses for this report, when the preliminary top model for any of the seasons with potential insect harassment included select landcover covariates (water edge; waterbody area proportional cover; esker proportional cover; or mean elevation), interactions were created between oestrid and mosquito daily harassment indices and those covariates and new candidate models were created including insect harassment (See Section 2.8.5.3 below for details).

2.6.2 Human development and distance from feature measurements

Polygon coverages of mining developments and mine roads were produced from data provided by Arctic Canadian Diamond Company Ltd. and Diavik Diamond Mines Inc. Winter road locations were based on the shapefile of the Tibbitt to Contwoyto Winter Road (polyline file provided by Arctic Canadian Diamond Company Ltd.); the Tibbitt to Contwoyto Winter Road was plotted as a line feature terminating at the Ekati Diamond Mine, the limit of its construction during the study period.

Additional mines, exploration sites, and other human developments within the range of the Bathurst caribou herd were provided as shapefiles by GNWT-ENR (ENR 2022), who maintain the development layer for the Bathurst Caribou Range Plan.

Using the Landscape Scripting Language (LSL, Kushneriuk and Rempel 2011), distances from the centroid of the 3.1-ha hexagon containing each real or random caribou location were calculated to:

- the nearest point on the nearest Ekati mine road polygon;
- the nearest point on the nearest Ekati or Diavik mine infrastructure polygon;
- the nearest point on the winter road; and
- the nearest point on the nearest human development or exploration area polygon > 10 ha, and not accounted for in three human development categories immediately above.

When the distance from the caribou location to a feature was > 30 km it was given a value of 30,001 m. Distance from winter roads were considered only in winter season analyses.

2.7 Study period and study area delineation

As the objective of the analyses was to examine fine-scale effects of the Ekati Diamond Mine on barren-ground caribou behaviour, the study period was defined by the period for which telemetry location data were collected multiple times per day. For 8-hour interval analyses the period was winter 2015/2016 through post-rut 2022. For 1-hour analyses the period was spring migration 2017 through post-rut 2022 as it was dependent on the deployment of radio-collars set to acquire locations on 1-hour intervals in the geofence areas (Section 2.3.1).

2.7.1 Regional study area

The spatial delineation of the study areas (Figure 2-4) was jointly determined by the area of potential influence of mining infrastructure and operations on caribou behaviour (see Section 2.8.4) and by the ranges used by the two herds during the study period. The regional study area (RSA, Figure 2-4) is defined as the limit of the extent of data considered in analyses.

The first objective was to characterize seasonal habitat selection based on landcover, topography, and insect harassment within the ranges of the Bathurst and Beverly caribou herds but beyond the influence of development infrastructure and operations (Figure 2.4). Telemetry data within that portion of the RSA were collected only at an 8-hour interval. After estimating seasonal habitat selection by caribou beyond the influence of development, the resulting seasonal habitat selection functions were used to predict relative habitat selection values within 30 km of the Ekati and Diavik mines and mine roads.

Predicted relative habitat selection value, movement characteristics, and distances from mine infrastructure and roads were then jointly analysed to determine the apparent effects of the proximity of mine infrastructure or mine roads on seasonal habitat selection at 8-hour time-step intervals and 1-hour time step intervals.

2.7.2 Ekati/Diavik 30 km halo

At the coarser temporal scale (8-hour interval) used for analyses, movement step data were restricted to an area within a 30 km buffer around the Ekati and Diavik mine roads and mine infrastructure (hereafter: Ekati/Diavik halo). The Ekati/Diavik halo is shown in purple in Figure 2-4.

2.7.3 Geofence 112 North (GF112N)

At the fine interval scale the objective was to examine behavioural responses that occur in short periods of time (1-hour intervals) and at the associated spatial resolution (a few hundred metres) – in an area within approximately 30 km of mining infrastructure (the approximate buffer around the Ekati and Diavik mines). The 1-hour data included in analyses in this report data were restricted to the portion of geofence 112 north of 64°12’ North latitude (hereafter: GF112N; in green in Figure 2-4).

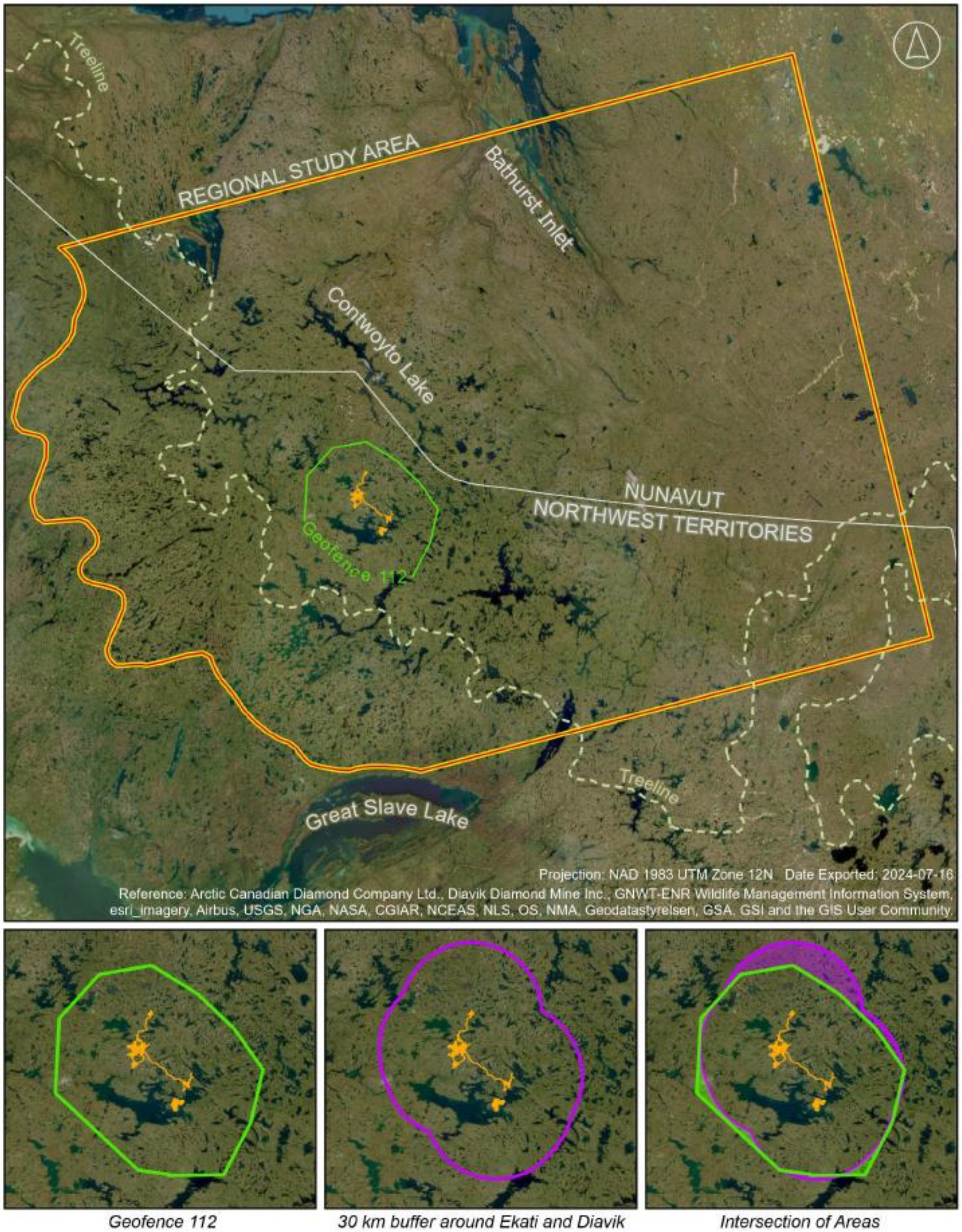


Figure 2-4:
Regional and Local Study Areas

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As there were no 1-hour interval data collected beyond the areas expected by GNWT-ENR to be affected by human development (i.e., the geofenced areas), it was not possible to estimate relative habitat selection values beyond the influence of human development as done for 8-hour interval data. Instead, predicted relative habitat selection values for 1-hour analyses were based on the same equations used in 8-hour interval analyses.

The Ekati/Diavik halo and GF112N differ slightly in their geographic limits. GF112N was set as the 30 km extent of 1-hour interval telemetry data acquisition before development of the Sable Project at Ekati (Figure 2-2). The Ekati/Diavik halo is a 30 km buffer around development as it existed for the period of data analyzed in this report. The differences in the extents of GF112N and the Ekati/Diavik halo are shown as insets in Figure 2-4.

2.8 Selection analyses

Throughout this report, the analytical approach will be generally referred to as habitat selection analysis following Fieberg et al. (2021) and Northrup et al. (2022). Specifically, the analyses used were step selection functions and integrated step selection analysis (iSSA).

The scale dependence in habitat selection (Johnson 1980; Wiens 1989) has influenced the development of data collection and habitat selection analyses techniques for several decades. The research objectives of this study are to examine caribou movement and habitat selection relative to distances to mine roads and other mining infrastructure over short time periods (i.e., 1-hour and 8-hour intervals); fine temporal scales that imply parallel fine-scale spatial scales and behaviour that requires available habitat to be re-defined with each movement. This follows the hierarchical interpretation of habitat selection first described by Johnson (1980). Older reports of habitat selection analyses for caribou (e.g., Rettie and Messier 2000; Johnson et al. 2005) incorporated a significant advance in analyses introduced by Arthur et al. (1996): the location-specific definition of available habitat in a circular buffer, scaled to step-length and centred on each location. An important drawback of generating random locations in circular buffers to define available habitat is that it implies that an individual perceives habitat as more available when it is further away from the starting location (Rhodes et al. 2005). Fortin et al (2005) further advanced the dynamic assessment of available habitat when they developed step selection functions (SSFs) in which each real movement step is matched with a number of random locations based on step lengths and turning angles observed in the real movement data, resulting in available random locations that reflect an animal's movement patterns. Forester et al. (2009) showed that incorporating movement into analyses would reduce bias in the resulting SSFs.

The development of iSSA (Avgar et al. 2016; Signer et al. 2019; Fieberg et al. 2021) incorporated both movement covariates and habitat covariates in the analysis of habitat selection. Consequently, iSSA was chosen for this examination of 8-hour and 1-hour habitat selection by caribou in the vicinity of the Ekati and Diavik diamond mines. This follows the recommendation of Northrup et al. (2022, p. 12) to use iSSA for selection analyses over short time intervals. In the examination of short-interval movements, it is important to reiterate the conditional nature of selective behaviour; habitat selection in a 1-hour or 8-hour interval is conditional on patches of habitat with specific attributes being accessible to an animal within a typical movement step during that time period. Step selection functions are scale-dependent (Fieberg et al. 2021) and differences are expected between model results from different time intervals, including between the 1-hour and 8-hour intervals in this study.

The iSSAs in this study examine two scales of selection (i.e., 1-hour and 8-hour interval movements). Together, telemetry data collection and the random step generation process included in SSF and iSSA determine the TRUE location (telemetry point) and the set of FALSE locations (random points) for each stratum. However, the grain at which the attributes of each point are measured to determined the characteristics of the locations is variable and is specified by the analyst. Analyses in this study include multiple grains of measurement for most covariates and allow the analytical processes to identify the best grains of measurement for covariates to fit the best model. The importance and implementation of multiple-grain habitat characterization for each used and random location are described in Section 2.5.3.

Mixed-effects Poisson models were fit in all SSFs and iSSAs using the glmmTMB function in the glmmTMB package in R (R Core Team 2022).

Following the recommendation of Northrup et al. (2022 p. 14) key factors were identified prior to the start of modelling. Of the four factors considered (herd, year, sex, and season), a priori expectations of sex and season effects in habitat selection made those two factors priorities. Consequently, all selection modelling was conducted separately for each sex within each of the seasons. The steps outlined below were followed for each of the data sets.

2.8.1 Random step generation

2.8.1.1 8-hour movement steps

Following the reduction of the 8-hour caribou location data to fixed collection times and the establishment of a fixed time period for the study, the locations were reduced to those that fell inside the established RSA during the study period. Animal movement step lengths were calculated in the traipse package in R (R Core Team 2022); locations with prior steps of 0 m length were removed. Remaining data were then divided into the nine seasons established for analyses.

Using the amt package in R (Signer et al. 2019; R Core Team 2022), data were then processed as follows:

- The movement interval was set to 8 hours ± 6 minutes;
- Animal-seasons with fewer than 20 locations were excluded from analyses. A minimum number of locations is necessary as each animal in each season in each year must have sufficient data to properly characterize the distribution of its movement step lengths and turning angles;
- In all analyses, step lengths and turning angles were determined for each individual animal-season of data. Data for each animal-season were used to create movement tracks; track data were then summarized and turning angles were fit to a Von Mises distribution while step-lengths were fit to a gamma distribution (Avgar et al. 2016; Signer et al. 2019);
- For each real movement step, five random locations were generated from the step-length and turning angle distributions. Each stratum for analyses consisted of one real (TRUE) location and five random (FALSE) locations with a common starting location and stratum identifier;
- All animal identification information and the insect harassment index values were copied from the real location to the random locations in each stratum; and
- A single file was written for each season. It contained all sets of real and random locations for both sexes from all years.

2.8.1.2 1-hour movement steps

Preparation of the 1-hour data inside GF112N around the Ekati and Diavik mines followed the same process used for 8-hour data. Data were reduced to the time period selected for the study. There were two differences in the processing of 1-hour data:

- Spatial screening to the limits of GF112N was applied in LSL as a precaution, though the 1-hour data were constrained by the geofence perimeter that resulted in the collection of data on a 1-hour interval; and
- The movement interval was set to 1 hour ± 6 minutes.
- As with 8-hour data, a single file was written for each season for 1-hour interval data. It contained all sets of real and random locations for both sexes from all years.

2.8.2 Addition of environmental covariate data for 8-hour and 1-hour step data

The resulting locations from 8-hour and 1-hour amt step generation were intersected with the LSL 3.1-ha hexagon data layer. The environmental covariate data for the hexagon containing the end point of each step were attached to each of the real and random steps in each file. These data consisted of the landcover proportions at each of the nested spatial grains (Section 2.5), topographic data (Section 2.5), insect harassment data (Section 2.6.1). Distances to human developments were calculated from each location to mine roads, mine infrastructure, and winter roads (Section 2.6.2).

For the 8-hour interval data, distance from human development data values of 30,001 m were used to screen data but not used in distance-from-feature analyses (Section 2.8.4).

2.8.3 Exploratory analyses, data transformation, and scaling

After defining covariates, exploratory analyses included examinations of data at each of the four grains of landcover measurement. Key results were:

- model sensitivity (true positive rates) and specificity (true negative rates) varied across grains, with the 59 ha (_S2) grain being poorest overall;
- two transformations of covariates were examined, logit and square root. In each case, proportional cover covariates were first transformed, after which they were centered and scaled using z-deviates (mean = 0, standard deviation = 1.0). Regardless of the transformation applied to proportional cover covariates, non-proportional continuous covariates (e.g., elevation and slope) were scaled, but not transformed. In almost every case the logit transformation of the explanatory covariates resulted in better model performance than the square root transformation. Scaling was applied to facilitate the interpretation of coefficients of covariates measured with different units; and
- analyses tested the relative performance of boosted regression tree (BRT) models (Section 2.8.5.1 below) that included quadratic form (squared versions of covariates). The models with quadratic terms performed better than those without.

These analyses supported three decisions regarding the data:

- The 59 ha grain (_S2 versions of covariates) were eliminated from further consideration at this point;
- All landcover covariates at all grains for all data records (real and random) were logit transformed and then scaled as z-deviates; and

- The transformed and scaled values were then squared to provide a second version of each of the covariates, to provide data to allow for nonlinear effects through quadratic forms of models (Fieberg et al. 2021).

Additionally, all distances from mine roads, mine infrastructure, and winter roads were rescaled from m to km. Factors were created for herd, year, and binary classification of the 3.1-ha hexagon as Boreal Forest and Woodland vegetation (1) or not (0).

Prior to iSSA modelling of 1-hour and 8-hour interval data, movement step covariates were transformed in R: step turn angles were transformed to cosine of the turn angle (cos.ta) and step lengths were rescaled from m to km (sl.km) and then transformed as the natural log of step length (log.sl.km) following recommendations of Avgar et al. (2016) and Prokopenko et al. (2017). Log transformed versions of distance from feature covariates were also created and used in some candidate models.

Following transformation and scaling, landcover covariates were analyzed for collinearity (and multicollinearity) among explanatory covariates at each grain using the variance inflation factor (VIF). The VIF was calculated using the function ols_vif_tol in the R package olsrr. The VIF measures the inflation in the variances of the covariate estimates due to collinearities that exist among the predictors (Belsley et al. 2005). A VIF of 1 means that there is no correlation, values between 1 and 5 suggest moderate correlation, and values exceeding 10 are signs of serious multicollinearity requiring correction. In preliminary analyses, collinearity was initially detected, with some VIF values approaching 20, but when proportional cover by water derived from landcover layers was replaced with proportion waterbody area derived from CanVec Series - Hydrographic Features (Natural Resources Canada 2019), collinearity (VIF) was greatly reduced.

Attributes common to all step selection analyses appear in Table B-1. The set of covariates used in 8-hour interval SSFs outside a 30 km buffer around the Ekati and Diavik mine roads and mine infrastructure (Ekati/Diavik halo, see Section 2.8.4 below) appear in Table B-2. Two interaction terms at the 3.1-ha grain were also added to the basic set of covariates (Table B-2). Covariates used in 8-hour interval iSSAs inside the Ekati/Diavik halo appear in Table B-3.

The covariates used for 1-hour interval iSSAs inside GF112N appear in Table B-4.

2.8.4 Separation of 8-hour interval data for modelling

Boulanger et al. (2021, p. 11) indicated 30 km as the likely limit of the effect of the Ekati and Diavik mines on caribou habitat selection, accounting for the selection of 30 km as the buffer used for the Ekati/Diavik halo (Section 8.4.3). Other distances of effects of human disturbances on Bathurst caribou have been estimated and applied in a number of previous analyses. In the Bathurst Caribou Range Plan (GNWT 2019, Appendix A, Table 2) zones of influence around active mines were buffered by 14 km while other polygonal features and linear features were buffered by ≤ 5 km. In the environmental assessment for the Jay Project (Dominion Diamond 2014, Table 12.4-15) the maximum extent of influence around communities and active mines was 15 km while all other development features were considered to have effects ≤ 5 km.

Eight-hour interval data for each season (with covariates attached as listed in Tables B-1 and B-2) were divided spatially:

- All records from strata whose TRUE step ended in the Ekati/Diavik halo (30 km buffer; Figure 2-5) were removed and retained for the iSSA analyses of 8-hour interval data; and

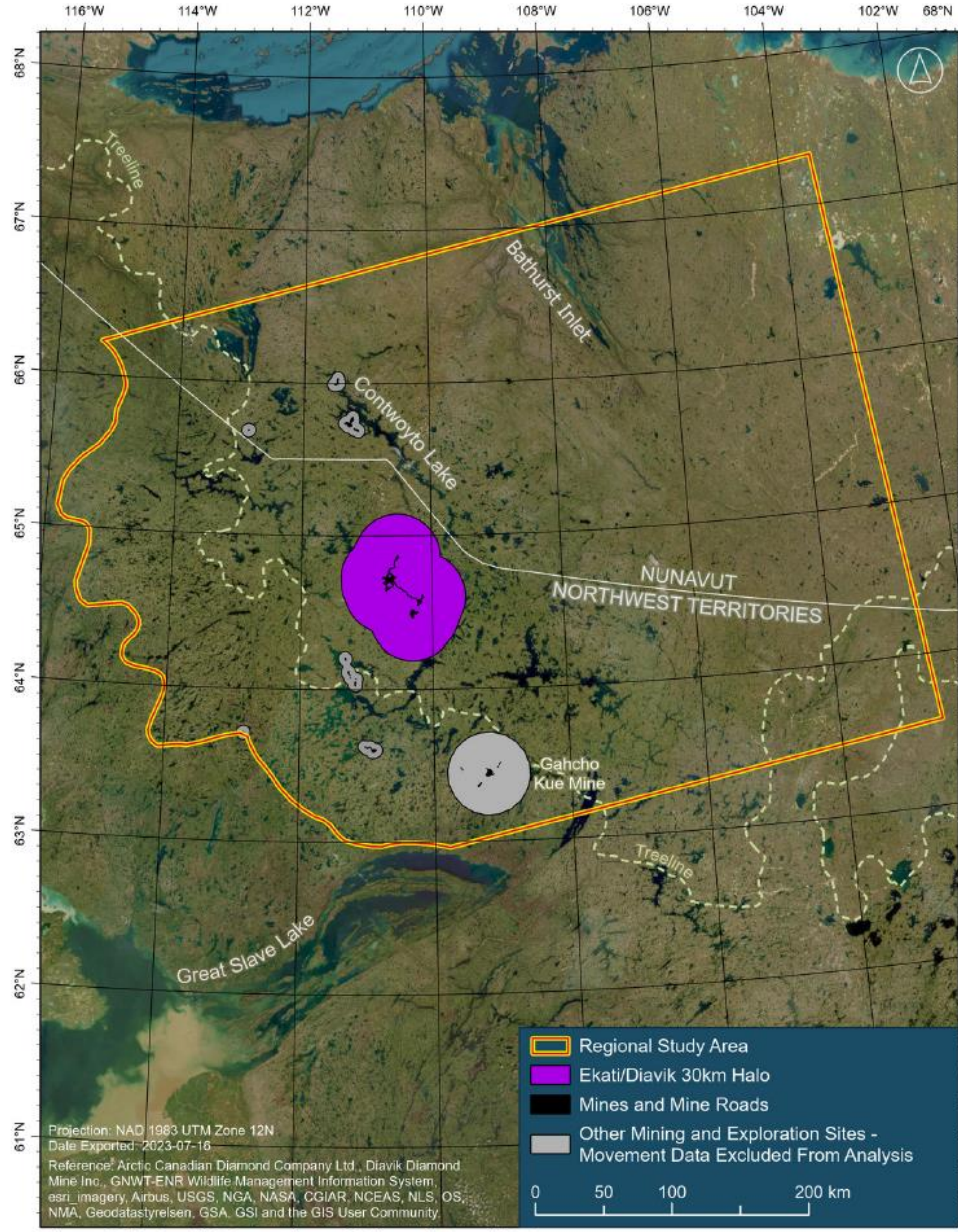

Figure 2-5: Spatial Screening of 8-hour Interval Data Prior to Integrated Step Selection Function Modelling.

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- From remaining data, all strata were removed if their TRUE step ended within 30 km of the centroid of the Gahcho Kué mine (active during the study period), or within 5 km of any other development, mine, or exploration site polygon > 10 ha found in the GNWT-ENR human disturbance data set for the Bathurst herd (Figure 2-5; GNWT-ENR 2022). These data were not used for any subsequent analyses.

The remaining data were strata with TRUE steps ending in the RSA but outside the influence of development (i.e., the Ekati/Diavik halo, the buffered Gahcho Kué mine, and the other buffered developments, mines, and exploration areas; Figure 2-5). These data were used in the SSF analyses of 8-hour interval habitat selection outside the Ekati/Diavik halo.

Each of the seasonal data sets were divided by sex and the data for each sex were then divided into train (70% of data) and test (30% of data) data sets. Rather than randomly splitting data pooled among all animals, data from each animal-season were kept together. This better accounted for inter-animal and inter-annual variation.

2.8.5 8-hour interval Step Selection Functions outside the Ekati/Diavik halo

The objective of the step selection functions (SSFs; 8-hour movement analyses outside the Ekati/Diavik halo) was to identify the best models of habitat selection for each sex by season. The exponentiated versions of the resulting SSFs were then used to predict relative habitat selection values for each 3.1-ha hexagon inside the Ekati/Diavik halo, a pre-cursor to iSSA analyses. To properly account for movement patterns, predicting relative habitat selection values from iSSAs requires extensive simulations of movement, analytical processes that are not advanced in their development (Signer et al. 2017; Fieberg et al. 2021; Northrup et al. 2022). While a recent publication (Michelot et al. 2024) presented a sample approach and a framework for its development, the simulations required are beyond the scope of this project. Consequently, SSF was chosen for these analyses, and movement covariates for turning angle and step length were excluded from candidate models.

The steps outlined below were followed for each of the sex by season data sets.

2.8.5.1 Generalized boosted regression models

The selection and measurement of multi-grain landcover and topographic covariates (Section 2.5.3), followed by their transformation, scaling, and squaring (Section 2.8.3) yielded an expansive set of covariates. To identify the covariates with the greatest relationship to caribou movement steps, the data were first explored (separately for each sex by season) with a boosted regression tree (BRT) model in R (R Core Team 2022) using the package gbm. Gradient BRT modelling is a sequential machine learning process that works to construct a predictive model with high accuracy.

The BRT models used for analyses in this report specified a Bernoulli distribution, as recommended for logistic regression, a 10-fold cross validation, and a maximum of 250 trees (iterations). The covariates included in BRT analyses are those listed in Table B-2 (Appendix B), excluding the last two items in the table, which are the insect harassment indices. The relative influence was calculated for each covariate and those covariates with relative influence values ≥ 1.0 were passed forward to stepAIC modelling (Section 2.8.5.2).

2.8.5.2 StepAIC modelling

The list of BRT covariates with relative influence values ≥ 1.0 were defined as the candidate covariates for the full model in the stepAIC modelling. Generalized linear models (glm) were fit using stepAIC in the

MASS package (Venables and Ripley 2002) in R (R Core Team 2022). The glm model used a forward/backward selection approach, where Akaike's Information Criterion (AIC) values were used to select the best model. Two performance measures were used. The first was deviance ratio (1 – (model deviance/null deviance)), which represents the proportion of variance explained. The second was AIC value, which assigns a penalty based on number of covariates included in the model to meet the objective of removing unnecessary information (Burnham and Anderson 2002).

2.8.5.3 Mixed effects Poisson models

The final model from the stepAIC process (a separate process for each sex by season) was used to select covariates from which candidate model sets were constructed (Table 2-3). Candidate model development followed the rule set described in Table 2-3 and produced four models for most seasons, with two additional candidate models added in summer and in late summer to account for insect harassment.

Table 2-3: Model development for 8-hour SSFs outside the Ekati/Diavik halo

Model name	Seasons	Origin and general characteristics of models
Mixed Grain 1	All	Inherited set of covariates from stepAIC process.
Mixed Grain 2	All	Inherited set of covariates from stepAIC process, then modified: a. removed all covariates where $p > 0.10$ [1]; b. where both grain 3 and 4 version of any covariate remained, they were reduced to a single covariate for coarser grains; first, broadly by significance, and, if significance was approximately equal then defaulted to grain 3; and c. when there was a squared version of any covariate, the base version of the covariate was added if it was not already in the model. This functionally developed a quadratic function for the covariate.
Fine Grain	All	Inherited set of covariates from Mixed Grain 2, then modified: when both grain 0 and grain 3 or 4 values of one or more covariates were included in Mixed Grain Model 2, then a fine grain model was created with only the grain 0 version of those covariates. Any model covariates contained in the Mixed Grain 2 model at only one grain were retained.
Coarse Grain	All	Inherited set of covariates from Mixed Grain 2, then modified: when both grain 0 and grain 3 or 4 values of one or more covariates were included in Mixed Grain Model 2, then a coarse grain model was created with the grain 0 version of those covariates removed (similar to the process applied to yield the Fine Grain Model). Any model covariates contained in the Mixed Grain 2 model at only one grain were retained.
Oestrid	summer, late summer	The top AIC model among the Mixed Grain, Fine Grain , and Coarse Grain models was modified by adding interaction terms between the OestIndx_1 and each of: ELEVATION, P_ESKER, WBAREA, and WAT_EDGE, when they occurred in the model, and at their finest grain of occurrence (Section 2.6.1). This was then included as an additional candidate model.
Mosquito	summer, late summer	The top AIC model among the Mixed Grain, Fine Grain , and Coarse Grain models was modified by adding interaction terms between the MosqIndx_1 and each of: ELEVATION, P_ESKER, WBAREA, and WAT_EDGE, when they occurred in the model, and at their finest grain of occurrence (Section 2.6.1). This was then included as an additional candidate model.

[1] a cut-off of $p > 0.10$ rather than $p > 0.05$ was chosen to include additional covariates from the stepAIC process in the candidate model sets.

Each candidate model was fit to the data using a mixed effects Poisson model with stratum-specific random intercepts. This was implemented using the glmmTMB function in the glmmTMB package in R (R Core Team 2022). A mixed effects Poisson model with stratum-specific random effects has the equivalent likelihood to a conditional logistic regression (Muff et al. 2020). It also provides a convenient framework for adding random slopes, as done for modelling data inside the Ekati/Diavik 30 km halo (Sections 2.8.7 and 2.8.8).

Following Burnham and Anderson (2002) and the recommendation of Aho et al. (2014), AIC was used to select the best model from the candidate model set for each sex in each season. Aho et al. (2014) noted that AIC evaluation of candidate models is likely to favour increased model complexity, i.e., include more covariates. Fang (2011) showed that for mixed effects models, marginal AIC and leave-one-cluster-out cross-validation are asymptotically equivalent and appropriate for population inference.

The overall performances of the top SSF models were assessed using receiver operating characteristics (ROCs) Area Under the Curve (AUC, Boyce et al. 2002) and the case probability. Case probability is a concordance statistic, a generalization of AUC for stratified models (Smith et al. 2022). It was calculated as the probability of a case (used location) being correctly classified (ranked higher than a random location). An AUC or case probability value of 1.0 indicates perfect prediction of used and random steps. The value declines to 0.50 when the prediction is equivalent to random allocation (i.e., no predictive power [Boyce et al. 2002]). To validate the model developed using train data, coefficients from the train data model were applied to the test data to obtain predicted values. Model fit and predictive accuracy were assessed using AUC, average case rank, average random rank, and case probability.

Each of the candidate models was run a second time, including movement covariates (step length, log step length, and cosine turning angle). The original random intercept model results were compared to the random intercept plus movement model results via graphical comparison of 95% confidence intervals (CI) for each fixed covariate coefficient.

The resulting SSF covariates and coefficients from analyses for each sex by season were used to calculate the relative habitat selection value for each 3.1-ha hexagon.

2.8.6 Prediction of relative habitat selection values within the Ekati/Diavik 30 km halo and geofence 112 North from 8-hour SSF analyses results in the Regional Study Area

The 8-hour sex by season SSFs from outside the Ekati/Diavik halo (Section 2.8.5), were used to determine predicted relative habitat selection value (PRHSV) for each 8-hour movement record in the Ekati/Diavik halo (Section 2.8.7 below) and each 1-hour movement record in GF112N (Section 2.8.8 below). The PRHSV (*w(x)*) was calculated in R (R Core Team 2022) by exponentiating the linear combination of the SSF covariates (x_i) and their coefficients (β_i), excluding the intercept (Boyce et al. 2002; Fortin et al. 2005).

$$\mathrm{w}(x) = exp(\beta_1 x_1 + \beta_2 x_2 + \cdots \beta_k x_k)$$

where:

w(x) is the relative habitat selection value for 3.1-ha cell x;

(x_i) is the measure of covariate i for hexagon x; and

(β_i), is the coefficient for covariate i.

When the SSF for a season included insect harassment covariates, the mean seasonal insect harassment index value was substituted as its coefficient in the equation for each hexagon.

For visual presentation, the predicted relative habitat selection value (PRHSV) for every 3.1-ha hexagon in the Ekati/Diavik halo was ranked, then mapped by percentile for each sex by season.

2.8.7 8-hour interval integrated Step Selection Analyses inside the Ekati/Diavik halo

Integrated step selection analyses were used to examine 8-hour interval data for each sex by season from within 30 km of the Ekati and Diavik mines. A common candidate model set for each sex by season integrated PRHSV, movement covariates, and distance from mining features. The objective of these analyses was to identify the effects of distance from mine features on 8-hour interval caribou behaviour,

As described in Section 2.6.2, distances from the centroid of the 3.1-ha hexagon containing the terminus of each real or random caribou movement step were calculated to:

- the nearest point on the nearest Ekati mine road polygon; and
- the nearest point on the nearest Ekati or Diavik mine infrastructure polygon.
- An additional distance-from-feature covariate was defined as the minimum of the distance from mine road and the distance from mine infrastructure. The minimum distance from mining feature is greatly influenced by the layout of the Ekati and Diavik mines; mine roads typically terminate at other mine infrastructure. As is apparent in Figure 2-6, locations inside the Ekati/Diavik halo are approximately 3 times more likely to be closer to mine infrastructure (76%) than mine-roads (24%).

The steps outlined below were followed for each of the sex by season data sets.

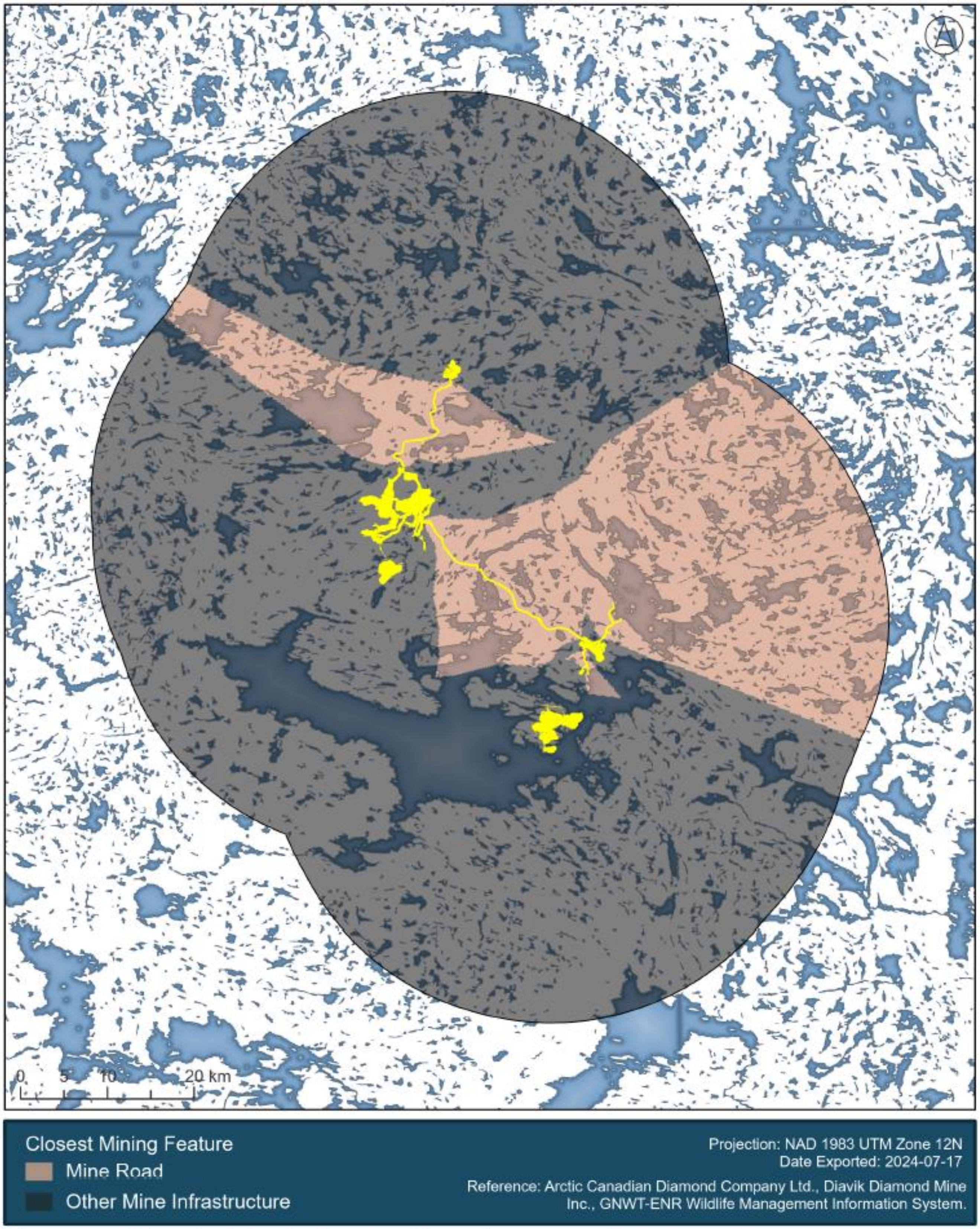

Figure 2-6: Closest mining feature type to each 3.1 ha hexagon in the Ekati/Diavik 30 km halo

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2.8.7.1 Mixed effects Poisson models

The 8-hour data from inside the Ekati/Diavik halo were modelled using mixed effects Poisson models. Each candidate model included movement covariates and the PRHSV (Section 2.8.6). A random intercept was included for stratum and random slopes were included for each individual animal in each year. Candidate model development followed the rule set described in Table 2-4 and produced four models for each season.

Table 2-4: Candidate models for 8-hour iSSAs inside the Ekati/Diavik halo

Model name	Seasons	Model description and formula
Base Model	All	3.1-ha hexagon predicted relative habitat selection value (PRHSV); movement covariates (cos.ta, sl.km, log.sl.km); random intercept for stratum; random slopes for log.sl.km and PRHSV.
		PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)
DFMines	All	Base model + log(distance from mine); + interaction between log(distance from mine) and log.sl.km; + interaction between log(distance from mine) and PRHSV; + random slopes for log(distance from mine) and interaction terms.
		PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)
DFMineRoads	All	Base model + log(distance from mine roads); + interaction between log(distance from mine roads) and log.sl.km; + interaction between log(distance from mine roads) and PRHSV; + random slopes for log(distance from roads) and interaction terms.
		PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)
MinDF	All	Base model + log(min distance from mine or mine road); + interaction between log(min distance from mine or mine road) and log.sl.km; + interaction between log(min distance from mine or mine roads) and PRHSV; + random slopes for log(min distance from mine or mine road) and interaction terms.
		PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)

Each of the 8-hour iSSA candidate models (Table 2-4) were fit with mixed effects Poisson models using the glmmTMB function in the glmmTMB package (R Core Team 2022).

Model predictions were ranked within each stratum. The AUC, case probability, and average ranks of cases and random locations were calculated for each model. Case probability is a concordance statistic, a generalization of AUC for stratified models (Smith et al. 2022); see Section 2.8.5.3 for more detail on case probability. Candidate models were sorted by case probability and the model with the highest case probability chosen as the top model. Case probability was also used to compare results of test and train data sets for the top model in each sex by season.

2.8.8 1-hour interval integrated Step Selection Analyses inside GF112N

As described in section 2.8.6, the 8-hour SSF models from outside the Ekati/Diavik halo (Section 2.8.5), were used to produce the PRHSV for each 1-hour movement record in GF112N. The objective of these analyses was to identify the effects of distance from mine features on 1-hour interval caribou behaviour.

The process for 1-hour interval iSSAs followed that used for 8-hour interval data in Section 2.8.7:

- Integrated step selection analyses were used to examine 1-hour interval data for each sex by season from within GF112N;
- The same common candidate model set (Table 2-4) used for 8-hour interval iSSAs was used for each 1-hour interval iSSA. The models integrated PRHSV, movement covariates, and distance from mining features, including a model with a minimum distance-from-feature covariate. A random intercept was included for stratum and random slopes were included for each individual animal in each year.

All 1-hour interval iSSA candidate models were fit with mixed effects Poisson models using the glmmTMB function in the glmmTMB package (R Core Team 2022). This is the same process used for the 8-hour iSSAs.

As with the 8-hour iSSA, model predictions, 1-hour iSSA model predictions were ranked within each stratum. The average ranks of cases and random locations were calculated for each model. Case probability was calculated and used to rank candidate models within each sex by season. Case probability was also used to compare results of test and train data sets for the top model in each sex by season.

2.9 Movement characterization

Following examination of movement data summaries, Poole et al. (2021) raised concerns regarding the relationship between diamond mines (including infrastructure, roads, and operations) and caribou movements. The simple relationship of caribou movements to the proximity of mine infrastructure is confounded by habitat selection and the spatial distribution of natural environmental features. These relationships were explicitly addressed through iSSAs as described in Section 2.8.

To examine the effects of an animal’s exposure to the Ekati and Diavik mines on its behaviour at the seasonal scale, analyses were conducted on 8-hour interval data to quantify and test the relationships between time spent in the Ekati/Diavik halo and: (1) total movement pathway within a season; and (2) delayed arrival at the next seasonal range.

2.9.1 Effect of exposure time in Ekati/Diavik halo on length of seasonal movement path

The total length of the seasonal movement path for each animal-season was calculated as the sum of all 8-hour movement steps in the season (determined in R package amt; R Core Team 2022). This included all locations for each animal, regardless of whether they were in or out of the RSA.

The seasonal movement path length calculated as a sum of step lengths is affected by missing movement steps for individuals. These occur owing to failed GPS location fixes, late-season collar deployment (typically in winter), mortality, scheduled collar removal, or collar failure. To provide relative consistency among animal-season records, a minimum of 90% of the maximum number of locations possible for an animal-season was required for the data to be included in analyses; at 8-hour intervals, the maximum number of locations is 3 times the season length in days.

The number of 8-hour movement steps ending in the Ekati/Diavik halo was then determined for each animal-season of data; essentially the total number of locations in the Ekati/Diavik halo for each animal in each season in each year. This was regarded as a measure of the animal's exposure time to the effects of the mines and mine roads.

Linear regression of seasonal path length on Ekati/Diavik halo exposure time was conducted in R. These analyses compare how far each animal moves in an entire season to how long it spent in the Ekati/Diavik halo in that season. In addition to separate analyses for each sex in each season it was necessary to divide data into the two herds as the season lengths varied between the Bathurst and Beverly herds (Table 2-1). Other than creating 90% UD seasonal ranges, this is the one instance in this report where herd was used to divide data prior to analyses.

2.9.2 Effect of exposure time in Ekati/Diavik halo on delayed arrival in next seasonal range

As with the examination of the effect of exposure to the Ekati/Diavik halo on total movement pathway, the number of 8-hour movement steps ending in the Ekati/Diavik halo was used to address concerns regarding the effect of exposure in one season on the arrival date in the 90% UD seasonal range used in the next season.

As seasonal ranges included areas outside the RSA (Section 2.4), the entire set of 8-hour locations for each animal-season was included in these analyses. Animal-seasons included in these analyses were restricted to sets of data with locations on ≥ 75% of 8-hour location fix attempts, the same threshold for data inclusion used for calculations of seasonal UDs (Section 2.4.3).

The first 8-hour telemetry location for each animal in each season (Table 2-1) was identified as the first possible date and time the animal could have been detected in a seasonal range. Each set of animal-season 8-hour locations was intersected with the appropriate 90% UD seasonal range to identify the earliest location of the animal recorded inside the seasonal range. A delay in arrival was defined as the number of days between the first telemetry location recorded for the season and the first telemetry location recorded inside the 90% UD seasonal range. When the first location for the season was within the 90% UD seasonal range the delay was recorded as 0.00 days (i.e., no delay).

The set of animal-season records contained cases where individuals present in one season did not have any locations in the following season, likely owing to mortality, collar failure, or collar removal. These records were removed from further consideration. There were also cases where individuals had telemetry location data from both seasons but never entered the 90% UD seasonal range delineated for the later season; these records are summarized in the results section but were not analysed further.

While the length of exposure to the Ekati/Diavik halo was measured (i.e., number of 8-hour movement steps as in Section 2.9.1) and the length of any delay was calculated for each animal-season, the data were ultimately reduced to binary categories for analyses: 1. Did the location data intersect the Ekati/Diavik halo - TRUE or FALSE; and 2. Was the animal delayed in arrival on the next seasonal range - TRUE or FALSE. Fisher's exact tests were used to test the independence of Ekati/Diavik halo intersection and delayed arrival in the next seasonal range in program R (R core team 2022).

3. RESULTS

3.1 Caribou location data

Telemetry location data received from GNWT-ENR (ENR 2022) for the Bathurst herd included data from 1996 to the end of 2022. The data received from GNWT-ENR for the Beverly herd were compromised for the period prior to December 2015, restricting available data for the Beverly herd to the period from December 2015 to December 2022 (Table 3-1).

The screening of caribou location data resulted in the removal of duplicate locations, locations collected less than 55 minutes apart, and locations deemed to be movement outliers. A review of location frequency by hours of the day and minutes of the hour provided information for additional screening and resulted in the selection of 8-hour and 1-hour intervals for SSFs and iSSAs. The collection of 1-hour interval data sufficient for analyses began with spring migration 2017 for the Bathurst herd and spring migration 2018 for the Beverly herd.

Table 3-1: Number of radio-collared Bathurst Herd and Beverly Herd caribou with location data[1] considered in this study: by herd, sex, and year

	Bathurst Herd		Beverly Herd	
Year	Male	Female	Male	Female
2016	15	27	9	27
2017	19	31	16	33
2018	16	24	22	36
2019	15	28	24	33
2020	16	56	13	21
2021	16	47	25	30
2022	20	48	21	36
Total	117	261	130	216

[1] *Environment and Natural Resources (2022).*

3.2 Seasonal caribou ranges (utilization distributions [UDs])

Time periods with daily location data and seasonal screening criteria are presented in Table 3-2 (Bathurst herd) and Table 3-3 (Beverly herd). The available data permitted 90% UD seasonal ranges to be calculated for each sex in each herd from winter 2015/2016 to post-rut 2022; seven complete years, though the sample size for Beverly males was only 4 animals with adequate location data prior to spring migration 2017. Iterative seasonal range smoothing parameter values for female Bathurst caribou were calculated beginning with winter 2008/2009 and results were included in the determination of Bathurst herd smoothing parameters; seasonal ranges for Bathurst females prior to winter 2015/2016 are not presented in this report.

The smoothing parameter applied to analyses for all Bathurst herd 90% UD seasonal ranges was 18,000 m. Beverly herd 90% UD seasonal ranges were determined with a smoothing parameter of 38,000 m.

Seasonal ranges for each sex in each herd in each year are presented in Appendix A (Figures A-1 to A-9).

Table 3-2: Summary of Bathurst herd telemetry locations used for seasonal kernel density estimate range analyses; one location per day per animal

Season	Season length (days)	Minimum locations per animal per season for inclusion	Individual years analysed for females	Individual years analysed for males
Winter	140	105	2008/2009 to 2021/2022	2015/2016 to 2021/2022
Spring Migration	43	33	2009 to 2022	2015 to 2022
Calving	15	12	2009 to 2022	2015 to 2022
Post-Calving	12	9	2009 to 2022	2015 to 2022
Summer	50	38	2009 to 2022	2015 to 2022
Late Summer	20	15	2009 to 2022	2015 to 2022
Pre-Rut	40	30	2009 to 2022	2015 to 2022
Rut	15	12	2009 to 2022	2015 to 2022
Post-Rut	30	23	2009 to 2022	2015 to 2022

Table 3-3: Summary of Beverly herd telemetry locations used for seasonal kernel density estimate range analyses; one location per day per animal

Season	Season length (days)	Minimum locations per animal per season for inclusion	Individual years analysed for females	Individual years analysed for males
Winter	115	87	2015/2016 to 2021/2022	2015/2016 to 2021/2022
Spring Migration	57	43	2016 to 2022	2016 to 2022
Calving	14	11	2016 to 2022	2016 to 2022
Post-Calving	19	15	2016 to 2022	2016 to 2022
Summer	35	27	2016 to 2022	2016 to 2022
Late Summer	30	23	2016 to 2022	2016 to 2022
Pre-Rut	39	30	2016 to 2022	2016 to 2022
Rut	14	11	2016 to 2022	2016 to 2022
Post-Rut	42	32	2016 to 2022	2016 to 2022

3.3 Intersection of Bathurst and Beverly caribou data with RSA extent

The RSA (Figure 2-4) was defined by available landcover (Sections 2.7 and 3.3) and the distribution of Bathurst and Beverly herd telemetry locations in the study period. Its total area is 212,355 km^2. The RSA included 91% of all Bathurst caribou telemetry locations and 69% of all Beverly caribou telemetry locations collected on 8-hour intervals within the study period (Tables 3-4 and 3-5).

Table 3-4: Summary of all Bathurst herd telemetry locations collected at 00h, 08h, and 16h for the study period - by season

Season	Total Bathurst herd telemetry locations December 1, 2015 to November 30, 2022 (number of animal-seasons in parentheses)	Locations recorded inside the Regional Study Area	Percentage of total Bathurst herd 8-hour interval telemetry locations within the Regional Study Area
Total	260,495 (2610)	238,012	91.4%
Winter	82,255 (333)	75,226	91.5%
Spring Migration	36,159 (332)	28,136	77.8%
Calving	13,946 (320)	10,104	72.5%
Post-Calving	9.588 (272)	9,086	94.8%
Summer	42,852 (317)	41,445	96.7%
Late Summer	16,129 (302)	15,694	97.3%
Pre-Rut	28,836 (256)	28,185	97.7%
Rut	10,486 (242)	10,180	97.1%
Post-Rut	20,243 (236)	19,956	98.6%

Table 3-5: Summary of all Beverly herd telemetry locations collected at 00h, 08h, and 16h for the study period - by season

Season	Total Beverly herd telemetry locations December 16, 2015 to December 15, 2022 (number of animal-seasons in parentheses)	Locations recorded inside the Regional Study Area	Percentage of total Beverly herd 8-hour interval telemetry locations within the Regional Study Area
Total	257,737 (2506)	176,951	68.7%
Winter	72,287 (342)	59,810	82.7%
Spring Migration	48,122 (311)	30,400	63.2%
Calving	12,018 (296)	2,334	19.4%
Post-Calving	15,671 (296)	1,194	7.6%
Summer	27,468 (289)	14,010	51.0%
Late Summer	21,581 (270)	19,010	88.1%
Pre-Rut	25,779 (242)	21,173	82.1%
Rut	9,015 (231)	7,063	78.3%
Post-Rut	25,796 (229)	21,957	85.1%

3.4 Landcover and associated data layers

3.4.1 Selected landcover classification

As noted in the methods section, LC2009 was considered as the preferred landcover classification where it existed. Both EOSD and LC2000 (ETM+) were considered for the remainder of the study area. Attempts to merge the LC2009 with the EOSD data layer resulted in poor alignment between the two classifications, and also revealed gaps between the two coverages on the edge of the woodland/tundra vegetation zones.

Ultimately, the combination of LC2009 for the main portion of the study area (Arctic Tundra vegetation zone) and the LC2000 (ETM+) classification for the Sub-Arctic Woodland Tundra portion of the study area provided the best combination of two landcover classifications. By limiting the LC2000 (ETM+) data specifically along Vegetation Zone boundary then the demarcation between the LC2009 and LC2000 (ETM+) became explicit (Figure 3-1).

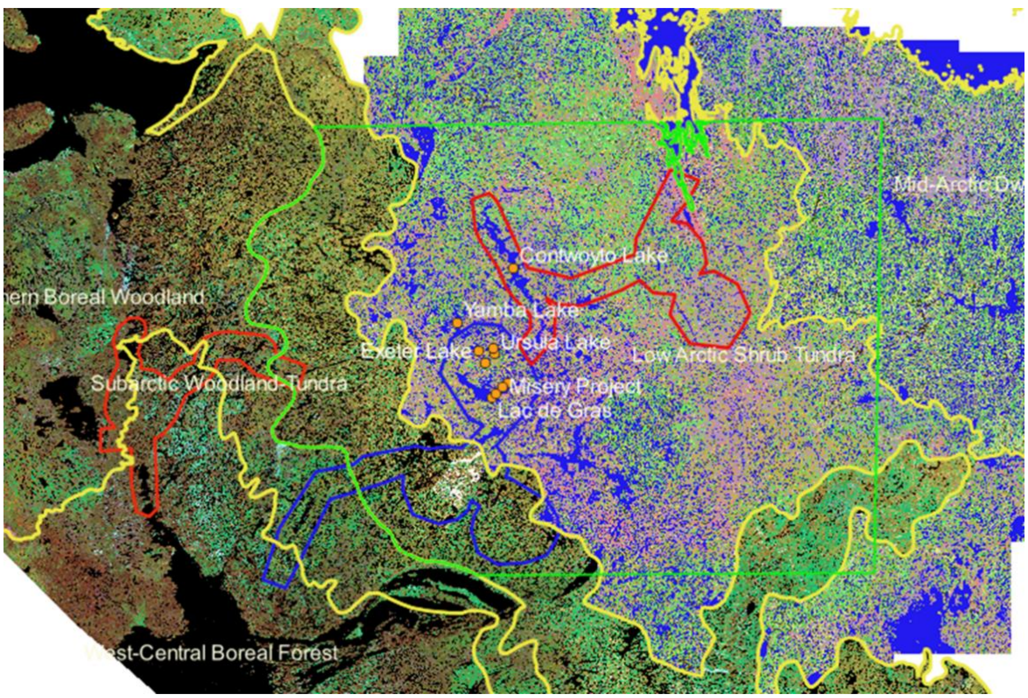

Figure 3-1: Regional Study Area Extent (green line) showing Vegetation Zone Boundaries (yellow lines). Note the exclusion of Northern Boreal Woodland and West-Central Boreal Forest that lie further to the west and south.

Grouping the 43 classes from LC2000 (ETM+) into 15 LC2009 classes provided stronger correspondence between the two classifications. The landcover classes from the two landcover products were grouped to a common classification of six categories useful for the habitat selection analyses: Bedrock-boulder, Tundra, Tussock, Sedge Wetland, Shrub, and Forest (Table 3-6). Water was initially classified from both these sources, but following preliminary analyses of collinearity among covariates it was overwritten with waterbody area classified from the CanVec Series Hydrographic Features data (see Section 3.3.2 below). During the grouping process various combinations were mapped, with the objectives of producing a relatively seamless map by landcover category. As an example, Figure 3.2 shows RSA extent maps from the final groupings for Tundra and Tussock, with abundance measured for each 3.1-ha hexagon; almost seamless maps with no evidence of strong demarcation between landcover source. Overall, the classification provided by the merged LC2000 (ETM+) and LC2009 data sets provide a landcover layer that is continuous and complete for the study area. The spatial resolution of the landcover is used to its maximum potential, with higher resolution LC2009 for the majority of the study area. The LSL processing then yielded a common resolution of 3.1-ha across the entire study area.

Table 3-6: Landcover classification, merged classes

Landcover category for analysis	LC2009	LC2000 (ETM+)
Bedrock-boulder	8, 9, 12	18, 19, 38
Tundra	3, 4, 7, 10	28, 35, 36
Tussock	1	23, 37, 41
Sedge Wetland	2, 11	25
Shrub	5, 6	15, 16, 21, 22, 24, 26, 39
Forest		1, 7, 8, 9

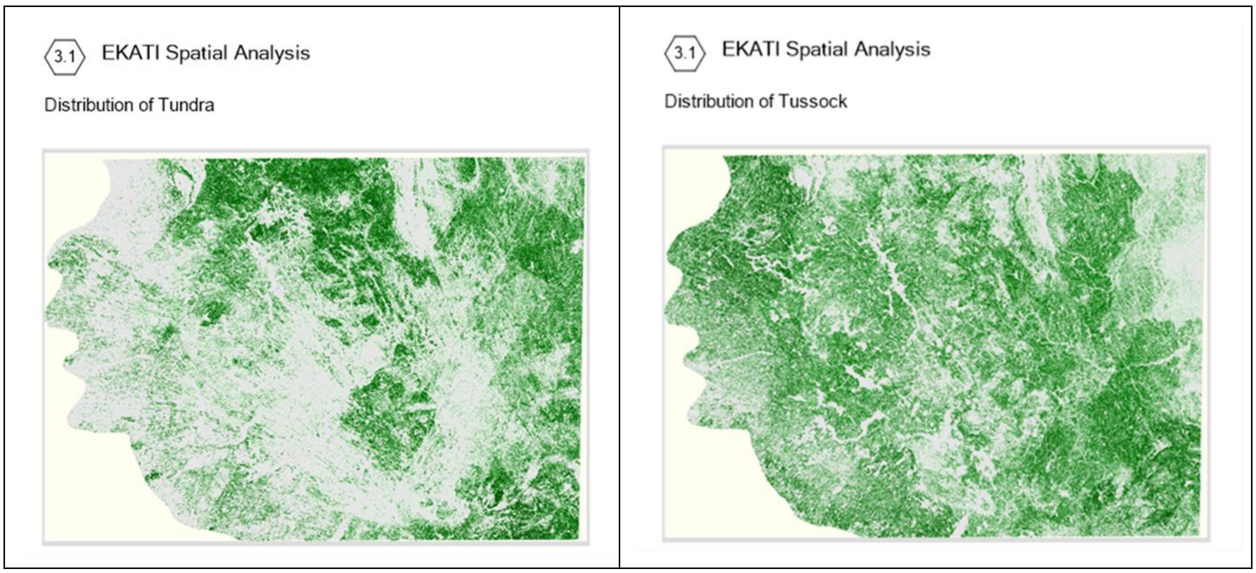

Figure 3-2. LSL output for proportion of Tundra and Tussock (3.1-ha grain) across the regional study area after grouping of LC2000 (ETM+) (west) and LC2009 (east) landcover classes. Note that there are no evident discontinuities or gaps between the landcover map sources at the map boundary.

3.4.2 Additional selected landcover and environmental attributes

The environmental attributes acquired from sources other than the raster-based landcover layers are listed in Table 3-7. They include categories for proportional coverage by water and eskers, water/land edge, topographic attributes, human disturbance, and insect harassment indices.

Table 3-7: Additional study area landcover and environmental attributes

Category for analysis	Data source	Description
Waterbody Area	Lakes, Rivers and Glaciers in Canada - CanVec Series - Hydrographic Features (Natural Resources Canada 2019)	Polygon features
Water/land edge	Lakes, Rivers and Glaciers in Canada - CanVec Series - Hydrographic Features (Natural Resources Canada 2019)	Linear measure of edge between water polygons and adjacent landcover polygons per unit area (m/ha)
Elevation	Canadian Digital Elevation Model Mosaic (Natural Resources Canada 2013)	Calculated within 3.1-ha hexagons
Slope	Canadian Digital Elevation Model Mosaic (Natural Resources Canada 2013)	Calculated within 3.1-ha hexagons
Aspect	Canadian Digital Elevation Model Mosaic (Natural Resources Canada 2013)	Calculated within 3.1-ha hexagons. Later removed from analyses.
Esker polygon	Linear Surficial Features of Canada (NTGS 2022 - Canadian Geoscience Map 195)	Esker polygons created as a 200 m wide polygon centred on esker line features appearing on 1:50,000 NTS map layer.
Mine roads	2021 Misery, Sable, Lynx, and Lac du Sauvage roads clipped from Ekati Diamond Mine shapefiles (Arctic Canadian Diamond Company Ltd.).	Polygons representing mine roads for the Ekati Diamond Mine. All Diavik Diamond Mine roads were included as mine infrastructure.
Winter roads	Shapefile of the Tibbitt to Contwoyto Winter Road provided by Arctic Canadian Diamond Company Ltd.	Polyline feature. Truncated at the Ekati Diamond Mine to reflect the limit of its construction during the study period.
Ekati and Diavik mine infrastructure	2021 Ekati Diamond Mine shapefiles excluding mine roads described above (Arctic Canadian Diamond Company Ltd.); 2021 Diavik Diamond Mine shapefiles (Diavik Diamond Mines Inc.)	No differentiation regarding type of infrastructure (e.g., pit, camp, processing site, wasterock storage area, etc.). Also includes mine roads at Diavik.
Other human developments	GNWT-ENR 2022. 2022 CIMP human disturbance layer	Historic mines, exploration sites, and other human developments up to and including 2022.
Oestrid harassment index	CircumArctic Rangifer Monitoring and Assessment (CARMA) Network	Daily index value calculated for each of five large spatial scales for each of the Beverly and Bathurst herds (Russell et al. 2013). Spatial scale with best match for seasonal caribou distribution was used. This covariate applied to Calving, Post Calving, Summer, and Late Summer data only.
Mosquito harassment index	CircumArctic Rangifer Monitoring and Assessment (CARMA) Network	Daily index value calculated for each of five large spatial scales for each of the Beverly and Bathurst herds (Russell et al. 2013). Spatial scale with best match for seasonal caribou distribution was used. This covariate applied to Calving, Post Calving, Summer, and Late Summer data only.

Polygon coverages of Ekati Mine roads and Ekati and Diavik mine infrastructure were produced to represent development for the 2016-2022 time period of the study (Figure 3-3). Ekati Diamond Mine roads (Sable, Misery, Lynx, and Lac du Sauvage roads) were grouped as the set of mine roads for analyses while all other Ekati and Diavik diamond mine features (Ekati Diamond Mine, including Misery, Lynx, and Sable projects, plus the Diavik Diamond Mine) were grouped as the set of mine infrastructure polygons for analyses. As described in the methods section, the winter road was plotted as a line feature terminating at the Ekati Diamond Mine, the limit of its construction during the study period.

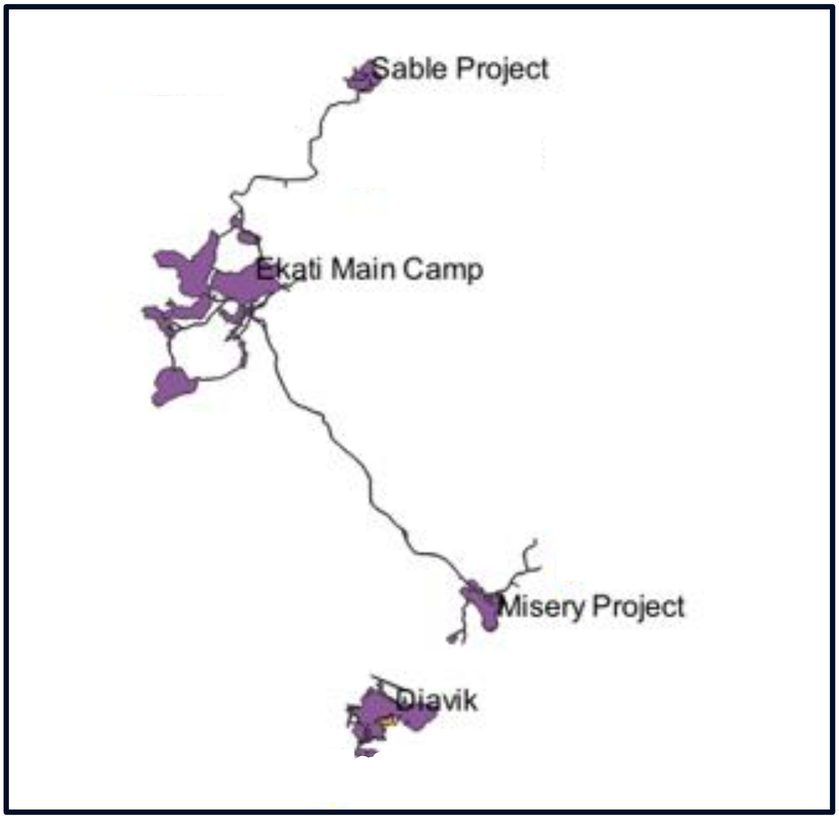

Figure 3-3. 2021 Ekati Diamond Mine roads and Diavik and Ekati Diamond mine infrastructure footprints for intersection with 2016-2022 caribou location data. Roads between sites are buffered by 25 m.

3.4.3 Resolution and multi-grain covariate data

The spatial averaging process completed in LSL results in covariate estimation to becoming progressively smoother after averaging at coarser grains (Figure 3-4). The resulting 3.1-ha hexagon shapefile for the RSA has attributes for all four grains attached to each 3.1-ha cell record and provides a structured data set for both training models and applying predictions from a multi-grain model across the entire landscape. There is a data record for each 3.1-ha hexagon in the RSA, each record with a column for each covariate (Table 3-8). Data from this shapefile were spatially joined to the telemetry location data to provide the raw input data for SSF and iSSA modelling. Location attribute data and covariates used in modelling are presented in Appendix B.

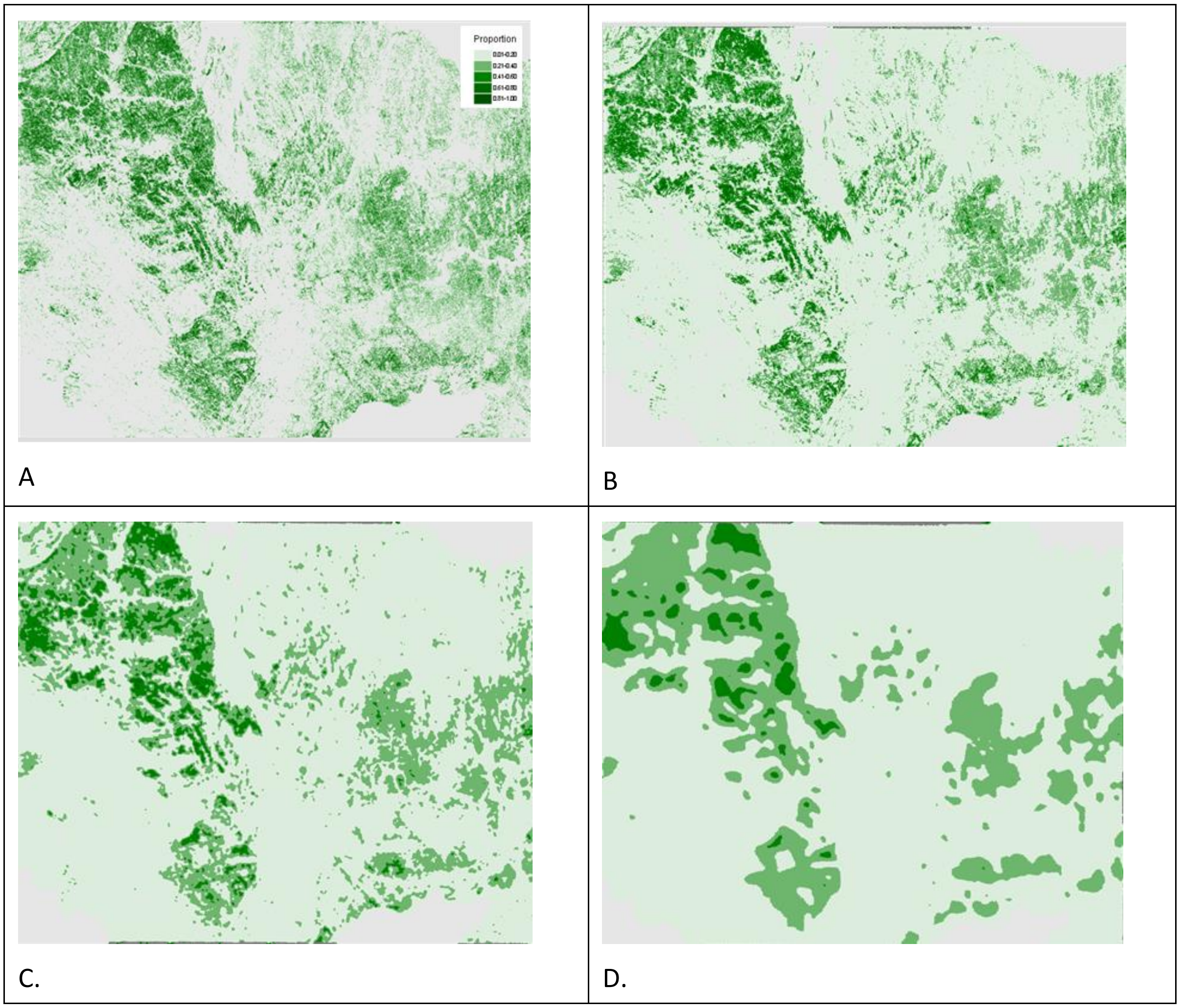

Figure 3-4. Proportion of Tundra measured across four grains. A) 3.1-ha; B) 59-ha; C) 524-ha; and D) 5137-ha. All maps are displays of 3.1-ha hexagon data records for Tundra – one at each of the four grains (See Table 3-8 for an example).

Table 3-8. Clip of LSL 3.1-ha hexagon attribute table illustrating the proportion of tundra at each of four grains (3.1-ha, 59-ha, 524-ha, and 5137-ha) for six of the hexagons in the RSA.

HEXID	**DF_MINE**	**TUNDRA (3.1-ha)**	**TUNDR_S2 (59-ha)**	**TUNDR_S3 (524-ha)**	TUNDR_S4 (5137-ha)
1001750	30001	0.230	0.495	0.509	0.464
1181262	28019	0.000	0.075	0.175	0.280
4350924	25172	0.602	0.696	0.471	0.348
4034102	30001	0.116	0.065	0.118	0.282
1650497	30001	0.691	0.378	0.287	0.183
1682329	30001	0.000	0.152	0.109	0.132

[1] HEXID is unique for each 3.1-ha hexagon and is linked when creating a seamless habitat layer across the entire study area. DF_MINE is the proximity of 3.1-ha hexagon to the nearest Ekati or Diavik mine footprint in metres. Complete sets of attributes are listed in Tables in Appendix B. There is a record for each 3.1-ha hexagon in the RSA.

3.5 Habitat selection analyses

3.5.1 Pre-SSF examination of collinearity of data for each landcover class

Following transformation and re-scaling (Section 2.8.3) and prior to model development, base landcover covariates in the train data sets were examined at three grains for each of the 14 sex by season combinations. The VIF was calculated using the function ols_vif_tol in the R package olsrr. Of the 432 season, sex, and covariate combinations examined, 38 (9%) had VIF > 5.00, with a maximum value of 7.21; of these, 36 were tundra and shrub covariates at the two coarsest grains. Some level of collinearity is expected among landcover classes, as some of these classes will tend to occur together. This is normal and was not considered to be an issue. Ultimately four of these covariates were included in SSFs (Table 3-9).

Table 3-9: Covariates with variance Inflation Factors > 5.00 that were included in SSFs. Data modelled were the train data sets used for 8-hour Regional Study Area Step Selection Analyses.

Season	Sex	Covariate	Tolerance	VIF	Grain (ha)
Rut	Male	WBAREA	0.193	5.194	3.1
Rut	Male	TUNDR_S4	0.182	5.497	5137
Rut	Female	WBAREA	0.193	5.194	3.1
PostRut	Female	LHSHRUB_S4	0.192	5.213	5137

[1] *Owing to seasonal distribution of animals, there was no assessment of the effect of development on caribou behaviour during calving season.*

3.5.2 Removal of records with incomplete data

During analysis it became evident that a small number of records lacked elevation data, rendering them incomplete and not possible to analyze. The locations were confined to the extreme southeast portion of the RSA (white rectangle in the lower right corner of Figure 3-5). The records lacking elevation data were removed from analyses.

Similarly, the first movement step in each movement pathway (the first step in every animal season and in each new movement burst following a missed location) did not have a turning angle and was not possible to include in iSSAs, all of which required the cosine of the turning angle as a covariate for each record.

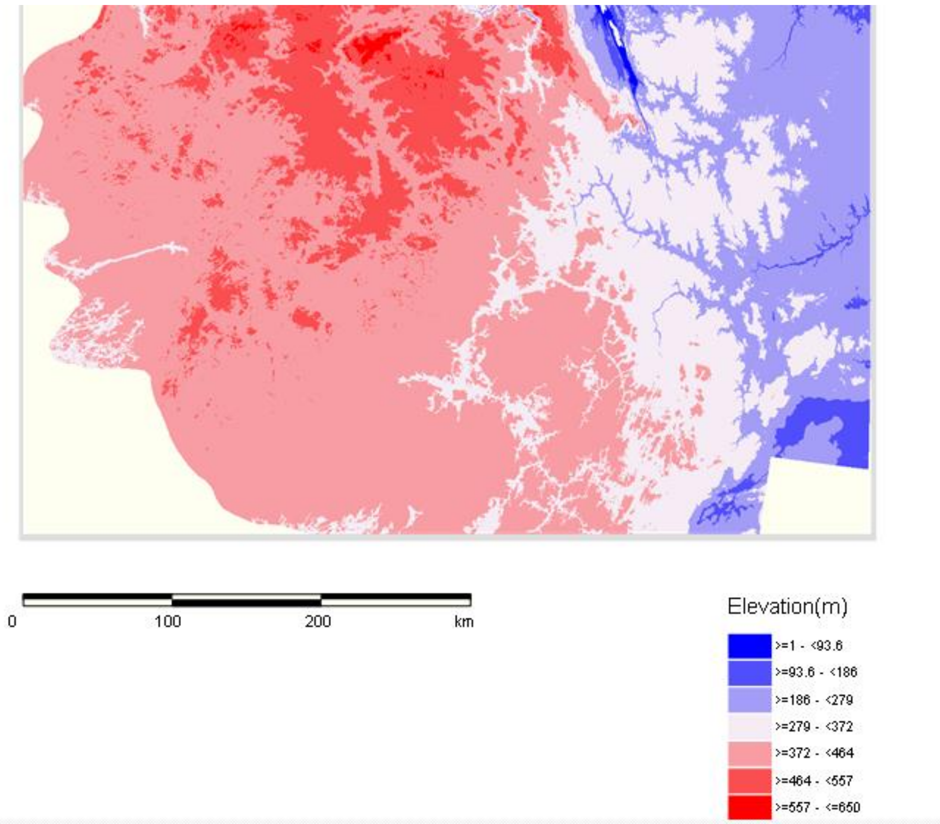

Figure 3-5. Map of elevation within the Regional Study Area (in metres above sea level) showing area in south east corner that lacked elevation data.

3.5.3 Exclusion of calving and post-calving seasons from analyses

The 2016 to 2022 8-hour interval data available for calving and post calving seasons inside the Ekati/Diavik halo were limited (calving season female steps = 21, male steps = 292; post-calving season female steps = 0, male steps = 151); making inferences derived from analyses unreliable. Consequently, movement and habitat selection were not analyzed for calving and post-calving seasons for either sex .

3.6 Results of SSFs for 8-hour movement intervals inside the RSA but outside the influence of development

Mixed-grain models

The AIC value was used to identify the top model from each sex and season set of candidate 8-hour SSF models. In seasons where the top stepAIC model included covariates at more than one grain, both fine- and coarse-grain candidate models were also created and included in the analyses (Table 2-3). Although fine- and coarse-grain models were included in 13 of 14 candidate model sets, the top model was a mixed-grain model rather than a fine-grain or coarse-grain model in every sex by season (Appendix C, Tables C-1 to C-14). The candidate model based on the top set of covariates from the stepAIC process (Mixed Grain 1) had the lowest AIC score in 7 of 14 model comparisons; these included a 7 month period from post-rut through winter and spring migration for both sexes.

With the exception of pre-rut for males, the refined versions of the mixed-grained models (Mixed Grain 2) were the top models for the remaining seasons (summer through rut) for both sexes. The mixed-grain model with oestrid harassment interaction terms was the top model for females in summer while the mixed-grain model with mosquito interaction terms was the top model for males in late summer.

Overall, SSFs revealed that 8-hour interval habitat preferences were based on landcover covariate abundances at a mixture of grains (i.e., at more than one spatial scale of assessment around the movement step end-point).

The covariates from each seasonal top model , their coefficients, the statistical significance of each coefficient, and the exponentiated coefficient are presented in Appendix D (Tables D-1 to D-14). As described in Section 2.8.5.3, the 8-hour SSF was re-run with candidate models amended to include movement covariates (step length, log step length, and cosine turning angle). The 95% confidence intervals of covariate coefficients in top models from the original SSF (random intercept models) were compared to the 95% confidence intervals for top model covariate coefficients from random intercept plus movement model. These are presented in Appendix E (Figures E-1 to E-14). They demonstrate an equivalence of coefficients from 8-hour models with and without movement.

To evaluate the ecological significance of individual covariates on relative selection of a resource unit (in our study, a 3.1-ha hexagon cell), Avgar et al. (2017) defined relative selection strength (RSS). The RSS was defined as the average change in the selection probability when a specific covariate is increased by one unit, conditional on all other covariates remaining constant and both habitat cells being available. The RSS for a continuous covariate is the value of the exponentiated coefficient (Avgar et al. 2017, p. 5324; Fieberg et al. 2021, p. 1028).

Topography

Elevation was included in the top model for five sex by season combinations, always with RSS > 1.00, indicating a positive relationship between locally higher elevation and the relative habitat selection value for a 3.1-ha habitat cell in an 8-hour step interval. The seasons with a significant relationship between relative habitat selection value and elevation were spring migration, summer, and late summer for females and spring migration and summer for males.

Proportion waterbodies

There was a general pattern across seasons and sexes for fine-grain avoidance of waterbodies. The 3.1-ha grain covariate for waterbody area was included in 13 of 14 top seasonal models; it had a significant RSS < 1.00 for 9 of the models and a significant RSS > 1.00 in 2 others. The squared version of the same covariate appeared with a significant RSS < 1.00 in all 12 of the 14 top models. Overall, water was avoided in the selection of the 3.1-ha hexagon containing the step end-point. When the covariates for waterbody area at the two coarsest grains included in the analyses appeared in top models (six seasons for males, four seasons for females), RSS > 1.00 in 13 of 16 instances, indicating preferential selection of habitat cells near water at coarser grains.

Fine-grain landcover

At the 3.1-ha grain, two landcover types had high RSS values for both sexes: tussock and low/high shrub. Both landcover types had RSS > 1.00 in top 8-hour interval SSF models for male caribou in all seasons; for female caribou, low/high shrub was included with RSS >1.00 in all season models except spring migration, while tussock was absent only in summer. The RSS for tundra was > 1.00 at the 3.1-ha grain for both males and females in post-rut, winter, and spring migration seasons. Generally, higher proportional cover by tussock, low/high shrub, and tundra increased the selection strength of a 3.1-ha cell for both sexes.

Conversely, sedge wetlands were avoided (RSS < 1.00) by female caribou in all seasons except during the rut, and by males in 4 of the 7 seasons. Bedrock-boulder had RSS < 1.00 for females in 5 of 7 seasons, but only during pre-rut by males.

Coarse-grain landcover

There were 45 coarser-grain covariates included in top seasonal SSFs compared with 88 covariates at the 3.1-ha grain (Table 3-10). The RSS for water was generally reversed from coarse-grains (where RSS>1.00) to fine-grain (where RSS<1.00) as discussed above. There were no other obvious patterns across sex by season models indicating reinforcement or reversal between fine and coarse grain RSSs.

Table 3-10: Numbers of significant[1] landcover and topographic covariates in top SSF models for each sex by season at the 8-hour interval scale.

Sex	Season	elevation/slope	Landcover grain (ha)		
			3.1	524	5137
Female	Winter	1	7	4	1
Female	Spring Migration	4	6	8	4
Female	Summer	2	6	2	0
Female	Late Summer	2	5	1	0
Female	Pre-Rut	1	7	0	0
Female	Rut	2	4	0	2
Female	Post-Rut	2	7	0	0
Male	Winter	2	6	3	1
Male	Spring Migration	4	8	5	1
Male	Summer	3	6	2	0
Male	Late Summer	0	5	4	0
Male	Pre-Rut	2	8	2	1
Male	Rut	1	6	1	1
Male	Post-Rut	1	7	1	1
	Totals	27	88	33	12

[1] *Significance determined as $P<0.05$.*

Model performance

The top model in each sex by season was determined using AIC (Section 2.8.5.3; Appendix C, Tables C-1 through C-14). The overall performance of the top models for each sex by season was then assessed using case probability (Tables C-1b through C-14b, summarized here in Table 3-11). Among all seasons, the lowest case probability score for each sex was for winter (0.571 for females, 0.578 for males). The highest case probabilities for females were 0.643 in summer and 0.635 in the rut. For males, the highest score was 0.635 during the rut. Overall, the mean seasonal case probabilities were 0.612 for females and 0.604 for males.

The measures of top model performance: AUC and case probability, are presented for both the train and test data sets for each sex by season top model in Tables C-1b through C-14b. The comparisons of case probability for test and train data for each sex by season are summarized in Table 3-11. Model validation depends on the performance of the model for the test data closely matching the performance of the train data; which was observed for all models. On average test data case probability was 0.002 below train data case probability (range: -0.014 to +0.008), with test data having higher case probability scores than train data in 6 of 14 comparisons.

Table 3-11: Model performance summary statistics for the three sets of selection analyses: 8-hour SSF in the RSA outside the Ekati/Diavik 30 km halo; 8-hour iSSA inside the Ekati/Diavik halo; and 1-hour iSSA inside GF112N.

		8-hr SSF in RSA (from Appendix C Tables C-1b to C-14b)		8-hr iSSA in Ekati/Diavik halo (from Appendix F Tables F-1b to F-14b)		1-hr iSSA in GF112N (from Appendix H Tables H-1b to H-14b)	
Sex	**Season**	**caseprob[1] train**	**caseprob test**	**caseprob train**	**caseprob test**	**caseprob train**	**caseprob test**
Female	Winter	0.571	0.573	0.569	0.580	0.544	0.535
Female	Spring Migration	0.575	0.580	0.621	0.590	0.557	0.556
Female	Summer	0.643	0.641	0.717	0.695	0.611	0.610
Female	Late Summer	0.615	0.605	0.666	0.684	0.584	0.589
Female	Pre-Rut	0.627	0.627	0.656	0.650	0.584	0.581
Female	Rut	0.635	0.628	0.680	0.664	0.601	0.599
Female	Post-Rut	0.618	0.622	0.635	0.636	0.607	0.566
Male	Winter	0.578	0.581	0.594	0.583	0.543	0.558
Male	Spring Migration	0.600	0.586	0.579	0.598	0.567	0.586
Male	Summer	0.595	0.597	0.637	0.658	0.554	0.564
Male	Late Summer	0.598	0.606	0.642	0.623	0.587	0.584
Male	Pre-Rut	0.607	0.605	0.650	0.677	0.579	0.597
Male	Rut	0.635	0.625	0.662	0.619	0.585	0.590
Male	Post-Rut	0.615	0.615	0.606	0.589	0.576	0.577

[1] caseprob (case probability) is a concordance statistic, a generalization of AUC for stratified models (Smith et al. 2022). It was calculated as the probability of a case (used location) being correctly classified (ranked higher than a random location).

3.7 Prediction of relative habitat selection values within the Ekati/Diavik 30 km halo and geofence 112 North from 8-hour SSF model results in the Regional Study Area

The results presented in Section 3.6 contained some general patterns of landcover selection in the RSA outside the Ekati/Diavik halo that were applicable for both sexes and across seasons. Both tussock and low/high shrub had high RSS for both sexes at the 3.1-ha grain, while waterbody area generally had high RSS values at coarser-grains but RSS<1.00 at the 3.1-ha grain. Those three cover types accounted for 81% of the total area within the Ekati/Diavik halo (Table 3-12) with waterbody area occupying 29.6% of the Ekati/Diavik halo compared with 20.7% of the RSA.

Table 3-12: Percent cover of water and landcover in the Regional Study Area and the Ekati/Diavik halo

Water / landcover category	Regional Study Area	Ekati/Diavik 30 km halo
Waterbody area	20.7	29.6
Tussock	25.4	26.8
Low / High Shrub	23.2	24.7
Tundra	18.8	9.6
Sedge wetland	7.4	8.7
Esker	1.1	0.8
Bedrock-boulder	2.5	0.4
Forest	1.5	0.0

Section 2.8.6 described the process by which 8-hour SSF results were used to generate season by sex-specific PRHSVs for each 3.1-ha cell inside the Ekati/Diavik halo. The primary objective of that process was to create a new covariate to represent overall relative habitat value, based on analyses of environmental data from an area outside the influence of mining development. The new PRHSV covariate was used in analyses of 1-hour and 8-hour movements (Section 3.8 and 3.9 below).

Sex by season PRHSVs were also generated for every cell in the Ekati/Diavik halo and used to generate maps (Figures 3-6 to 3-12) to provide a set of spatial images of predicted habitat values for each sex in each season. There are some key items to consider in reviewing the figures:

1. All habitat values are relative to other values within that map only; the value for each cell is on a percentile scale with the values for the other cells on that map.
2. Relative habitat selection values in each figure were calculated using the mean value for each coefficient. Each coefficient has a standard error, as presented in Appendices D and E. Accounting for standard errors of coefficients would provide estimates of uncertainty in the predicted relative habitat selection values mapped here and differences would be less apparent when mapped.
3. The maps show conditional predicted relative habitat selection values specific to the scale of analysis. In this case the scale is an 8-hour movement step. The condition is that an animal would need to already be present within a normal 8-hour movement step distance (typically a 2 to 4 km range for these data) to be able to select a cell. A useful way to think of it is that if animals were randomly placed on the landscape, they would tend to make movements that would distribute them according to the relative habitat selection values mapped.
4. The left-hand panel of each figure is the relative probability of habitat selection by female caribou for the season; probability of selection by males is in the right-hand panel of each figure. The top models from those analyses were constructed from landcover, topography, and insect harassment covariates alone. All spatial variation in relative habitat selection value is based only on those covariates, and is not related to mining and development activity. The mine footprints have been added for spatial reference but did not influence calculation of predicted relative habitat selection values shown in the figure. The map should be used as a reference for predicted relative habitat selection value within 30 km of the Ekati and Diavik mines for 8-hour selective behaviour for that sex in that season.

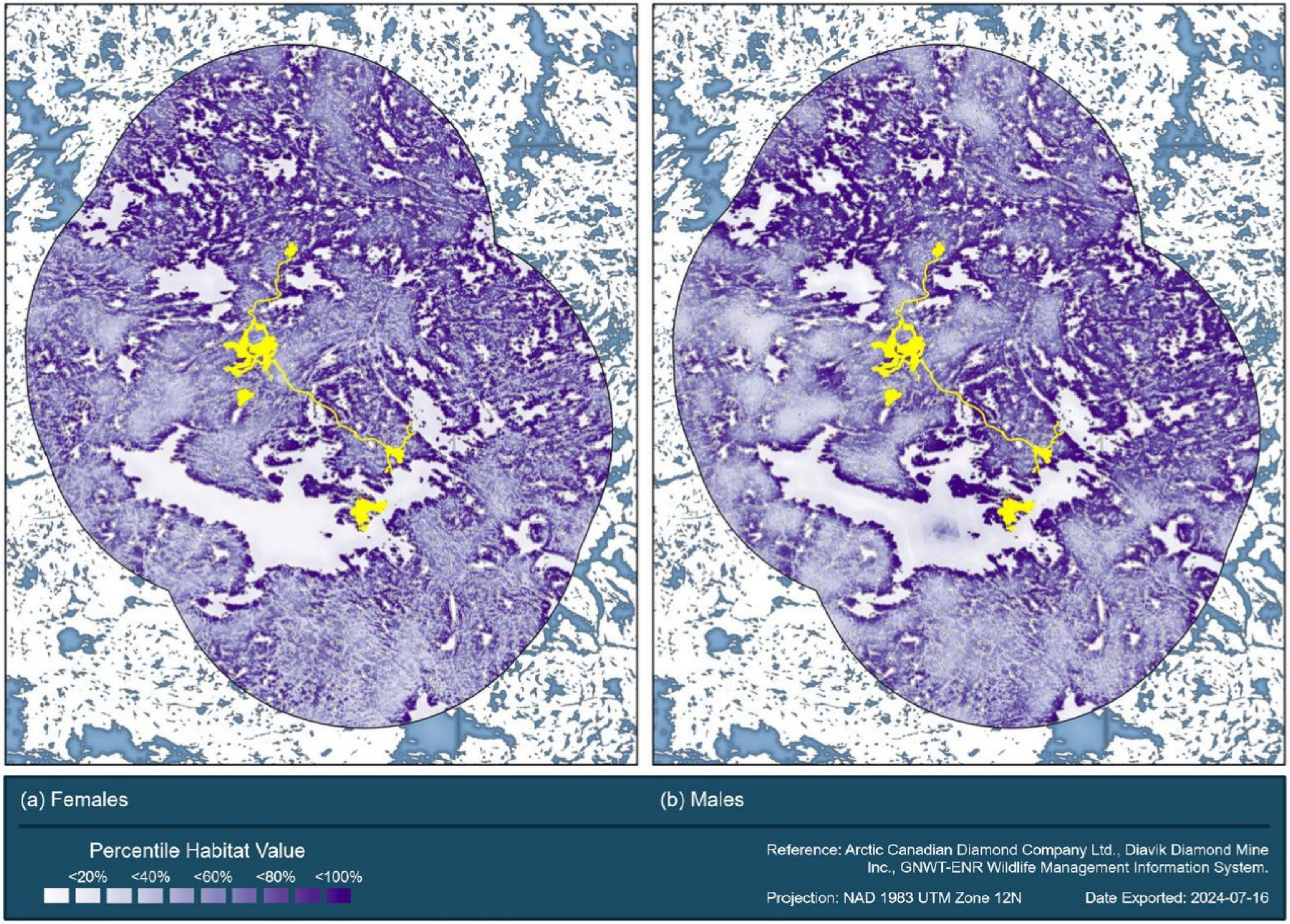

Figure 3-6: Winter Relative Habitat Selection Value for Barren-ground Caribou. Predicted from 8-hour interval range scale analyses excluding development

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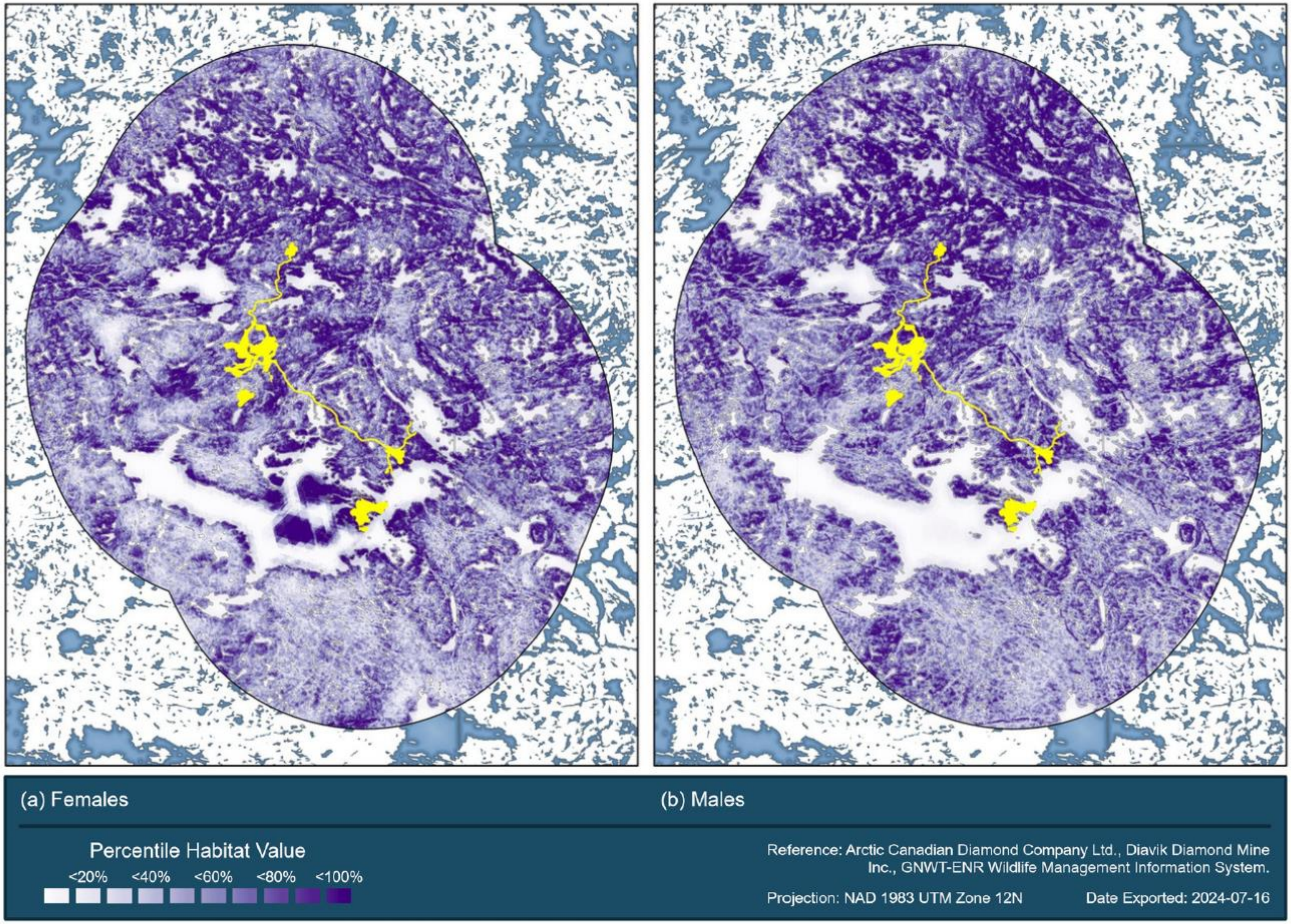

Figure 3-7: Spring Migration Relative Habitat Selection Value for Barren-ground Caribou. Predicted from 8-hour interval range scale analyses excluding development

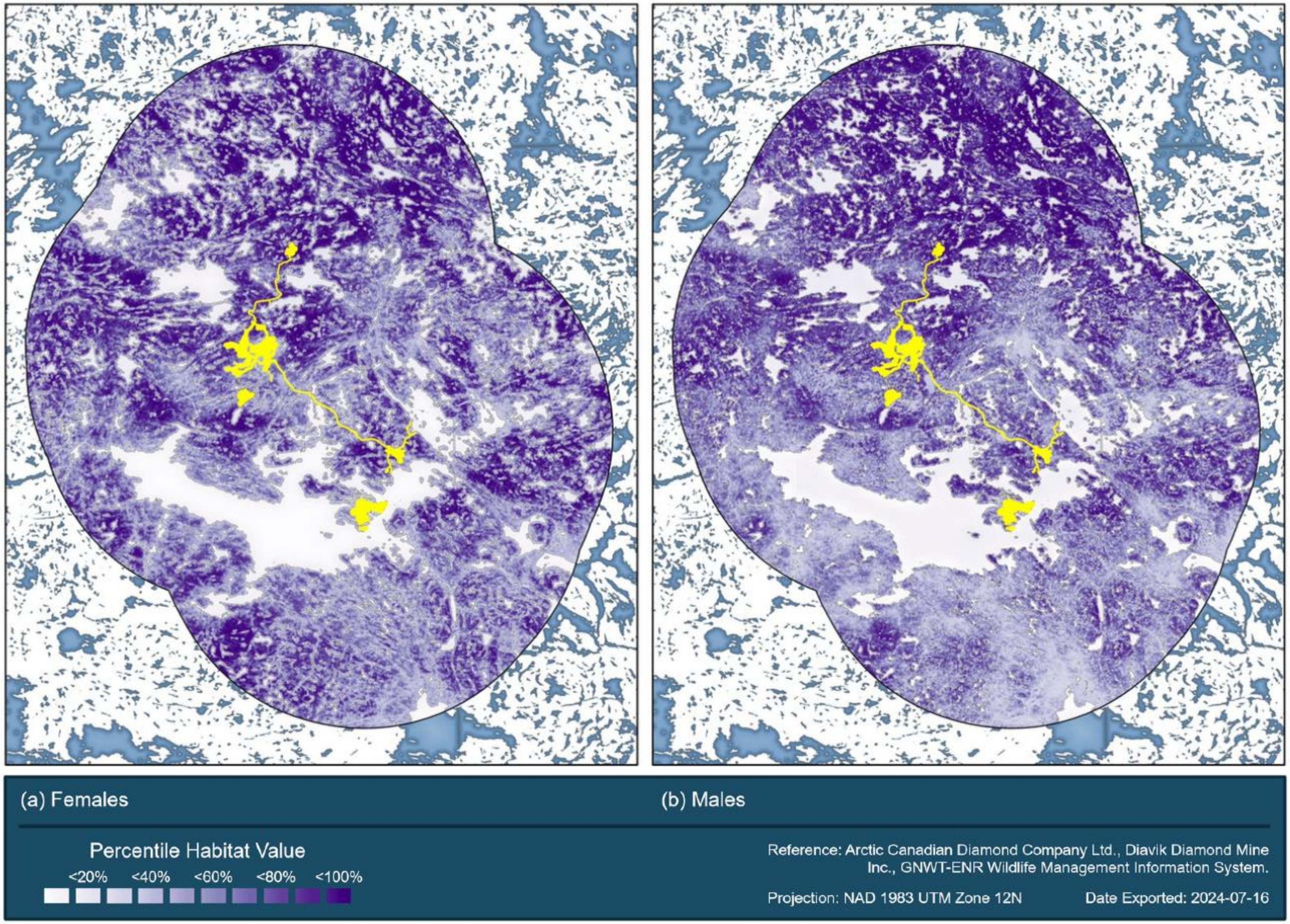

Figure 3-8: Summer Relative Habitat Selection Value for Barren-ground Caribou. Predicted from 8-hour interval range scale analyses excluding development

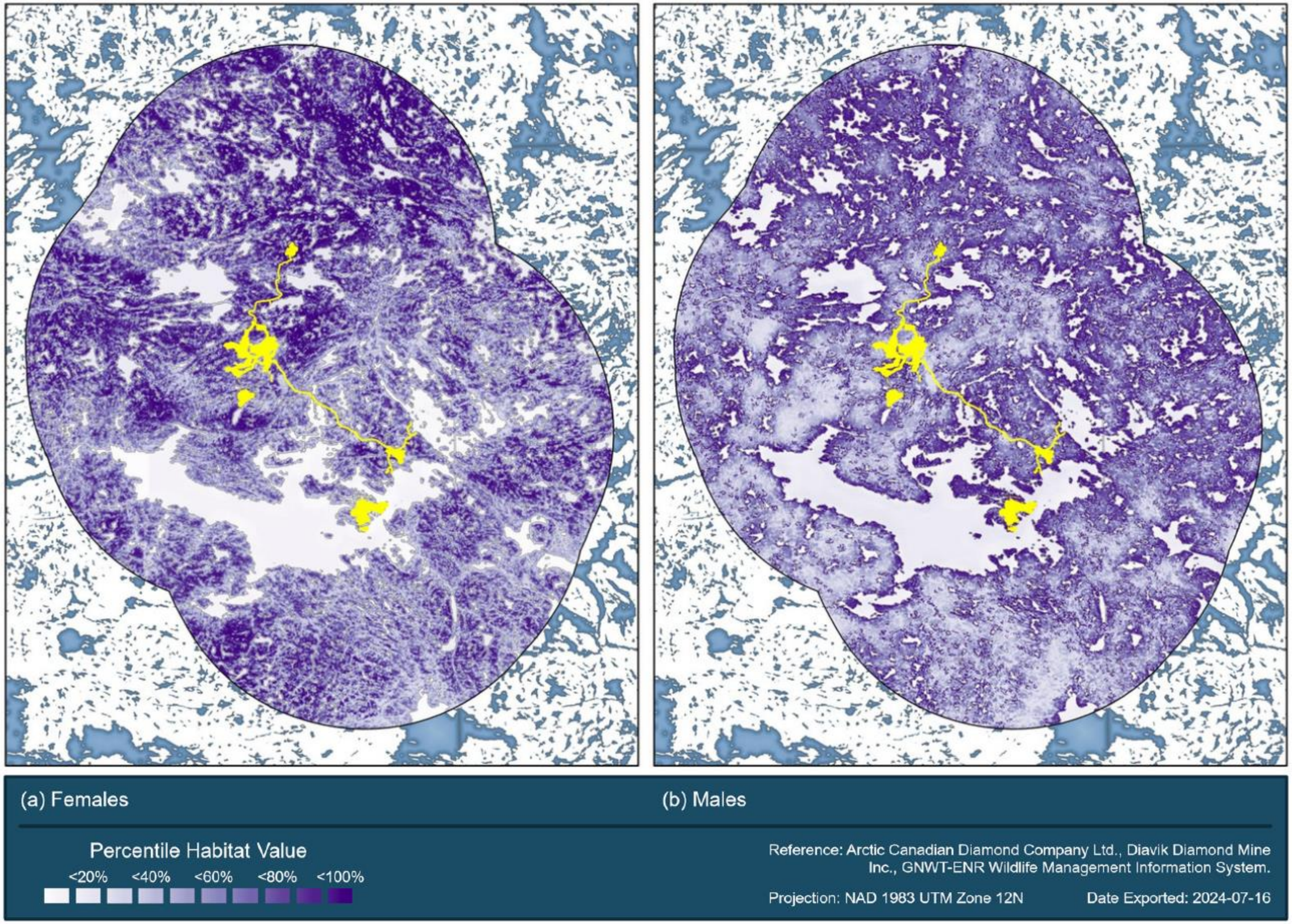

Figure 3-9: Late Summer Relative Habitat Selection Value for Barren-ground Caribou. Predicted from 8-hour interval range scale analyses excluding development

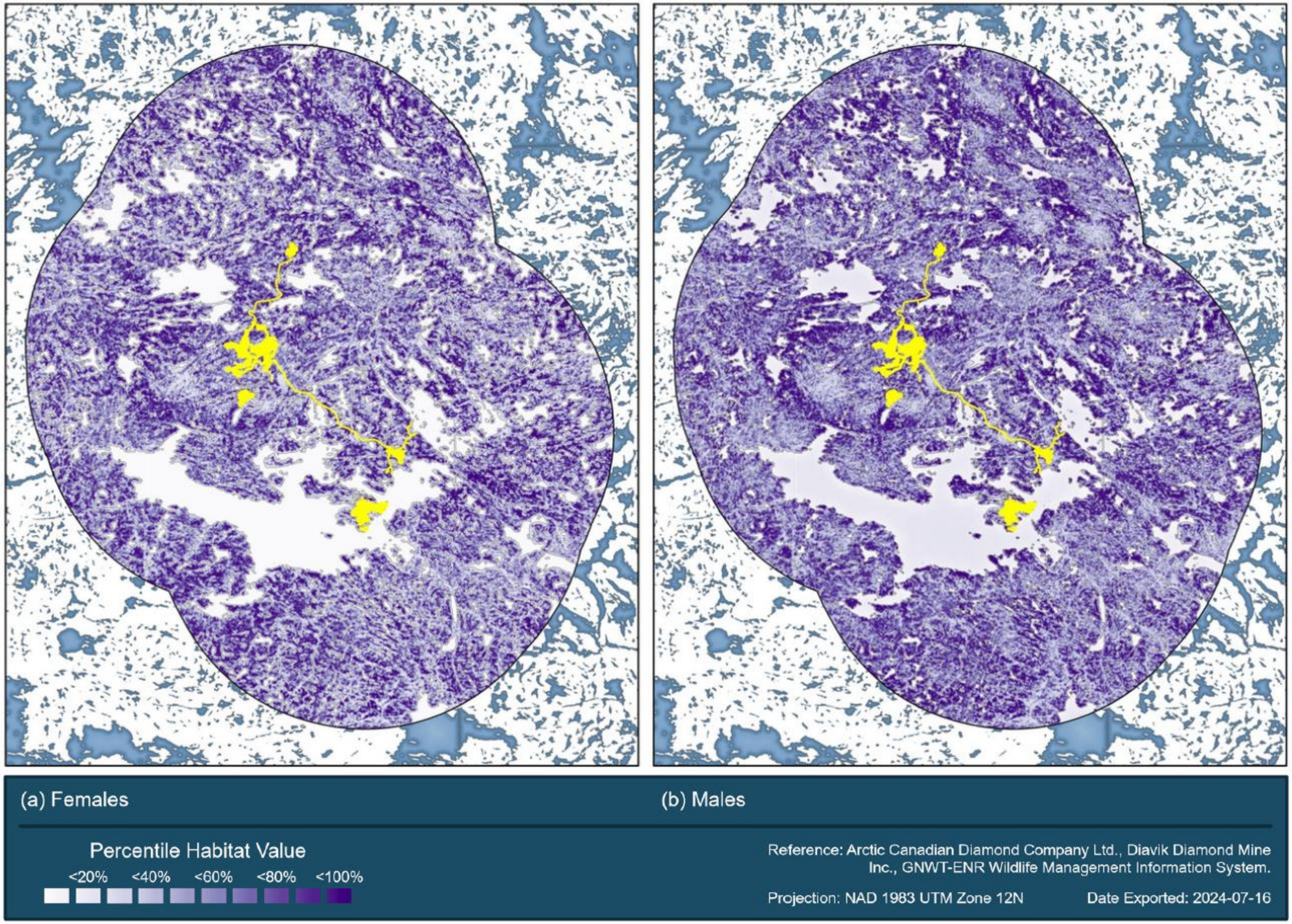

Figure 3-10: Pre-Rut Relative Habitat Selection Value for Barren-ground Caribou. Predicted from 8-hour interval range scale analyses excluding development

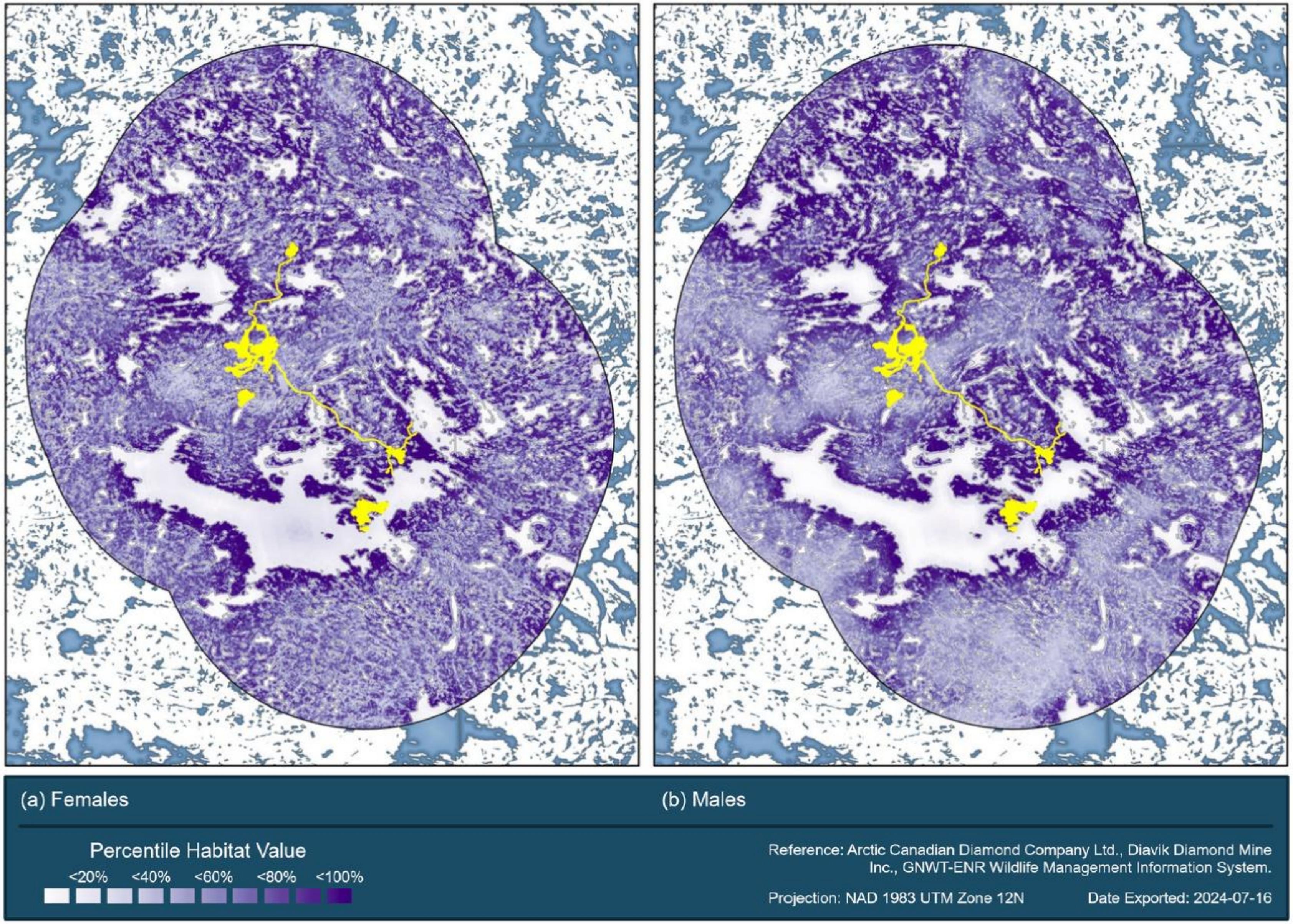

Figure 3-11: Rut Relative Habitat Selection Value for Barren-ground Caribou. Predicted from 8-hour interval range scale analyses excluding development

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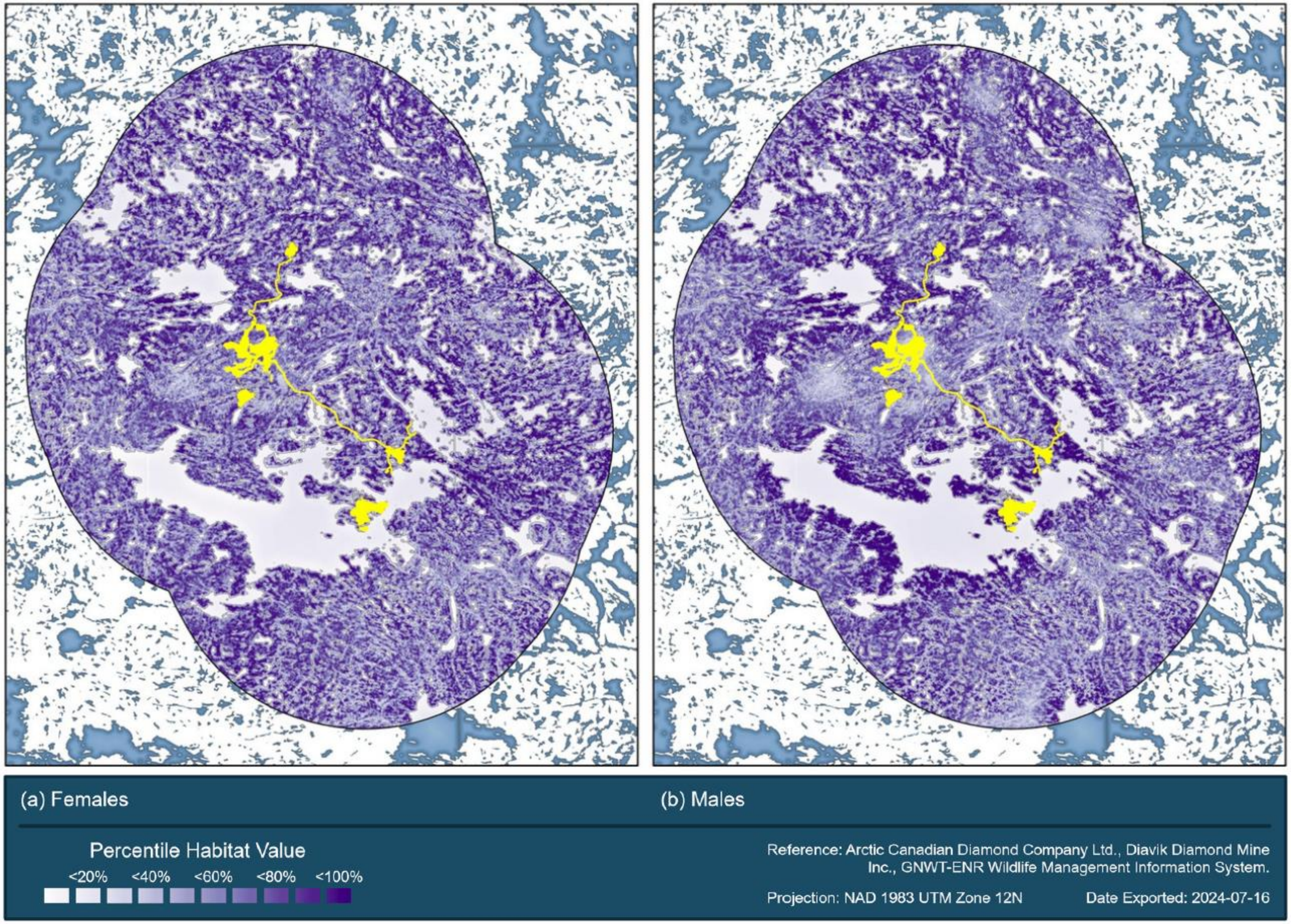

Figure 3-12: Post-Rut Relative Habitat Selection Value for Barren-ground Caribou. Predicted from 8-hour interval range scale analyses excluding development

3.8 Results of iSSAs for 8-hour movement intervals inside the Ekati/Diavik halo

8-hour interval relative selection probability for 3.1-ha hexagons in the Ekati/Diavik halo

As described in Section 2.8.6, the iSSAs of 8-hour interval data within the Ekati/Diavik halo integrated a covariate for predicted habitat value (PRHSV) with movement and distance-from-feature covariates. After calculating the PRSHV for each movement record for each sex by season, the set of candidate models differed from each other in the distance-from-feature covariate included (as a simple term and also in interactions); the set of model distance-from-feature elements for 8-hour interval iSSAs were standardized across all sex and season combinations (see Table 2-4).

Model structures and evaluation for both sexes and all seasons are presented in Appendix F, Tables F-1/F-1b to F-14/F-14b. The model with the highest case probability was selected as the top model in each sex by season iSSA. Comparisons of case probability of the train data set with the test data set for each sex by season top model are presented in Tables F-1b to F-14b and summarized in Table 3-11 of this report.

The covariates for the top model from each seasonal iSSA, their coefficients, and the statistical significance of each coefficient are presented in Appendix G, Tables G-1 to G-14. In iSSA, coefficients for log.sl.km, sl.km, and cos.ta are used to adjust the movement covariates to account for the effect of habitat selection (Fieberg et al. 2021, p. 1038). For the objectives of these analyses, the interaction terms are of greatest interest as they examine the relationships of distance-from-feature to step length and PRSHV. The single habitat covariate, PRHSV and log.sl.km are of secondary interest.

A summary of the top sex by season models and the significance of the interaction terms they contain (from Appendices F and G) is presented in Table 3-13.

Summary of distance from feature covariates and their interactions with PRHSV and step length

Table 3-13 shows that top model in 11 of 14 sex by season categories included a distance-from-feature covariate and its associated interaction terms. However, none of the top models had a significant interaction term between PRHSV and the relevant distance-from-feature covariate (Table 3-13). That is, there was no interaction identified in any season that suggested that 3.1-ha resource unit selection was significantly related to distance from mining features.

There were significant positive interactions between step length and distance-from-feature for female caribou in three seasons and for male caribou in four seasons. These included:

- RSS > 1.00 for step length interaction with minimum distance from the nearest feature for both males and females during the rut, and for male caribou in summer;
- RSS > 1.00 for step length interaction with distance from (non-road) mine infrastructure by male caribou in spring migration and by female caribou in summer and post-rut.
- The RSS values of these interactions indicate that caribou make shorter movements when they are closer to the mining features included in the interaction term.

The one significant interaction with RSS < 1.00 was between distance from mine roads and step length by male caribou in winter: suggestive of longer movements being made by caribou when they are closer to mine roads.

Table 3-13: Summary of top iSSA models and their interaction terms for 8-hour movements inside the Ekati/Diavik 30 km halo

Sex	Season	Top Model	Significant[1] interaction terms	RSS[2]
Female	Winter	Base Model	NA	NA
Female	Spring Migration	Base Model	NA	NA
Female	Summer	DFMines	Step length x distance from mines	1.853
Female	Late Summer	DFMineRoads	none	NA
Female	Pre-Rut	MinDF	none	NA
Female	Rut	MinDF	Step length x minimum distance from feature	1.158
Female	Post-Rut	DfMines	Step length x distance from mines	1.214
Male	Winter	DFMineRoads	Step length x distance from mine roads	0.828
Male	Spring Migration	DFMines	Step length x distance from mines	1.183
Male	Summer	MinDF	Step length x minimum distance from feature	1.376
Male	Late Summer	MinDF	none	NA
Male	Pre-Rut	DFMines	none	NA
Male	Rut	MinDF	Step length x minimum distance from feature	1.265
Male	Post-Rut	DFMines	none	NA

[1] Significance determined as coefficient with $P<0.05$

[2]RSS is relative selection strength. It is calculated as exp(coefficient)

NA – not applicable

Predicted relative habitat selection covariates

In 12 of 14 iSSA top sex by season models for the 8-hour interval, there was a significant coefficient for the predicted relative habitat selection value (PRHSV) of the 3.1-ha hexagon; the coefficients for PRHSV for male summer and pre-rut were insignificant. In each of the 12 seasons, the RSS for PRHSV was >1.00. Each unit increase in PRHSV yielded an increase in the resource unit selection value of more than one unit.

Model performance

The top model in each sex by season was determined using case probability for the train data set for each sex by season (all data Appendix F, Tables F-1 through F-14, summarized here in Table 3-11). Case probability was also the metric used to assess model performance. For females, the lowest seasonal case probability score (0.569) was for the winter model; for males the lowest score (0.579) was for spring migration. The highest case probabilities for females were 0.717 in summer and 0.680 in the rut. For males, the highest score was 0.662 during the rut. Overall, the mean seasonal case probabilities were 0.649 for females and 0.624 for males.

In six seasons, one or more models failed to converge on a best fit within glmmTMB; in those instances, the performance criteria are identified with “#NA”. When there was no value for case probability, the performance criterion used for model ranking, those models were not considered in model evaluation.

Measures of top model performance: AUC and case probability, are presented for both the train and test data sets for each sex by season top model in Tables F-1b through F-14b. The comparisons of case probability for test and train data for the iSSA top model for each sex by season are summarized in Table 3-11. Model validation depends on the performance of the model with the test data compared with the performance of the model with the train data. As observed for the results of 8-hour interval SSFs (from data outside the Ekati/Diavik halo), for each sex by season the case probability of the 8-hour interval iSSA model applied to the test data closely matched the case probability of the train data used to create the model. On average test data case probability was 0.005 below train data case probability (range: -0.043 to +0.027), with test data having higher case probabilities than train data in 6 of 14 instances.

3.9 Results of iSSAs for 1-hour movement intervals inside GF112N

1-hour interval relative selection probability for 3.1-ha hexagons in the Ekati/Diavik halo

Following the process described in Section 2.8.7, the iSSAs of 1-hour interval data within GF112N integrated a covariate for predicted habitat value (PRHSV) with movement and distance-from-feature covariates. The same set of iSSA models were applied to 1-hour data as were used to analyse 8-hour data sets (Table 2-4). After calculating the PRSHV for each movement record for each sex by season, the set of candidate models differed from each other in the distance-from-feature covariate included (as a simple term and also in interactions); the set of model distance-from-feature elements for 1-hour interval iSSAs were standardized across all sex and season combinations (see Table 2-4).

Model structures and evaluation for both sexes and all seasons are presented in Appendix H, Tables H-1/H-1b to H-14/H-14b. The model with the highest case probability was selected as the top model in each sex by season iSSA. Comparisons of case probability of the train data set with the test data set for each sex by season top model are presented in Appendix H, Tables H-1b to H-14b and summarized in Table 3-11 of this report.

The covariates for the top model from each seasonal iSSA, their coefficients, and the statistical significance of each coefficient are presented in Appendix I, Tables I-1 to I-14. As noted for 8-hour interval analyses, for the objectives of these analyses, the interaction terms are of greatest interest as they examine the relationships of distance-from-feature to step length and PRSHV. The single habitat covariate, PRHSV and log.sl.km are of secondary interest.

A summary of the top sex by season models and the significance of the interaction terms they contain (from Appendices H and I) is presented in Table 3-14.

Summary of distance from feature covariates and their interactions with PRHSV and step length

Table 3-14 shows that the top model in 12 of 14 sex by season categories included a distance-from-feature covariate and its associated interaction terms. Only one of the 14 top models had a significant interaction term between PRHSV and the relevant distance-from-feature covariate: that is, there was no interaction identified in 13 sex by season analyses that suggested that habitat selection was significantly related to distance from mining features. The one exception was the top model for female caribou during the rut, where RSS = 0.855 for the interaction between distance from mine roads and PRHSV. The interpretation of this result it that habitat selection value declined with increasing distance from mine roads; i.e., habitat value was higher closer to the road.

There were no significant interactions between distance-from-feature and step length for male caribou in any season, and only one significant interaction for females: between step length and distance-from-feature in summer where RSS = 1.041. An absence of significant interactions between step-length and distance-from-feature indicates that analyses failed to find evidence that caribou vary their step length based on their proximity to mining infrastructure.

Table 3-14: Summary of top iSSA models and their interaction terms for 1-hour movements inside GF112N

Sex	Season	Top Model	Significant[1] interaction terms	RSS[2]
Female	Winter	DFMines	none	NA
Female	Spring Migration	Base Model	NA	NA
Female	Summer	DFMineRoads	Step length x distance from mine roads	1.041
Female	Late Summer	DFMines	none	NA
Female	Pre-Rut	MinDF	none	NA
Female	Rut	DFMineRoads	PRHSV x distance from mine roads	0.855
Female	Post-Rut	DFMines	none	NA
Male	Winter	Base Model	none	NA
Male	Spring Migration	DFMineRoads	none	NA
Male	Summer	DFMines	none	NA
Male	Late Summer	MinDF	none	NA
Male	Pre-Rut	DFMineRoads	none	NA
Male	Rut	DFMines	none	NA
Male	Post-Rut	DFMineRoads	none	NA

[1] Significance determined as coefficient with P<0.05.

[2]RSS is relative selection strength. It is calculated as exp(coefficient)

NA – not applicable

Predicted relative habitat selection value covariate

For both males and females, there was a significant coefficient for PRHSV in every season. It was the only covariate with a significant coefficient in 6 of 14 sex by season iSSA top models. In each season, the RSS for PRHSV was >1.00. Each unit increase in PRHSV yielded an increase in the resource unit relative selection of more than one unit.

Model performance

The top model in each sex by season was determined using case probability for the train data set for each sex by season (all data Appendix H, Tables H-1 through H-14, summarized above in Table 3-11). Case probability was also the metric used to assess model performance. For females, the lowest seasonal case probability score (0.544) was for the winter model; for males the lowest score (0.543), also for winter. The highest case probability for females was 0.611 in summer. For males, the highest score was 0.587 during the rut. Overall, the mean seasonal case probabilities were 0.584 for females and 0.570 for males.

Measures of top model performance: AUC and case probability, are presented for both the test and train data sets for each sex by season top model in Tables H-1b through H-14b. The comparisons of case probability for test and train data for the iSSA top model for each sex by season are summarized in Table 3-11. Model validation depends on the performance of the model with the test data compared with the performance of the model with the train data.

As observed for the results of 8-hour interval analyses both inside and outside the Ekati/Diavik halo, for each sex by season the case probability of the 1-hour interval iSSA model applied to the test data closely matched the case probability of the train data used to create the model. On average, test data case probability was 0.001 above train data case probability (range: -0.041 to +0.019), with test data having higher case probabilities than train data in 7 of 14 instances.

3.10 Movement characterization

3.10.1 Effect of exposure time in Ekati/Diavik halo on length of seasonal movement path

Accounting for two herds with two sexes in each of nine seasons, there were 36 separate analyses conducted, regressing total seasonal movement path length (in km) on the number of 8-hour movement steps ending in the Ekati/Diavik halo. Graphs and equations of the 36 regression lines are in Appendix J, (Figures J-1 to J-4).

Of the 36 regressions there were 11 with significant slopes indicating a relationship between the number of 8-hour movement steps in the Ekati/Diavik halo and the total path length travelled by caribou during the season. One of the 11 significant results (Bathurst female calving season) was based on 203 animal-seasons of data, only one of which intersected the Ekati/Diavik halo. The equations of the other 10 are presented in Table 3-15.

Table 3-15: Significant results of regression of exposure to the Ekati/Diavik halo on total seasonal movement path length (km)

Sex	Herd	Season	Y-int[1]	slope(β)[1]	P	n Animal Seasons
Female	Bathurst	Winter	670	+1.54	0.018	74
Female	Bathurst	Summer	729	-1.63	0.002	180
Female	Bathurst	Late Summer	158	-0.385	0.010	166
Female	Bathurst	Pre-Rut	370	-0.997	<0.001	164
Female	Beverly	Pre-Rut	516	-2.99	<0.001	116
Female	Beverly	Post-Rut	369	+1.62	0.027	96
Male	Bathurst	Winter	433	+0.83	0.047	40
Male	Bathurst	Calving	129	+2.12	0.020	98
Male	Bathurst	Summer	562	-1.77	0.021	92
Male	Bathurst	Pre-Rut	390	-0.84	0.037	71

[1] The units of measure for the equation are km: Y-intercept in km and slope in km/8-hour step ending inside the Ekati/Diavik halo.

Of the 10 herd by sex by season combinations with significant effects of exposure to the Ekati/Diavik halo on total movement path, four (11%) are positive relationships: caribou seasonal movement paths increased with greater time spent in the halo during winter for Bathurst male and female caribou, during calving for Bathurst males, and during the post-rut for female Beverly caribou. The other six (17%) results indicated that animals had shorter seasonal paths when they spent time within 30 km of the Ekati and Diavik mines.

For the other 26 (72%) herd by sex by season combinations, there were no significant relationships between time spent in the Ekati/Diavik halo and the distance travelled during the season.

3.10.2 Effect of exposure time in Ekati/Diavik halo on delayed arrival in next seasonal range

After examining the effect of exposure to the Ekati and Diavik mines of the total distance travelled in a season (Section 3.10.1 above), the other potential effect tested was delayed arrival in the next seasonal range. Following examination of available data (individual animal-season summaries), each animal-season was classified by two binary covariates: (1) did the animal's seasonal path intersect the Ekati/Diavik halo, and (2) was the animal present in the 90% UD seasonal range for the next season when its first location for the season was recorded, or was its arrival delayed.

The results of the analyses for each sex by season are presented in Table 3-16. Of the 18 sex by season combinations there were two seasons where a significant effect of exposure on delay was detected. Female caribou that did not intersect the Ekati/Diavik halo during summer were more likely to be delayed in their arrival on the late summer range than female caribou whose summer range included the Ekati/Diavik halo. The same pattern was observed for female caribou in the subsequent season, where caribou whose late summer range did not include the Ekati/Diavik halo were more likely to have a delayed arrival on the pre-rut range.

There was no season where spending time in the Ekati/Diavik halo made it more likely for animals of either sex to be delayed in arriving in the seasonal range for the next season.

There were also 62 animal-seasons where individuals had telemetry locations from both the earlier season and the later season but never entered the 90% UD seasonal range delineated for the later season (i.e., not delayed in their arrival at the next 90% UD seasonal range, but did not arrive at all). Of these, 53 were animals that had not entered into the Ekati/Diavik halo during the earlier season; the remaining nine animals had earlier season movement that included the Ekati/Diavik halo – they were from eight different sex by season combinations. They were not included in any formal analyses.

Table 3-16: Results of Fisher's exact tests of the effects of caribou encountering the Ekati/Diavik halo in one season on their arrival time in their seasonal range in the next season.

Sex	Season	Total Animal Seasons	Total Animal-Seasons Intersecting Ekati/Diavik Halo		Total Animal-Seasons Not Intersecting Ekati/Diavik Halo		P
			No delay in arrival	Delayed arrival next season	No delay in arrival	Delayed arrival next season	
Female	Winter	176	45	2	117	12	0.3585
Female	Spring Migration	326	85	3	229	9	1.0000
Female	Calving	346	0	0	339	7	1.0000
Female	Post-Calving	331	0	0	313	18	1.0000
Female	Summer	312	131	1	167	13	0.0053
Female	Late Summer	297	86	1	190	20	0.0107
Female	Pre-Rut	293	77	1	207	8	0.4530
Female	Rut	291	65	9	200	17	0.2488
Female	Post-Rut	229	70	2	155	2	0.5918
Male	Winter	106	22	0	75	9	0.1987
Male	Spring Migration	200	59	6	119	16	0.6387
Male	Calving	200	20	3	172	5	0.0509
Male	Post-Calving	194	8	0	177	9	1.0000
Male	Summer	192	54	0	130	8	0.1083
Male	Late Summer	168	34	0	124	10	0.2156
Male	Pre-Rut	159	32	0	123	4	0.5839
Male	Rut	149	31	0	110	8	0.2057
Male	Post-Rut	115	28	3	76	8	1.0000
	Totals	4,084	847	31	3,023	183	

4. DISCUSSION

The main objective of this study was to determine if there were effects of the Ekati Diamond Mine on fine-scale behaviour of Beverly and Bathurst herd caribou. The analyses were divided by sex, season, and scale (1-hour and 8-hour intervals), and explicitly addressed effects related to proximity to mining roads vs. other infrastructure. The period with data available at a scale of less than 24-hour intervals defined the study period as winter 2015/2016 to post-rut 2022. In the study period, data were collected every 8-hours throughout the range of both herds; 1-hour interval data collection in the GF112N area around the Ekati and Diavik mines began with spring migration 2017 for the Bathurst herd and spring migration 2018 for the Beverly herd.

The SSFs and iSSAs are inherently spatial analyses. Non-spatial factors of interest and potential influence identified prior to analyses included herd membership, season, sex, and year; factors best addressed with separate sets of models (Northrup et al. 2022). With two herds, two sexes, nine seasons, and seven years there were 252 potential model sets, an unmanageable number. As seasonal range use and habitat selection are known to vary between the sexes and by season (see Section 3.2 and Appendix A) those two factors were considered important enough to warrant independent analyses from the outset. In the 8-hour scale SSF analyses, herd membership was included in BRT analyses. However, herd membership was never included among important factors from the analyses, and so was not considered further.

Prior to using iSSAs to examine the effects of proximity to mining features on each sex by season at each scale, a predicted relative habitat selection value was calculated for the end point of each movement step. Predicted habitat selection values were based on SSFs from analyses of environmental data and caribou habitat selection spatially remote from mining development. The landcover data (LC2009) used to classify the majority of the RSA (including all of the Ekati/Diavik halo) was the same as that used in recent studies in the region by Boulanger et al. (2012, 2021). Rather than a summary of area covered in a single fixed buffer around each caribou location, landcover data in the analyses reported here were characterized at multiple grains (Laforge et al. 2015; McGarigal et al. 2016; Northrup et al. 2022) centred on each 3.1-ha cell in the RSA. Key attributes of SSFs are that they introduce time-dependency to constrain the distribution of available locations while allowing it to vary in time and space – changing with current locations and individual movement tendencies (Fieberg et al. 2021).

In the 8-hour BRT, stepAIC, and SSF analyses, multi-grain covariates competed in models. The resulting SSFs provided insight into the perceptual ranges of caribou and the influence of environmental covariates at different grains on behaviour at the 8-hour interval scale of analysis (Laforge et al. 2015; Bastille-Rousseau et al. 2018).

8-hour interval step selection function characteristics

The SSF analyses identified caribou habitat selection when animals are more than 30 km from development. Based on results presented here, caribou select habitat in an 8-hour interval based on a set of covariates that spans the range of nested grains included in the analyses (from 3.1-ha to 5,137-ha). The grain of response is an important consideration when characterizing habitat for any behavioural analysis. Earlier studies on Bathurst animals (Johnson et al. 2005; Boulanger et al. 2012, 2021) characterized used and available locations using 1 km buffers around each location, irrespective of the time interval between locations. For 8-hour intervals the results in this report support characterization of habitat at multiple grains, spanning at least 3.1-ha to 5,137-ha, the limits of the grains used to characterize habitat at observed and random locations in the analyses presented here. If an inter-location interval examined for caribou in this region is coarser than 8-hours, a corresponding increase in the range of grains examined may be warranted.

The CARMA insect harassment data used in these analyses had a spatial resolution (29,226 km^2 to 278,387 km^2) between 6 and 7 orders of magnitude coarser than the resolution of landcover (3.1-ha, as compiled for the analyses), and a temporal resolution 3 times the 8-hour interval used in analyses. Despite this, interaction terms revealed an effect of insect abundance on caribou behaviour in two of four seasons examined. CARMA's use of MERRA data is a reasonable solution to characterize insect harassment broadly for a season, but for the finer scale analyses conducted here, it does not provide adequate resolution. The 1-hour and 8-hour intervals of interest for these analyses require fine spatial and temporal resolution data to predict insect harassment risk. Coupled with caribou distribution over an area the size of the RSA (i.e., the large extent required as a control area), acquiring fine spatial and temporal resolution data to predict insect harassment for use in SSF and iSSAs may be impractical.

Overall, there was a general pattern for caribou to preferentially include waterbodies at coarser-grains and avoid them at the 3.1-ha grain. Tussock graminoid tundra and shrub landscapes were selected at the 3.1-ha grain by both sexes in most seasons. Of the 14 sex by season SSFs, all but one (female summer) contained covariates from multiple grains. Tussock graminoid tundra, waterbody area, and shrub landscapes were selected landcover types identified in SSFs, and they collectively dominate the area of the Ekati/Diavik halo, making up more than 80% of the landscape. The Ekati/Diavik halo contains important landcover types for barren-ground caribou.

The case probability ROC values for SSFs ranged from 0.57 to 0.64, below the 0.70 value threshold that Boyce et al. (2002, p.288) considered for "useful applications".

Though arguably of low predictive value, the sex by season SSFs were used to predict habitat selection values for 8-hour and 1-hour iSSAs for each sex by season inside the Ekati/Diavik halo. The PRHSVs effectively represent the best predictions of relative, development-free, habitat selection value. Those predicted values were included in iSSA models to determine if distance from mining features was related to habitat selection value and movement step lengths.

Caution is always recommended when making predictions in areas or time periods outside the data used to generate models. However, the approach employed in the analyses in this report was to withhold the 8-hour data from all study animals in the entire study period when they occurred in a 6,662 km^2 area centrally located in a 212,355 km^2 RSA (i.e., 3% of the RSA).

8-hour interval step selection functions and the influence of distance from mining features on habitat selection

Model performance of 8-hour interval iSSA ranged from 0.57 to 0.72, with a median value of 0.64 indicating a better predictive value for 8-hour interval iSSAs than observed for SSFs. Further, there was significant RSS > 1.00 for the PRHSV in 12 of 14 seasons, indicating that it was an important measure of relative selection of a habitat cell. The absence of a significant interaction between distance from mining feature and PRHSV for any season is an indication that selection of a habitat cell was related to the predicted habitat value and was not affected by its proximity to mining development.

The mining features included in top iSSA models varied by sex and season. Seven of the 14 sex by season top models had an interaction between distance-from-feature and step length with significant coefficients; in six of the seven cases RSS > 1.00, indicating habitat cell selection followed shorter movements when a caribou was closer to the relevant mining feature. Caribou appear to select resource units following shorter steps when they are closer to mining development features than farther from them. The one exception was males in winter, whose steps were longer when they were closer to a mine road.

In summary, the relative probability of 8-hour interval selection of a habitat cell inside the Ekati/Diavik halo was related to a predicted value based on SFF habitat attributes outside the Ekati/Diavik halo – relative habitat selection was not affected by proximity to mine features. However, proximity to mine features did affect step length in 7 of 14 seasons, primarily resulting in shorter steps nearer to mine infrastructure.

1-hour interval selection functions and the influence of distance from mining features on habitat selection

Overall, the results of 1-hour interval iSSAs were largely insignificant. Model performance (case probability) ranged from 0.54 to 0.61, a low predictive accuracy.

Of all covariates, PRHSV had a significant coefficient, with RSS > 1.00 in every season. As with 8-hour iSSA results, this indicated that PRHSV that it was an important measure of relative selection of a habitat cell within GF112N. There was a significant interaction of PRHSV and distance from mine roads for female caribou during the rut; RSS = 0.855 indicating relative selection of resource units was higher near mine roads.

For the other 13 of 14 sex by season models, the absence of a significant interaction between distance from mining feature and PRHSV for any season is an indication that selection of a habitat cell was related to the predicted habitat value and was not affected by its proximity to mining development.

As for 8-hour iSSAs, the mining features included in top models varied by sex and season. For the 1-hour data only one of the sex by season top models had a significant interaction with step length: female summer where RSS = 1.041 for the interaction between step length and distance from mine roads, indicating habitat cell selection followed shorter movements when a caribou was closer to a mine road.

In summary, the relative probability of 1-hour interval selection of a habitat cell inside the Ekati/Diavik halo was related to a predicted value based on SSF habitat attributes outside the Ekati/Diavik halo – habitat selection was not affected by proximity to mine features. However, the low case probability values and the relative absence of significant covariates other than PRHSV indicate that analyses of 1-hour movement data did not improve the understanding of caribou behaviour at this scale.

Summary of iSSA results

The 8-hour interval analyses produced the following information on barren-ground caribou behaviour:

- Overall, caribou selected habitat cells inside the Ekati/Diavik halo that had higher relative habitat selection values predicted from SSFs created from data outside the Ekati/Diavik halo. And they did so regardless of proximity to mining features. This suggests retention of relative habitat value in areas near the Ekati and Diavik mines.
- With respect to movement behaviour, caribou tended to take shorter steps when they were closer to Ekati and Diavik mining infrastructure in 6 of 14 seasons. While the relative selection of valued habitat did not differ when caribou were closer to mine infrastructure, the caribou did move more slowly in 8-hour time intervals.

The results from 1-hour analyses were largely insignificant. Further analyses of these data should await the acquisition of environmental data that match the spatial and temporal scale of caribou movements. An obvious candidate is traffic data from the mine roads. However, before compiling and analyzing those data there should be careful consideration of:

- the ecological risk to caribou (especially at the population level – survival and reproduction) of not collecting traffic data; and
- the mitigation actions that might result from analyses of traffic data, and if those mitigation actions could be monitored with sufficient power to detect a change in ecological effect.

In an early study of resource selection by the Bathurst caribou herd Johnson et al. (2005, p. 31) noted that the significance of the effects of mining on wildlife required an understanding of demographic effects. A failure to assess demographic risk has continued to be a shortcoming of analyses of the effects of northern mining operations on barren-ground caribou. Boulanger et al. (2021 p. 14) explicitly acknowledged that their work made no attempt to understand the effects of the zones of influence they modelled on caribou demography.

Effects of exposure to the Ekati/Diavik halo on movement path length and delays in arrival to seasonal ranges

Concerns have been expressed about the potential for mining infrastructure to interrupt movements of barren-ground caribou. Boulanger et al. (2024, p. 15) suggested that delays in migration and increases in movement pathways may contribute to demographic declines in barren-ground caribou from the Lorillard and Wager Bay herds, though they went on to dismiss the notion that arrival time on calving grounds was an appropriate measure of effect. In this report, the effects of exposure to the Ekati/Diavik halo on total seasonal movement path and delayed arrival in the 90% UD for the next season were adopted as measures to assess the effect of proximity to mines on seasonal caribou movement. Owing to different season lengths for each of the Beverly and Bathurst herds, movement paths were measured for each herd by sex by season. Ten of the 36 cases had statistically significant results, four with positive slopes (i.e., longer exposure in the halo yielded longer total seasonal movement paths), and six had negative slopes (longer halo exposure yielded shorter movement paths in the season).

The only significant effects of Ekati/Diavik halo exposure on delayed arrival in the next seasonal range were that female caribou that did not have any locations in the halo were more likely to be delayed on their arrival on late summer and pre-rut seasonal ranges. There was no season where spending time in the Ekati/Diavik halo made it more likely for animals of either sex to be delayed in arriving in the seasonal range for the next season.

Ecologically, the concerns of exposure to diamond mining infrastructure and roads yielding deflected, longer movements and delays in range-scale movements do not appear to be warranted. Four of 36 sex by season by herd seasonal pathway length comparisons showed significantly longer pathways related to encounter times in the Ekat/Diavik halo, compared with six of 36 comparisons showing significantly shorter seasonal pathways, and 26 of 36 showing no significant differences. Regardless of what individual pathways and movement patterns are, caribou encountering the Ekati Diamond Mine are not typically travelling farther than animals that do not encounter the Ekati/Diavik mine complex, nor are they delayed in arrival on their subsequent seasonal range.

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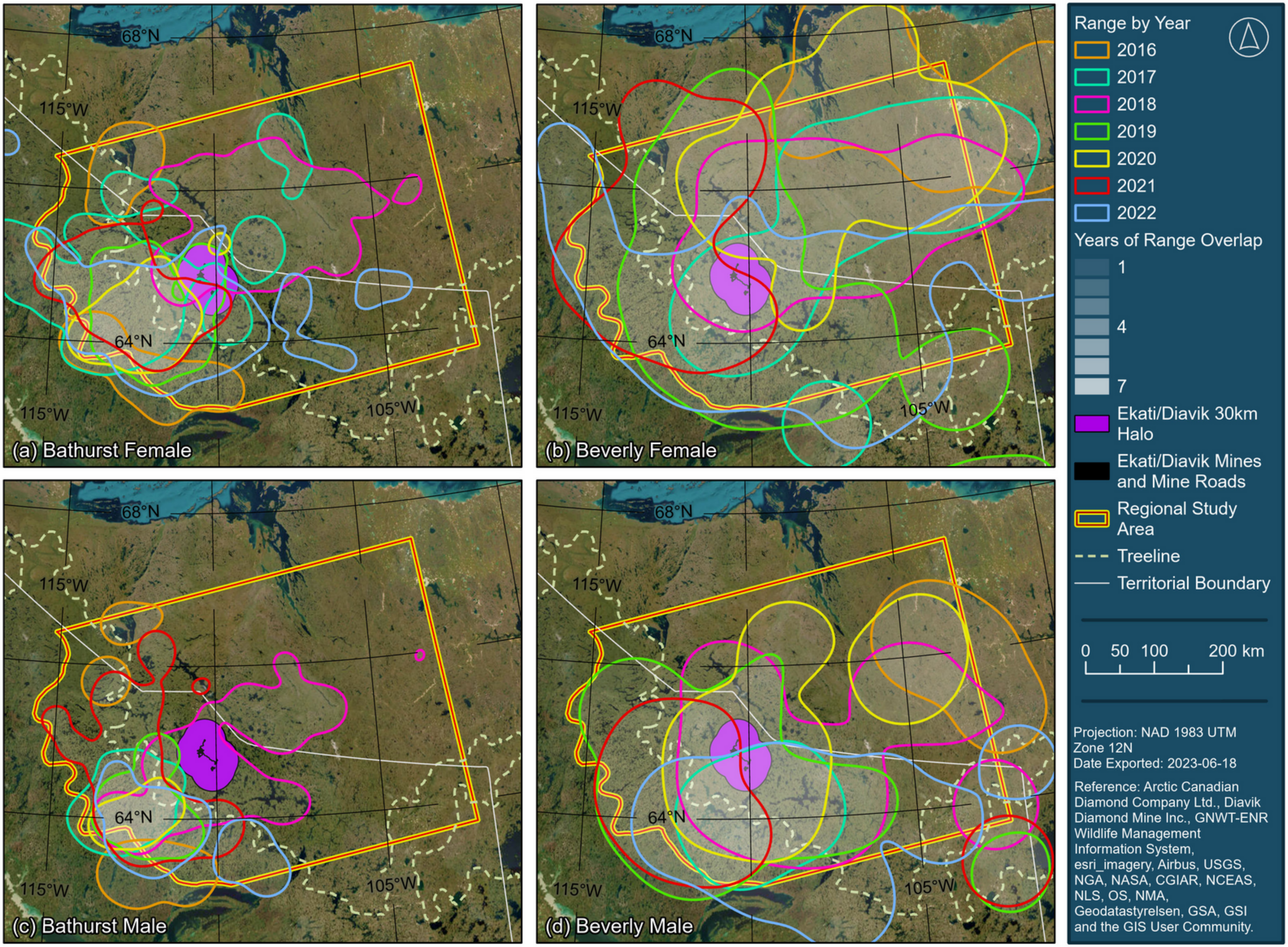

Figure A-1: Winter Range 90% Utilization Distributions for Bathurst and Beverly Caribou for 2016 to 2022

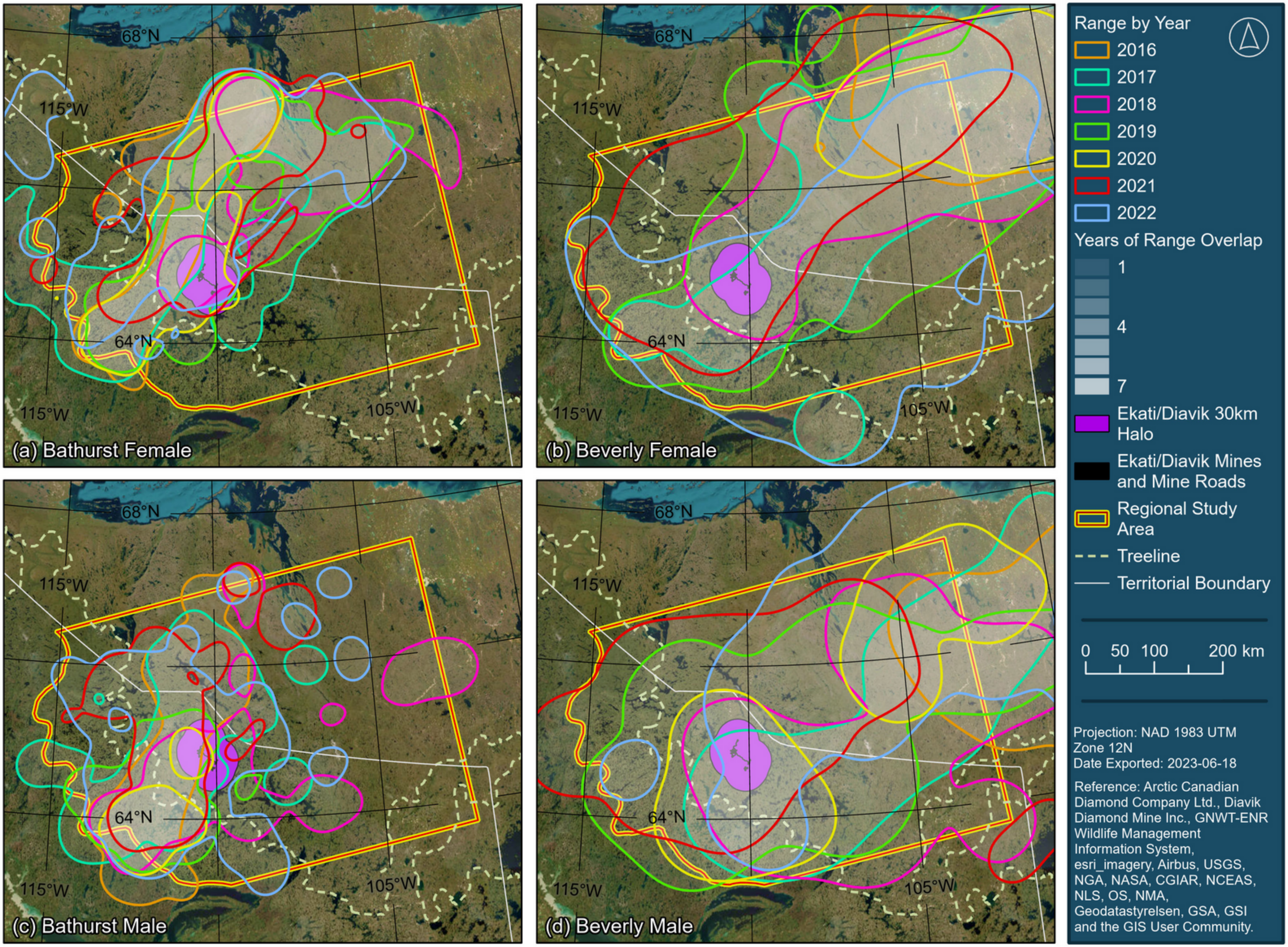

Figure A-2: Spring Migration Range 90% Utilization Distributions for Bathurst and Beverly Caribou for 2016 to 2022

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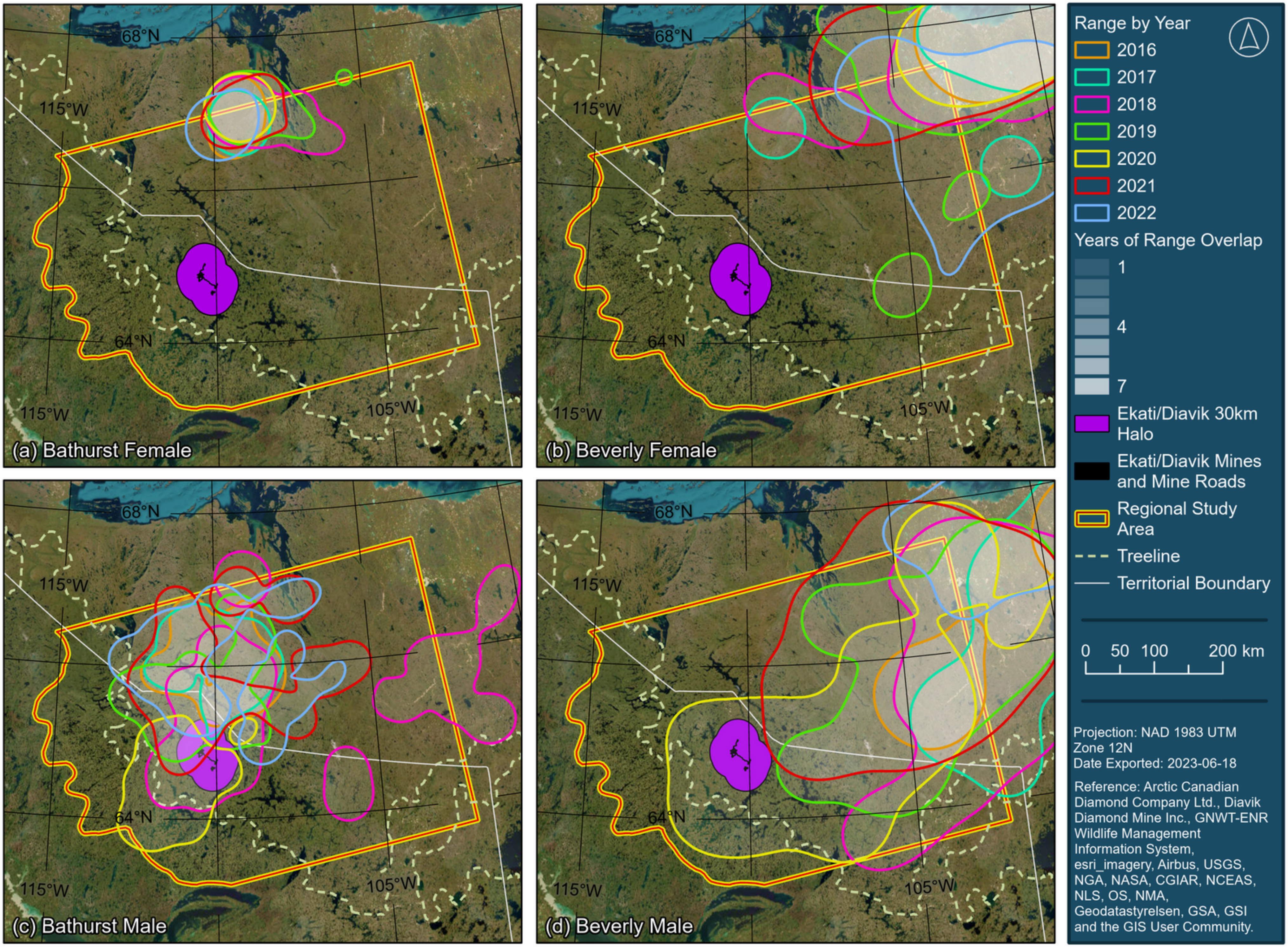

Figure A-3: Calving Range 90% Utilization Distributions for Bathurst and Beverly Caribou for 2016 to 2022

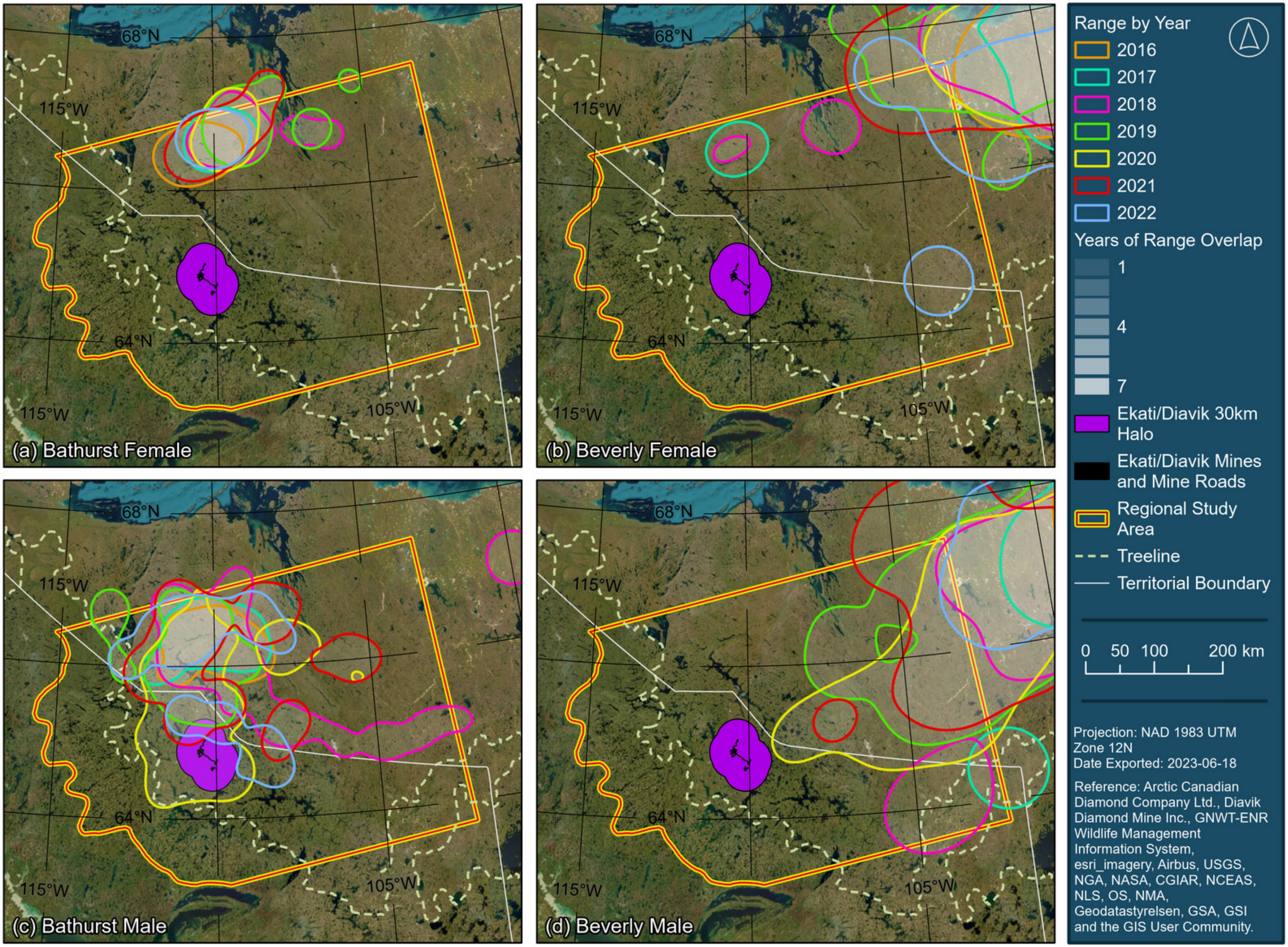

Figure A-4: Post-Calving Range 90% Utilization Distributions for Bathurst and Beverly Caribou for 2016 to 2022

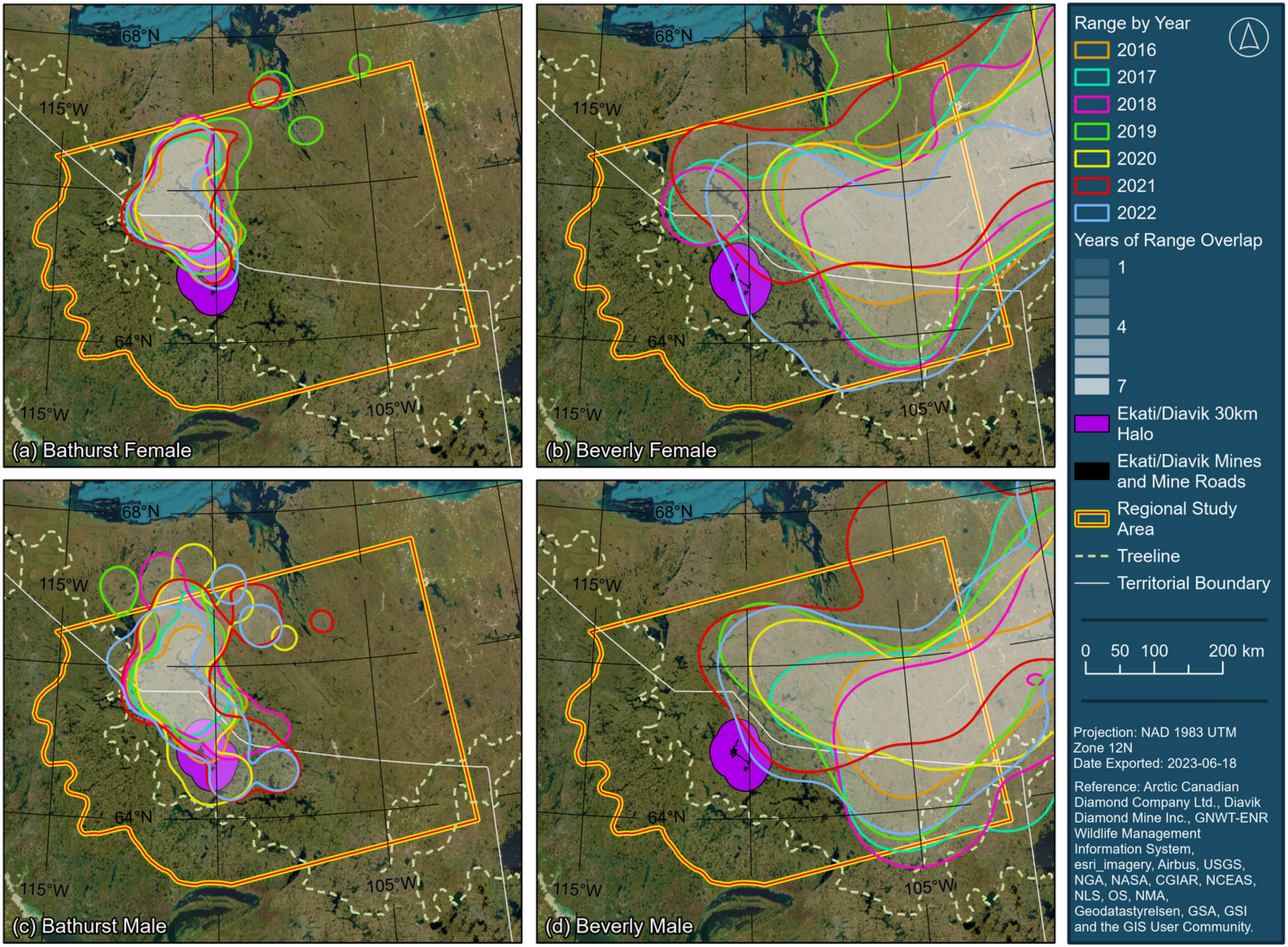

Figure A-5: Summer Range 90% Utilization Distributions for Bathurst and Beverly Caribou for 2016 to 2022

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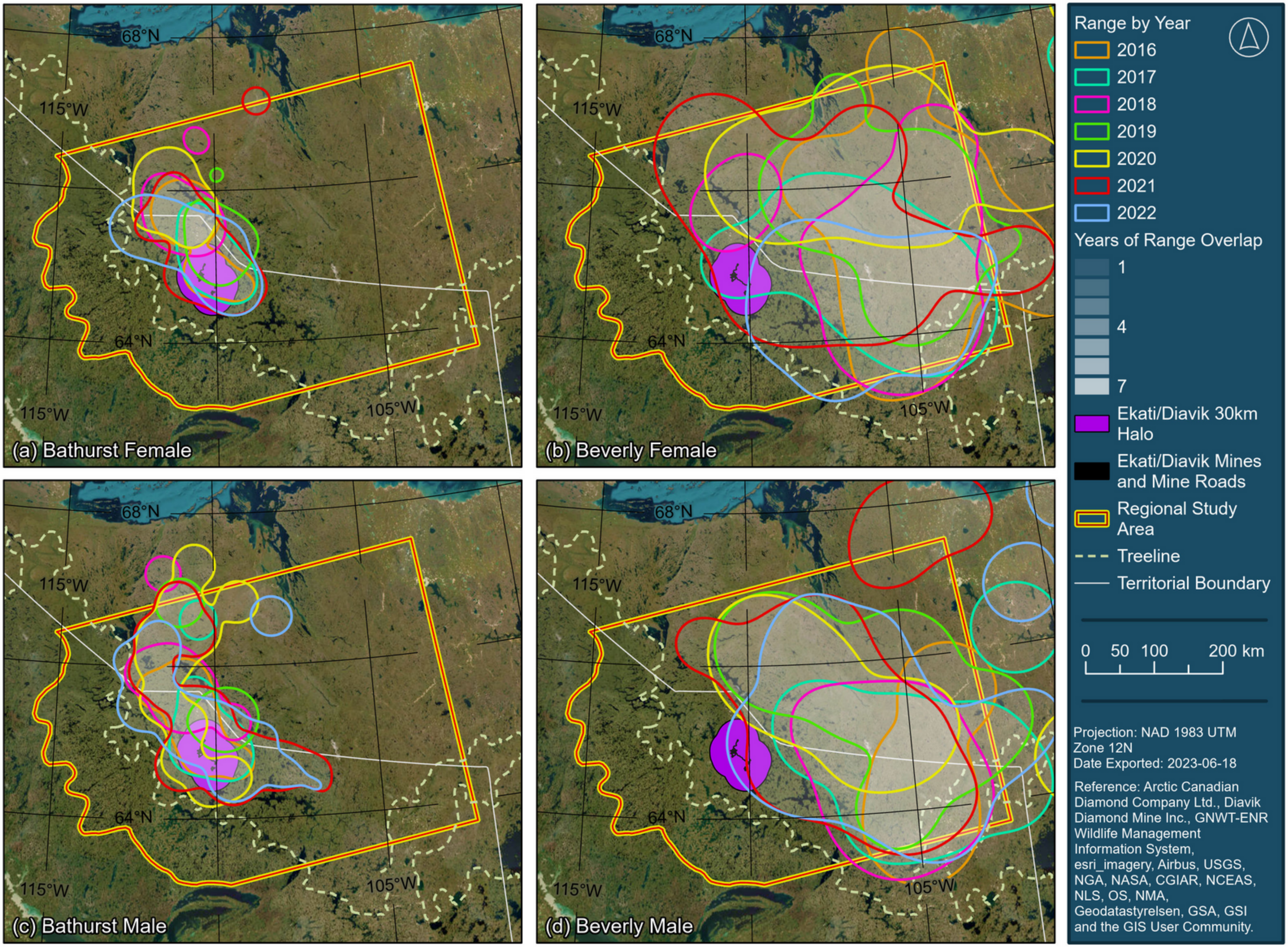

Figure A-6: Late Summer Range 90% Utilization Distributions for Bathurst and Beverly Caribou for 2016 to 2022

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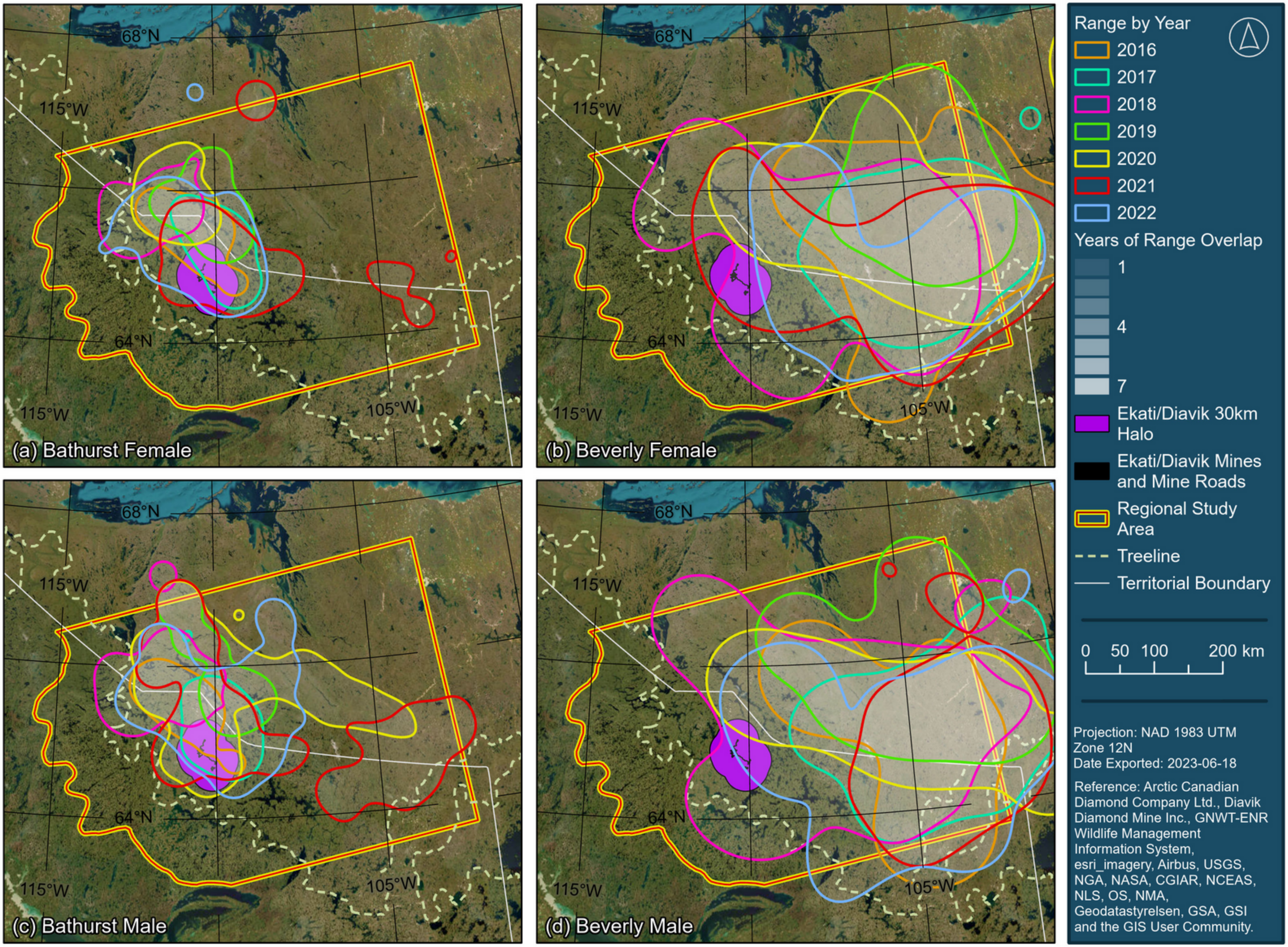

Figure A-7: Pre-Rut Range 90% Utilization Distributions for Bathurst and Beverly Caribou for 2016 to 2022

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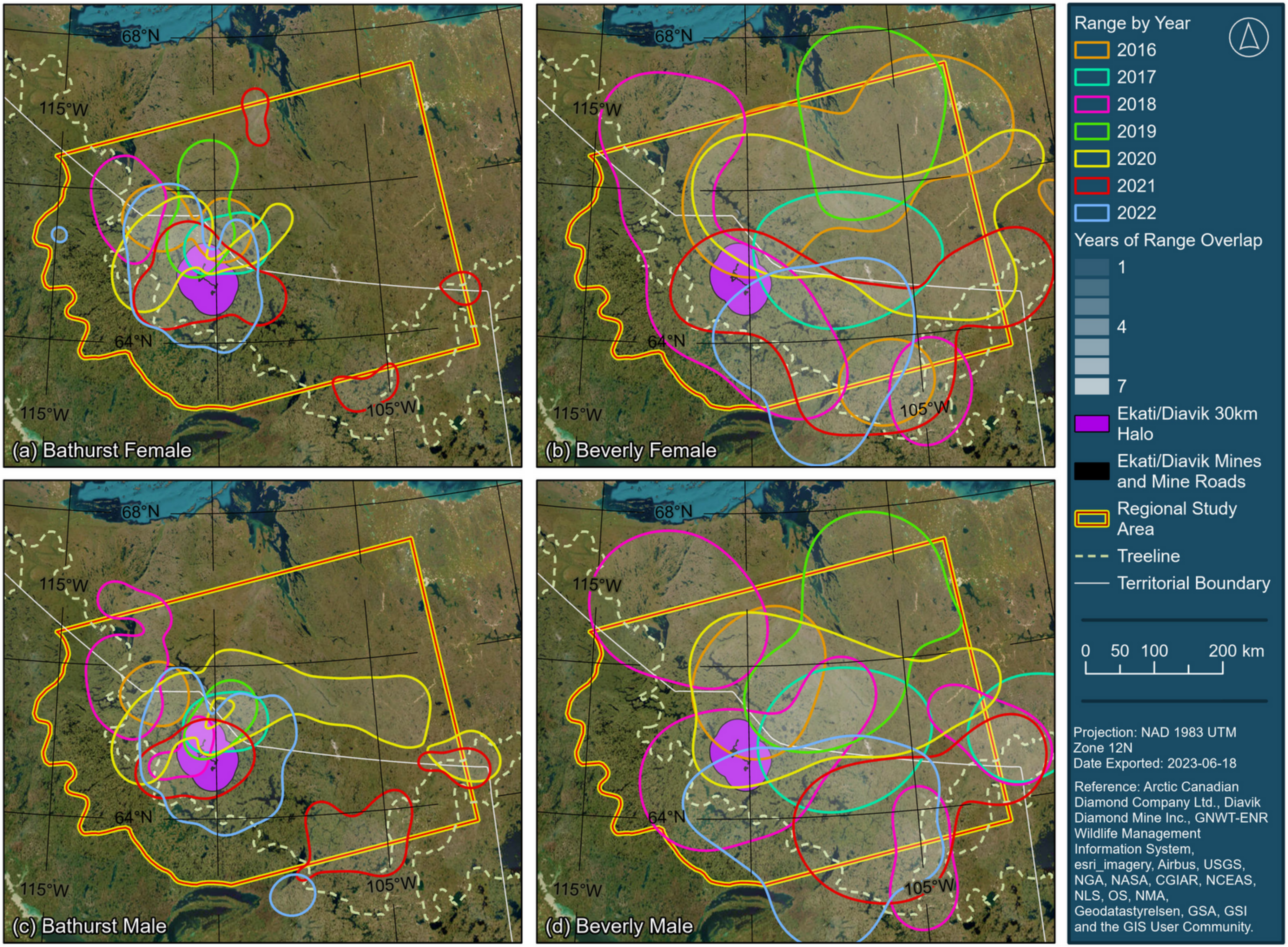

Figure A-8: Rut Range 90% Utilization Distributions for Bathurst and Beverly Caribou for 2016 to 2022

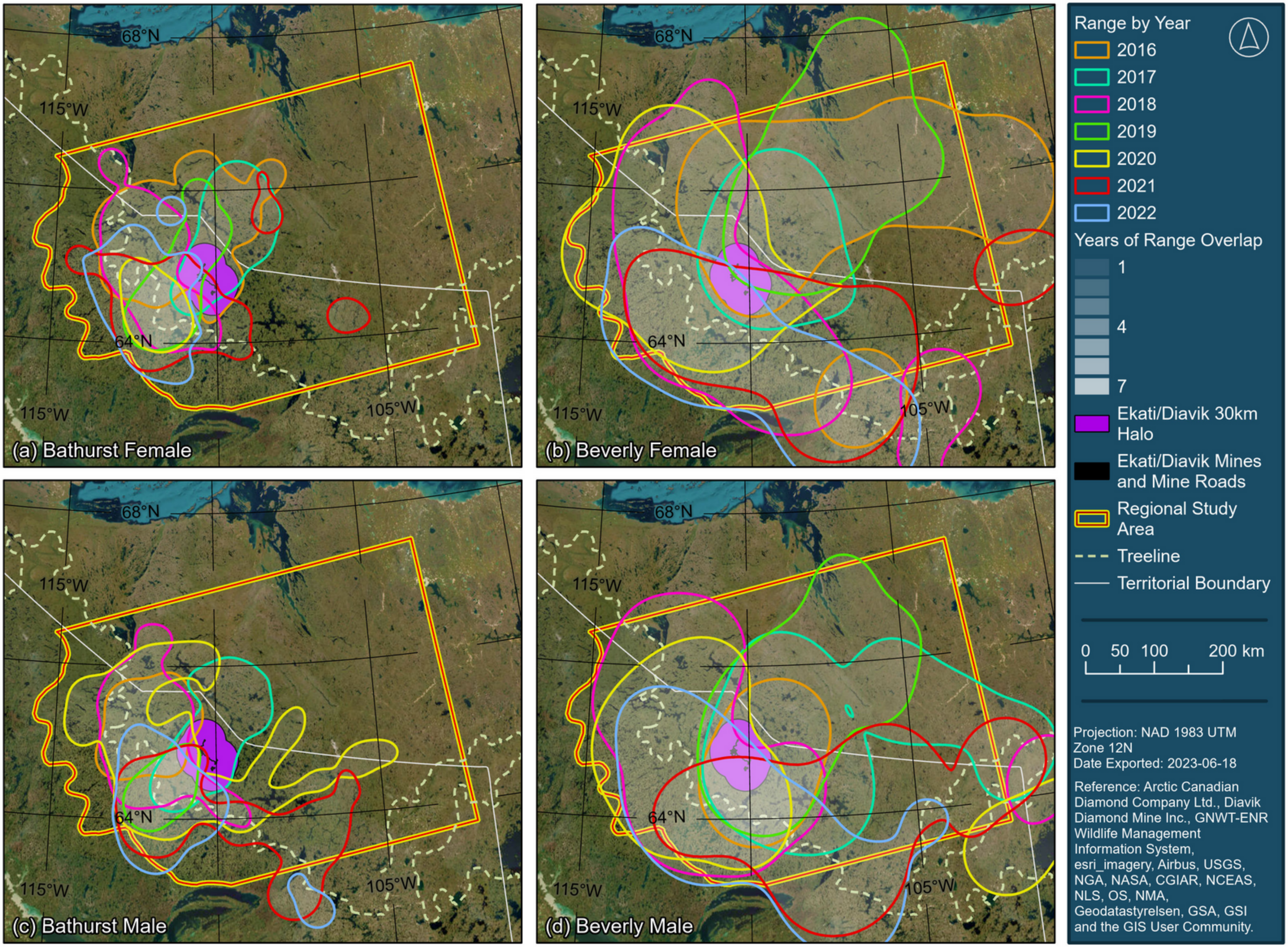

Figure A-9: Post-Rut Range 90% Utilization Distributions for Bathurst and Beverly Caribou for 2016 to 2022

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APPENDIX B SELECTION ANALYSIS INPUT COVARIATES

Regional scale analyses were conducted separately for each sex in each of the 9 seasons. Data from both the Beverly and Bathurst herds were combined in each sex by season combination. Details of analyses are provided in the body of the report (Section 2.8). Landcover covariates for each 3.1 ha hexagon were initially calculated for 4 nested scales: 3.1 ha, 58.9 ha, 524 ha, and 5,137 ha (Section 2.5.3). Following initial examination of data, the 58.9 ha scale data were not included in subsequent analyses (Section 2.8.3).

Table B-1 shows step attribute data attached to records in analyses both inside and outside the Ekati/Diavik 30 km halo (Report Figure 2-4). Table B-2 shows spatial covariates of the hexagons at the end point of each 8-hour step used in SSF modelling 8-hour outside the Ekati/Diavik 30 km halo. Table B-3 shows spatial covariates of the hexagons at the end point of each step used in 8-hour iSSA inside the Ekati/Diavik 30 km halo; note that inside the halo, the individual landcover and environmental covariates used in modelling movements outside the halo have been excluded and replaced by a single covariate (PRHSV) that reflects the predicted relative habitat selection value for the hexagon, based on the top 8-hour habitat selection model outside the halo.

Table B-4 is the list of covariates for all 1-hour iSSA inside GF112N (Report Figure 2-4). It contains the same list of covariates as Table B-3. The 8-hour and 1-hour analyses were conducted on different caribou movement data sets using the same set of candidate models.

Table B-1: Selection step attributes used in 8-Hour analyses outside and inside the Ekati/Diavik 30 km Halo and 1-Hour analyses inside geofence 112 north

Covariate	type	Grain (ha)	Description
Season	character	NA	One of 9 time periods in each year. These are unique dates for each of the two herds but are considered ecologically equivalent regardless of the slight differences in start and end dates. Data were divided by season prior to any analyses.
AnalysisYr	numeric	NA	A year that runs from December (of AnalysisYr-1) to December of the next year (of AnalysisYr - the year beginning in January). E.g,. AnalysisYr = 2018 runs from December 2017 to December 2018.
Herd	character	NA	Beverly or Bathurst - assigned by GNWT
Sex	character	NA	Assigned by GNWT - Male or Female
ID	character	NA	Caribou number assigned by GNWT
IDYr	character	NA	Identifier specifying combination of animal ID and AnalysisYr
case_	logical	NA	Indicates a real step (TRUE) or one of five random steps (FALSE) generated in package amt to simulate availability
step_id_	integer	NA	a package amt value - not relevant for processing
stepnum	numeric	NA	a unique value within each season - to keep a batch of TRUE (n=1) and FALSE (n=5) cases together. These numbers are unique to each step within a season. They do not repeat across animals, across years, across sexes, or across herds. The numbering process starts at 1 for each season and numbers repeat across seasons, which are analysed separately.
burst_	integer	NA	a package amt value - not relevant for processing
x1_	numeric	NA	x coordinate at point 1
x2_	numeric	NA	x coordinate at point 2

y1_	numeric	NA	y coordinate at point 1
y2_	numeric	NA	y coordinate at point 2
sl_	numeric	NA	step length from point 1 to point 2 (in metres) - calculated in amt package
ta_	numeric	NA	turn angle (in radians) - calculated in amt package
t1_	POSIXct	NA	UTC time and date of starting location
t2_	POSIXct	NA	UTC time and date of ending location
dt_	integer	NA	the elapsed time between the two successive locations. All records were screened before and during amt processing and are valid for either 8-hour intervals or 1-hour intervals, as appropriate for the specific analyses.
YearF	factor	NA	Factor with 7 levels

Table B-2: Step spatial covariates used in 8-Hour SSF outside the Ekati/Diavik 30 km Halo

Covariate	type	Grain (ha)	Description
VegZoneF	factor	3.1	1 if majority of 3.1 ha hexagon is Boreal Forest & Woodland vegetation zone. Otherwise 0.
HerdF	factor	NA	Bathurst or Beverly
EskerF	factor	3.1	1 if 3.1 ha hexagon is > 10% Esker. Otherwise 0
WAT_EDGE	numeric	3.1	length of water/land edge (m/ha); z-scaled
WATEDGE_S3	numeric	524	length of water/land edge (m/ha); z-scaled
BEDBOULD	numeric	3.1	proportion Bedrock-boulder: logit transformed; then z-scaled
TUNDRA	numeric	3.1	proportion Tundra: logit transformed; then z-scaled
TUSSK	numeric	3.1	proportion Tussock: logit transformed; then z-scaled
SEDGEWET	numeric	3.1	proportion Sedge Wetland: logit transformed; then z-scaled
LHSHRUB	numeric	3.1	proportion Shrub: logit transformed; then z-scaled
FOREST	numeric	3.1	proportion Forest: logit transformed; then z-scaled
BEDBLD_S3	numeric	524	proportion Bedrock-boulder: logit transformed; then z-scaled
TUNDR_S3	numeric	524	proportion Tundra: logit transformed; then z-scaled
TUSSK_S3	numeric	524	proportion Tussock: logit transformed; then z-scaled
SEDWET_S3	numeric	524	proportion Sedge Wetland: logit transformed; then z-scaled
LHSHRUB_S3	numeric	524	proportion Shrub: logit transformed; then z-scaled
FOREST_S3	numeric	524	proportion Forest: logit transformed; then z-scaled
BEDBLD_S4	numeric	5,137	proportion Bedrock-boulder: logit transformed; then z-scaled
TUNDR_S4	numeric	5,137	proportion Tundra: logit transformed; then z-scaled
TUSSK_S4	numeric	5,137	proportion Tussock: logit transformed; then z-scaled
SEDWET_S4	numeric	5,137	proportion Sedge Wetland: logit transformed; then z-scaled
LHSHRUB_S4	numeric	5,137	proportion Shrub: logit transformed; then z-scaled
FOREST_S4	numeric	5,137	proportion Forest: logit transformed; then z-scaled
P_ESKER	numeric	3.1	proportion Esker: logit transformed; then z-scaled
P_ESKER_S3	numeric	524	proportion Esker: logit transformed; then z-scaled
P_ESKER_S4	numeric	5,137	proportion Esker: logit transformed; then z-scaled

WBAREA	numeric	3.1	proportion Waterbody Area: logit transformed; then z-scaled
WBAREA_S3	numeric	524	proportion Waterbody Area: logit transformed; then z-scaled
WBAREA_S4	numeric	5,137	proportion Waterbody Area: logit transformed; then z-scaled
ELEVATION	numeric	3.1	mean elevation (in m ASL) within 3.1 ha hexagon: z-scaled
SLOPE	numeric	3.1	mean slope (in degrees) within 3.1 ha hexagon: z-scaled
TUNDRA_sq	numeric	3.1	squared value of transformed, rescaled landcover variable
TUSSK_sq	numeric	3.1	squared value of transformed, rescaled landcover variable
ELEVATION_sq	numeric	3.1	squared value of rescaled mean elevation within 3.1 ha hexagon
WBAREA_sq	numeric	3.1	squared value of transformed, rescaled landcover variable
SEDGEWET_sq	numeric	3.1	squared value of transformed, rescaled landcover variable
LHSHRUB_sq	numeric	3.1	squared value of transformed, rescaled landcover variable
SLOPE_sq	numeric	3.1	squared value of rescaled mean slope within 3.1 ha hexagon
P_ESKER_sq	numeric	3.1	squared value of transformed, rescaled landcover variable
WAT_EDGE_sq	numeric	3.1	squared value of rescaled length of water/land interface
BEDBOULD_sq	numeric	3.1	squared value of transformed, rescaled landcover variable
TUNDR_S3_sq	numeric	524	squared value of transformed, rescaled landcover variable
TUSSK_S3_sq	numeric	524	squared value of transformed, rescaled landcover variable
SEDWET_S3_sq	numeric	524	squared value of transformed, rescaled landcover variable
LHSHRUB_S3_sq	numeric	524	squared value of transformed, rescaled landcover variable
BEDBLD_S3_sq	numeric	524	squared value of transformed, rescaled landcover variable
WBAREA_S3_sq	numeric	524	squared value of transformed, rescaled landcover variable
P_ESKER_S3_sq	numeric	524	squared value of transformed, rescaled landcover variable
TUNDR_S4_sq	numeric	5,137	squared value of transformed, rescaled landcover variable
TUSSK_S4_sq	numeric	5,137	squared value of transformed, rescaled landcover variable
WBAREA_S4_sq	numeric	5,137	squared value of transformed, rescaled landcover variable
SEDWET_S4_sq	numeric	5,137	squared value of transformed, rescaled landcover variable
LHSHRUB_S4_sq	numeric	5,137	squared value of transformed, rescaled landcover variable
P_ESKER_S4_sq	numeric	5,137	squared value of transformed, rescaled landcover variable
WATEDGE_S3_sq	numeric	524	squared value of rescaled length of water/land interface
BEDBLD_S4_sq	numeric	5,137	squared value of transformed, rescaled landcover variable
TUNDRA * WBAREA	numeric	3.1	interaction term of two 3.1 ha transformed, rescaled landcover variables
TUNDRA * BEDBOULD	numeric	3.1	interaction term of two 3.1 ha transformed, rescaled landcover variables
OestIndx_1	numeric	3.1	Daily CARMA oestrid harassment index at step end location
MosqIndx_1	numeric	3.1	Daily CARMA mosquito harassment index at step end location

Table B-3: Step covariates used in 8-Hour iSSA inside the Ekati/Diavik 30 km Halo

Covariate	type	Grain (ha)	Description
PRHSV	numeric	3.1, based on prior multi-grain analyses	The predicted relative probability of selection of a 3.1 ha hexagon based on exponentiated application of the top model for the specific sex and season. Determined as an output of 8-hour SSF modelling of data outside the Ekati/Diavik 30 km halo. $PRHSV = w_x = exp(x_1\beta_1 + \cdots x_k\beta_k)$
sl_	numeric	NA	step length from point 1 to point 2 (in metres) - calculated in amt package
ta_	numeric	NA	turn angle (in radians) - calculated in amt package
t1_	POSIXct	NA	time and date of starting location
t2_	POSIXct	NA	time and date of ending location
dt_	integer	NA	the elapsed time between the two successive locations. All records were screened before and during amt processing (separately for 1-hour and 8-hour interval data sets) and are valid for the specified interval
sl.km	numeric	NA	Step length in km
log.sl.km	numeric	NA	natural log transformed step length in km (sl.km)
cos.ta	numeric	3.1	cosine transformed turning angle (ta_)
DF_PROADS	numeric	3.1	Shortest distance from centroid of 3.1 ha hexagon containing each real or random caribou location to nearest 2021 Ekati Mine road ("P"olygon feature). Values inside the road polygon perimeter are set to 0. Measured in km.
DF_MINES	numeric	3.1	Shortest distance from centroid of 3.1 ha hexagon containing each real or random caribou location to Ekati or Diavik 2021 mine infrastructure. Values inside the mine polygon perimeter are set to 0. Measured in km.
log.dfproads	numeric	3.1	natural log transformed (DF_PROADS + 1)
log.dfmines	numeric	3.1	natural log transformed (DF_MINES + 1)
log.minDF	numeric	3.1	natural log transformed ([minimum of {DFPROADS and DF_MINES}] + 1). I.e., the minimum distance from the hexagon to the nearest mining road or infrastructure feature
log.dfmines * log.sl.km	numeric	3.1	interaction term of two covariates from list above
log.dfmines * PRHSV	numeric	3.1	interaction term of two covariates from list above
log.dfproads * log.sl.km	numeric	3.1	interaction term of two covariates from list above
log.dfproads * PRHSV	numeric	3.1	interaction term of two covariates from list above
log.minDF * log.sl.km	numeric	3.1	interaction term of two covariates from list above
log.minDF * PRHSV	numeric	3.1	interaction term of two covariates from list above

Table B-4: Step covariates used in 1-hour iSSA inside Geofence 112 North

Covariate	type	Grain (ha)	Description
PRHSV	numeric	3.1, based on prior multi-grain analyses	The predicted relative probability of selection of a 3.1 ha hexagon based on exponentiated application of the top model for the specific sex and season. Determined as an output of 8-hour SSF modelling of data outside the Ekati/Diavik 30 km halo. $PRHSV = w_x = exp(x_1\beta_1 + \cdots x_k\beta_k)$
sl_	numeric	NA	step length from point 1 to point 2 (in metres) - calculated in amt package
ta_	numeric	NA	turn angle (in radians) - calculated in amt package
t1_	POSIXct	NA	time and date of starting location
t2_	POSIXct	NA	time and date of ending location
dt_	integer	NA	the elapsed time between the two successive locations. All records were screened before and during amt processing (separately for 1-hour and 8-hour interval data sets) and are valid for the specified interval
sl.km	numeric	NA	Step length in km
log.sl.km	numeric	NA	natural log transformed step length in km (sl.km)
cos.ta	numeric	3.1	cosine transformed turning angle (ta_)
DF_PROADS	numeric	3.1	Shortest distance from centroid of 3.1 ha hexagon containing each real or random caribou location to nearest 2021 Ekati Mine road ("P"olygon feature). Values inside the road polygon perimeter are set to 0. Measured in km.
DF_MINES	numeric	3.1	Shortest distance from centroid of 3.1 ha hexagon containing each real or random caribou location to Ekati or Diavik 2021 mine infrastructure. Values inside the mine polygon perimeter are set to 0. Measured in km.
log.dfproads	numeric	3.1	natural log transformed (DF_PROADS + 1)
log.dfmines	numeric	3.1	natural log transformed (DF_MINES + 1)
log.minDF	numeric	3.1	natural log transformed ([minimum of {DFPROADS and DF_MINES}] + 1). I.e., the minimum distance from the hexagon to the nearest mining road or infrastructure feature
log.dfmines * log.sl.km	numeric	3.1	interaction term of two covariates from list above
log.dfmines * PRHSV	numeric	3.1	interaction term of two covariates from list above
log.dfproads * log.sl.km	numeric	3.1	interaction term of two covariates from list above
log.dfproads * PRHSV	numeric	3.1	interaction term of two covariates from list above
log.minDF * log.sl.km	numeric	3.1	interaction term of two covariates from list above
log.minDF * PRHSV	numeric	3.1	interaction term of two covariates from list above

APPENDIX C 8-HOUR INTERVAL STEP SELECTION FUNCTION MODELS IN THE REGIONAL STUDY AREA

After excluding data from the calving and post-calving seasons, 8-hour interval scale analyses were conducted separately for each sex in each of the seven remaining seasons. Data from both the Beverly and Bathurst herds were combined in each sex x season combination. Details are provided in the body of the report (Section 2.8). Candidate models for each sex in each season are presented, with their rankings and scores, in Tables C-1 to C-14 below. Comparisons of train vs test model performance are presented in Tables C-1b to C-14b that accompany the main tables in this Appendix.

Model performance criteria:

AIC – Akaike's Information Criterion. This is the model performance criterion used for model ranking in the main Tables in this Appendix.

ΔAIC – The difference in AIC from the top model in the set.

BIC – Bayesian Information Criterion.

AUC - Area under the curve.

Caserank – the mean rank of used movement steps.

Randomrank – the mean rank of random movement steps.

Caseprob – Case probability: A measure of concordance based on the mean rank of the used step within a stratum. A generalization of ROC AUC for stratified models. This is the criterion used to compare test vs. train model performance in the "b" Tables in this Appendix.

Table C-1: Female - Winter Regional Scale 8-hour interval models

Model name	N	AIC	ΔAIC	Wt AIC	BIC	AUC	Formula
Mixed Grain 1	292144	943412.6	0.0	0.986	943560.8	0.563	case_ ~ WBAREA_sq + WBAREA + WBAREA_S3 + LHSHRUB + SLOPE_sq + TUSSK + FOREST + TUNDRA + SEDGEWET + TUSSK_S3 + FOREST_S3 + LHSHRUB_S3_sq + FOREST_S4 - 1 + (1 | stepnum) + (1 | IDYr)
Mixed Grain 2	292144	943421.1	8.5	0.014	943569.2	0.558	case_ ~ WBAREA_sq + WBAREA + WBAREA_S3 + LHSHRUB + SLOPE_sq + TUSSK + FOREST + TUNDRA + SEDGEWET + TUSSK_S3 + FOREST_S3 + LHSHRUB_S3_sq + SLOPE - 1 + (1 | stepnum) + (1 | IDYr)
Fine Grain	292144	943565.7	153.2	0.000	943671.6	0.556	case_ ~ WBAREA_sq + WBAREA + LHSHRUB + SLOPE_sq + TUSSK + FOREST + TUNDRA + SEDGEWET + SLOPE - 1 + (1 | stepnum) + (1 | IDYr)
Coarse Grain	292144	945019.6	1607.0	0.000	945114.8	0.533	case_ ~ WBAREA_S3 + SLOPE_sq + TUNDRA + SEDGEWET + TUSSK_S3 + FOREST_S3 + LHSHRUB_S3_sq + SLOPE - 1 + (1 | stepnum) + (1 | IDYr)

Table C-1b: Model Performance of top Female - Winter Regional Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.563	3.145	3.566	0.571
test	0.564	3.134	3.568	0.573

Table C-2: Female – Spring Migration Regional Scale 8-hour interval models

Model name	N	AIC	ΔAIC	Wt AIC	BIC	AUC	Formula
Mixed Grain 1	117565	382008.0	0.0	1.000	382269.2	0.537	case_ ~ SLOPE + WBAREA_sq + TUNDRA + WBAREA_S4 + FOREST_S3 + ELEVATION + TUSSK_S3_sq + ELEVATION_sq + SLOPE_sq + SEDWET_S3_sq + SEDGEWET + LHSHRUB_S3_sq + TUNDR_S3 + WBAREA_S4_sq + TUSSK_S4_sq + TUSSK_S3 + P_ESKER_S3_sq + WBAREA_S3_sq + SEDWET_S4_sq + TUSSK + WAT_EDGE + FOREST_S4 + BEDBOULD + BEDBLD_S3_sq + TUNDR_S4_sq + LHSHRUB_S3 - 1 + (1 | stepnum) + (1 | IDYr)
Mixed Grain 2	117565	382050.6	42.6	0.000	382292.5	0.543	case_ ~ SLOPE + WBAREA_sq + TUNDRA + WBAREA_S4 + FOREST_S3 + ELEVATION + TUSSK_S3_sq + ELEVATION_sq + SLOPE_sq + SEDWET_S3_sq + SEDGEWET + LHSHRUB_S3_sq + TUNDR_S3 + WBAREA_S4_sq + TUSSK_S3 + P_ESKER_S3_sq + TUSSK + WAT_EDGE + BEDBOULD + BEDBLD_S3_sq + LHSHRUB_S3 + WBAREA + SEDWET_S3 + P_ESKER_S3 - 1 + (1 | stepnum) + (1 | IDYr)
Fine Grain	117565	382192.0	184.0	0.000	382356.5	0.542	case_ ~ SLOPE + WBAREA_sq + TUNDRA + FOREST_S3 + ELEVATION + ELEVATION_sq + SLOPE_sq + SEDGEWET + LHSHRUB_S3_sq + P_ESKER_S3_sq + TUSSK + WAT_EDGE + BEDBOULD + LHSHRUB_S3 + WBAREA + P_ESKER_S3 - 1 + (1 | stepnum) + (1 | IDYr)
Coarse Grain	117565	382282.8	274.8	0.000	382466.6	0.532	case_ ~ SLOPE + WBAREA_S4 + FOREST_S3 + ELEVATION + TUSSK_S3_sq + ELEVATION_sq + SLOPE_sq + SEDWET_S3_sq + LHSHRUB_S3_sq + TUNDR_S3 + WBAREA_S4_sq + TUSSK_S3 + P_ESKER_S3_sq + WAT_EDGE + BEDBLD_S3_sq + LHSHRUB_S3 + SEDWET_S3 + P_ESKER_S3 - 1 + (1 | stepnum) + (1 | IDYr)

Table C-2b: Model Performance of top Female – Spring Migration Regional Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.537	3.124	3.554	0.575
test	0.539	3.101	3.558	0.580

Table C-3: Female – Summer Regional Scale 8-hour interval models

Model name	N	AIC	ΔAIC	Wt AIC	BIC	AUC	Formula
Oestrid	132407	422111.3	0.0	0.876	422248.4	0.615	case_ ~ WBAREA + WBAREA_sq + SEDGEWET + ELEVATION + LHSHRUB + BEDBOULD + TUNDRA + BEDBLD_S3 + SLOPE_sq + LHSHRUB_S3 + SLOPE + (1 | stepnum) + (1 | IDYr) + WBAREA:OestIndx_1 + ELEVATION:OestIndx_1 - 1
Mosquito	132407	422115.2	3.9	0.124	422252.3	0.614	case_ ~ WBAREA + WBAREA_sq + SEDGEWET + ELEVATION + LHSHRUB + BEDBOULD + TUNDRA + BEDBLD_S3 + SLOPE_sq + LHSHRUB_S3 + SLOPE + (1 | stepnum) + (1 | IDYr) + WBAREA:MosqIndx_1 + ELEVATION:MosqIndx_1 - 1
Mixed Grain 2	132407	422139.3	27.9	0	422256.8	0.614	case_ ~ WBAREA + WBAREA_sq + SEDGEWET + ELEVATION + LHSHRUB + BEDBOULD + TUNDRA + BEDBLD_S3 + SLOPE_sq + LHSHRUB_S3 + SLOPE - 1 + (1 | stepnum) + (1 | IDYr)
Mixed Grain 1	132407	422147.9	36.6	0	422294.8	0.613	case_ ~ WBAREA + WBAREA_sq + SEDGEWET + ELEVATION + LHSHRUB + BEDBOULD + TUSSK + WBAREA_S4 + TUNDRA + BEDBLD_S3 + SLOPE_sq + LHSHRUB_S3 + LHSHRUB_S4 + BEDBLD_S4 - 1 + (1 | stepnum) + (1 | IDYr)
Coarse Grain	132407	422286.9	175.5	0	422384.8	0.612	case_ ~ WBAREA + WBAREA_sq + SEDGEWET + ELEVATION + TUNDRA + BEDBLD_S3 + SLOPE_sq + LHSHRUB_S3 + SLOPE - 1 + (1 | stepnum) + (1 | IDYr)
Fine Grain	132407	422311.2	199.9	0	422409.1	0.614	case_ ~ WBAREA + WBAREA_sq + SEDGEWET + ELEVATION + LHSHRUB + BEDBOULD + TUNDRA + SLOPE_sq + SLOPE - 1 + (1 | stepnum) + (1 | IDYr)

Table C-3b: Model Performance of top Female - Summer Regional Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.615	2.784	3.641	0.643
test	0.610	2.796	3.638	0.641

Table C-4: Female – Late Summer Regional Scale 8-hour interval models

Model name	N	AIC	ΔAIC	Wt AIC	BIC	AUC	Formula
Mixed Grain 2	74235	237703.9	0.0	0.479	237796.1	0.580	case_ ~ WBAREA_sq + LHSHRUB + TUSSK + SEDGEWET + BEDBOULD + ELEVATION + SLOPE + BEDBLD_S3 + WBAREA - 1 + (1 | stepnum) + (1 | IDYr)
Mosquito	74235	237704.3	0.4	0.389	237814.9	0.581	case_ ~ WBAREA_sq + LHSHRUB + TUSSK + SEDGEWET + BEDBOULD + ELEVATION + SLOPE + BEDBLD_S3 + WBAREA + (1 | stepnum) + (1 | IDYr) + WBAREA:MosqIndx_1 + ELEVATION:MosqIndx_1 - 1
Oestrid	74235	237706.9	3.0	0.109	237817.5	0.581	case_ ~ WBAREA_sq + LHSHRUB + TUSSK + SEDGEWET + BEDBOULD + ELEVATION + SLOPE + BEDBLD_S3 + WBAREA + (1 | stepnum) + (1 | IDYr) + WBAREA:OestIndx_1 + ELEVATION:OestIndx_1 - 1
Mixed Grain 1	74235	237710.4	6.5	0.019	237839.4	0.582	case_ ~ WBAREA_sq + LHSHRUB + TUSSK + SEDGEWET + BEDBOULD + WBAREA_S4 + ELEVATION + LHSHRUB_S4 + SLOPE + TUSSK_S4 + SEDWET_S4 + BEDBLD_S3 + BEDBLD_S4 - 1 + (1 | stepnum) + (1 | IDYr)
Fine Grain	74235	237713.4	9.5	0.004	237796.3	0.581	case_ ~ WBAREA_sq + LHSHRUB + TUSSK + SEDGEWET + BEDBOULD + ELEVATION + SLOPE + WBAREA - 1 + (1 | stepnum) + (1 | IDYr)
Coarse Grain	74235	237746.2	42.2	0	237829.1	0.579	case_ ~ WBAREA_sq + LHSHRUB + TUSSK + SEDGEWET + ELEVATION + SLOPE + BEDBLD_S3 + WBAREA - 1 + (1 | stepnum) + (1 | IDYr)

Table C-4b: Model Performance of top Female – Late Summer Regional Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.580	2.923	3.614	0.615
test	0.574	2.975	3.604	0.605

Table C-5: Female – Pre-Rut Regional Scale 8-hour interval models

Model name	N	AIC	ΔAIC	Wt AIC	BIC	AUC	Formula
Mixed Grain 2	116218	371481.4	0.0	0.948	371578.1	0.621	case_ ~ WBAREA + LHSHRUB + TUSSK + WBAREA_sq + SEDGEWET + SLOPE_sq + SLOPE + BEDBOULD + BEDBOULD_sq - 1 + (1 | stepnum) + (1 | IDYr)
Mixed Grain 1	116218	371487.3	5.8	0.052	371612.9	0.620	case_ ~ WBAREA + LHSHRUB + TUSSK + WBAREA_sq + SEDGEWET + SLOPE_sq + SLOPE + BEDBOULD + LHSHRUB_S4 + WBAREA_S4 + BEDBOULD_sq + BEDBLD_S4 - 1 + (1 | stepnum) + (1 | IDYr)

Table C-5b: Model Performance of top Female – Pre-Rut Regional Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.621	2.866	3.623	0.627
test	0.622	2.866	3.623	0.627

Table C-6: Female – Rut Regional Scale 8-hour interval models

Model name	N	AIC	ΔAIC	Wt AIC	BIC	AUC	Formula
Mixed Grain 2	38832	124157.5	0.0	0.804	124251.7	0.626	case_ ~ WBAREA + WBAREA_sq + TUSSK + LHSHRUB + WBAREA_S4 + SLOPE_sq + SLOPE + WBAREA_S4_sq + TUSSK_S3_sq + TUSSK_S3 - 1 + (1 | stepnum) + (1 | IDYr)
Mixed Grain 1	38832	124161.0	3.5	0.139	124280.9	0.627	case_ ~ WBAREA + WBAREA_sq + TUSSK + LHSHRUB + WBAREA_S4 + SLOPE_sq + SLOPE + WBAREA_S3 + LHSHRUB_sq + WBAREA_S4_sq + LHSHRUB_S4 + TUSSK_S4 + TUSSK_S3_sq - 1 + (1 | stepnum) + (1 | IDYr)
Fine Grain	38832	124162.8	5.3	0.056	124231.4	0.622	case_ ~ WBAREA + WBAREA_sq + TUSSK + LHSHRUB + SLOPE_sq + SLOPE + WBAREA_S4_sq - 1 + (1 | stepnum) + (1 | IDYr)
Coarse Grain	38832	124892.5	735.0	0.000	124961.0	0.589	case_ ~ LHSHRUB + WBAREA_S4 + SLOPE_sq + SLOPE + WBAREA_S4_sq + TUSSK_S3_sq + TUSSK_S3 - 1 + (1 | stepnum) + (1 | IDYr)

Table C-6b: Model Performance of top Female - Rut Regional Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.626	2.824	3.632	0.635
test	0.628	2.859	3.627	0.628

Table C-7: Female – Post-Rut Regional Scale 8-hour interval models

Model name	N	AIC	ΔAIC	Wt AIC	BIC	AUC	Formula
Mixed Grain 1	101182	324032.4	0.0	0.444	324156.2	0.613	case_ ~ WBAREA + WBAREA_sq + TUSSK + LHSHRUB + SLOPE + SLOPE_sq + BEDBOULD + SEDGEWET + WBAREA_S3 + TUSSK_S4 + TUNDRA + LHSHRUB_S4 - 1 + (1 | stepnum) + (1 | IDYr)
Mixed Grain 2	101182	324032.7	0.2	0.396	324147.0	0.615	case_ ~ WBAREA + WBAREA_sq + TUSSK + LHSHRUB + SLOPE + SLOPE_sq + BEDBOULD + SEDGEWET + WBAREA_S3 + TUSSK_S4 + TUNDRA - 1 + (1 | stepnum) + (1 | IDYr)
Fine Grain	101182	324034.5	2.0	0.161	324129.7	0.612	case_ ~ WBAREA + WBAREA_sq + TUSSK + LHSHRUB + SLOPE + SLOPE_sq + BEDBOULD + SEDGEWET + TUNDRA - 1 + (1 | stepnum) + (1 | IDYr)
Coarse Grain	101182	325799.8	1767.4	0.000	325885.6	0.573	case_ ~ LHSHRUB + SLOPE + SLOPE_sq + BEDBOULD + SEDGEWET + WBAREA_S3 + TUSSK_S4 + TUNDRA - 1 + (1 | stepnum) + (1 | IDYr)

Table C-7b: Model Performance of top Female – Post-Rut Regional Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.613	2.908	3.616	0.618
test	0.614	2.889	3.621	0.622

Table C-8: Male – Winter Regional Scale 8-hour interval models

Model name	N	AIC	ΔAIC	Wt AIC	BIC	AUC	Formula
Mixed Grain 1	150745	486398.7	0.0	0.652	486557.4	0.564	case_ ~ WBAREA + WBAREA_sq + WBAREA_S3 + SLOPE + LHSHRUB + TUNDRA + TUSSK + TUSSK_S3_sq + TUSSK_S3 + FOREST_S3 + SLOPE_sq + WBAREA_S4_sq + TUSSK_sq + TUNDR_S3 + TUNDRA_sq - 1 + (1 | stepnum) + (1 | IDYr)
Mixed Grain 2	150745	486399.9	1.3	0.348	486528.9	0.566	case_ ~ WBAREA + WBAREA_sq + WBAREA_S3 + SLOPE + LHSHRUB + TUNDRA + TUSSK + TUSSK_S3_sq + TUSSK_S3 + SLOPE_sq + TUSSK_sq + TUNDRA_sq - 1 + (1 | stepnum) + (1 | IDYr)
Fine Grain	150745	486463.2	64.5	0.000	486562.4	0.561	case_ ~ WBAREA + WBAREA_sq + SLOPE + LHSHRUB + TUNDRA + TUSSK + SLOPE_sq + TUSSK_sq + TUNDRA_sq - 1 + (1 | stepnum) + (1 | IDYr)
Coarse Grain	150745	486935.6	537.0	0.000	487025.0	0.553	case_ ~ WBAREA_S3 + SLOPE + LHSHRUB + TUNDRA + TUSSK_S3_sq + TUSSK_S3 + SLOPE_sq + TUNDRA_sq - 1 + (1 | stepnum) + (1 | IDYr)

Table C-8b: Model Performance of top Male - Winter Regional Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.564	3.109	3.574	0.578
test	0.567	3.094	3.578	0.581

Table C-9: Male – Spring Migration Regional Scale 8-hour interval models

Model name	N	AIC	ΔAIC	Wt AIC	BIC	AUC	Formula
Mixed Grain 1	93154	300890.3	0.0	0.968	301116.9	0.566	case_ ~ WBAREA + SLOPE + WBAREA_sq + ELEVATION + WBAREA_S4 + SEDGEWET + SEDWET_S3 + TUNDRA + ELEVATION_sq + TUSSK + LHSHRUB + BEDBLD_S4 + WATEDGE_S3 + WBAREA_S3 + SLOPE_sq + BEDBLD_S3_sq + P_ESKER_sq + SEDGEWET_sq + TUSSK_S4 + TUSSK_S3 + TUNDRA_sq + TUNDR_S4 + TUSSK_S3_sq - 1 + (1 | stepnum) + (1 | IDYr)
Mixed Grain 2	93154	300897.2	6.8	0.032	301104.9	0.566	case_ ~ WBAREA + SLOPE + WBAREA_sq + ELEVATION + WBAREA_S4 + SEDGEWET + SEDWET_S3 + TUNDRA + ELEVATION_sq + TUSSK + LHSHRUB + SLOPE_sq + BEDBLD_S3_sq + P_ESKER_sq + SEDGEWET_sq + TUSSK_S3 + TUNDRA_sq + TUNDR_S4 + TUSSK_S3_sq + P_ESKER + BEDBLD_S3 - 1 + (1 | stepnum) + (1 | IDYr)
Fine Grain	93154	300974.5	84.2	0.000	301135.0	0.567	case_ ~ WBAREA + SLOPE + WBAREA_sq + ELEVATION + SEDGEWET + TUNDRA + ELEVATION_sq + TUSSK + LHSHRUB + SLOPE_sq + BEDBLD_S3_sq + P_ESKER_sq + SEDGEWET_sq + TUNDRA_sq + P_ESKER + BEDBLD_S3 - 1 + (1 | stepnum) + (1 | IDYr)
Coarse Grain	93154	301220.9	330.6	0.000	301362.5	0.548	case_ ~ SLOPE + ELEVATION + WBAREA_S4 + SEDWET_S3 + ELEVATION_sq + LHSHRUB + SLOPE_sq + BEDBLD_S3_sq + P_ESKER_sq + TUSSK_S3 + TUNDR_S4 + TUSSK_S3_sq + P_ESKER + BEDBLD_S3 - 1 + (1 | stepnum) + (1 | IDYr)

Table C-9b: Model Performance of top Male – Spring Migration Regional Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.566	3.002	3.587	0.600
test	0.555	3.070	3.578	0.586

Table C-10: Male – Summer Regional Scale 8-hour interval models

Model name	N	AIC	ΔAIC	Wt AIC	BIC	AUC	Formula
Mixed Grain 2	68249	218965.5	0.0	0.349	219093.4	0.579	case_ ~ WBAREA + WBAREA_sq + LHSHRUB + TUSSK + ELEVATION + SLOPE_sq + WATEDGE_S3 + SLOPE + SEDWET_S3 + TUNDRA_sq + SEDGEWET_sq + TUNDRA + SEDGEWET - 1 + (1 | stepnum) + (1 | IDYr)
Coarse Grain	68249	218965.8	0.3	0.298	219075.4	0.579	case_ ~ WBAREA + WBAREA_sq + LHSHRUB + TUSSK + ELEVATION + SLOPE_sq + WATEDGE_S3 + SLOPE + SEDWET_S3 + TUNDRA_sq + TUNDRA - 1 + (1 | stepnum) + (1 | IDYr)
Mixed Grain 1	68249	218966.1	0.6	0.264	219103.0	0.579	case_ ~ WBAREA + WBAREA_sq + LHSHRUB + TUSSK + ELEVATION + SLOPE_sq + WATEDGE_S3 + SLOPE + SEDWET_S3 + TUNDRA_sq + SEDGEWET_sq + WBAREA_S4_sq + LHSHRUB_sq + TUNDRA - 1 + (1 | stepnum) + (1 | IDYr)
Mosquito	68249	218969.5	3.9	0.048	219124.7	0.579	case_ ~ WBAREA + WBAREA_sq + LHSHRUB + TUSSK + ELEVATION + SLOPE_sq + WATEDGE_S3 + SLOPE + SEDWET_S3 + TUNDRA_sq + SEDGEWET_sq + TUNDRA + SEDGEWET + (1 | stepnum) + (1 | IDYr) + WBAREA:MosqIndx_1 + WATEDGE_S3:MosqIndx_1 + ELEVATION:MosqIndx_1 - 1
Oestrid	68249	218969.9	4.3	0.040	219125.1	0.580	case_ ~ WBAREA + WBAREA_sq + LHSHRUB + TUSSK + ELEVATION + SLOPE_sq + WATEDGE_S3 + SLOPE + SEDWET_S3 + TUNDRA_sq + SEDGEWET_sq + TUNDRA + SEDGEWET + (1 | stepnum) + (1 | IDYr) + WBAREA:OestIndx_1 + WATEDGE_S3:OestIndx_1 + ELEVATION:OestIndx_1 - 1
Fine Grain	68249	218980.4	14.8	0.000	219099.1	0.578	case_ ~ WBAREA + WBAREA_sq + LHSHRUB + TUSSK + ELEVATION + SLOPE_sq + WATEDGE_S3 + SLOPE + TUNDRA_sq + SEDGEWET_sq + TUNDRA + SEDGEWET - 1 + (1 | stepnum) + (1 | IDYr)

Table C-10b: Model Performance of top Male - Summer Regional Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.579	3.024	3.592	0.595
test	0.579	3.013	3.594	0.597

Table C-11: Male – Late Summer Regional Scale 8-hour interval models

Model name	N	AIC	ΔAIC	Wt AIC	BIC	AUC	Formula
Mosquito	40636	130375.0	0.0	0.999	130504.1	0.597	case_ ~ WBAREA_sq + TUSSK + WAT_EDGE + WBAREA_S3 + LHSHRUB + WAT_EDGE_sq + SEDGEWET + BEDBLD_S3 + BEDBLD_S3_sq + TUSSK_S3 + TUSSK_S3_sq + WBAREA + (1 | stepnum) + (1 | IDYr) + WBAREA:MosqIndx_1 + WAT_EDGE:MosqIndx_1 - 1
Mixed Grain 2	40636	130389.8	14.8	0.001	130501.7	0.596	case_ ~ WBAREA_sq + TUSSK + WAT_EDGE + WBAREA_S3 + LHSHRUB + WAT_EDGE_sq + SEDGEWET + BEDBLD_S3 + BEDBLD_S3_sq + TUSSK_S3 + TUSSK_S3_sq + WBAREA - 1 + (1 | stepnum) + (1 | IDYr)
Oestrid	40636	130390.3	15.3	0.000	130519.5	0.596	case_ ~ WBAREA_sq + TUSSK + WAT_EDGE + WBAREA_S3 + LHSHRUB + WAT_EDGE_sq + SEDGEWET + BEDBLD_S3 + BEDBLD_S3_sq + TUSSK_S3 + TUSSK_S3_sq + WBAREA + (1 | stepnum) + (1 | IDYr) + WBAREA:OestIndx_1 + WAT_EDGE:OestIndx_1 - 1
Mixed Grain 1	40636	130390.9	15.9	0.000	130537.3	0.598	case_ ~ WBAREA_sq + TUSSK + WAT_EDGE + WBAREA_S3 + LHSHRUB + WAT_EDGE_sq + SEDGEWET + BEDBLD_S3 + BEDBLD_S3_sq + LHSHRUB_S4 + WBAREA_S4 + WATEDGE_S3 + TUNDRA_sq + TUSSK_S3 + SEDGEWET_sq + TUSSK_S3_sq - 1 + (1 | stepnum) + (1 | IDYr)
Fine Grain	40636	130436.4	61.4	0.000	130522.5	0.591	case_ ~ WBAREA_sq + TUSSK + WAT_EDGE + LHSHRUB + WAT_EDGE_sq + SEDGEWET + BEDBLD_S3 + BEDBLD_S3_sq + WBAREA - 1 + (1 | stepnum) + (1 | IDYr)
Coarse Grain	40636	130929.5	554.5	0.000	131015.6	0.571	case_ ~ WAT_EDGE + WBAREA_S3 + LHSHRUB + WAT_EDGE_sq + SEDGEWET + BEDBLD_S3 + BEDBLD_S3_sq + TUSSK_S3 + TUSSK_S3_sq - 1 + (1 | stepnum) + (1 | IDYr)

Table C-11b: Model Performance of top Male – Late Summer Regional Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.597	3.012	3.597	0.598
test	0.608	2.970	3.604	0.606

Table C-12: Male – Pre-Rut Regional Scale 8-hour interval models

Model name	N	AIC	ΔAIC	Wt AIC	BIC	AUC	Formula
Mixed Grain 1	58831	188906.9	0.0	0.635	189086.6	0.607	case_ ~ WBAREA_sq + WBAREA + LHSHRUB + TUSSK + WBAREA_S3 + SLOPE_sq + BEDBOULD + LHSHRUB_S4 + SLOPE + SEDGEWET + ELEVATION + TUNDRA + TUNDRA_sq + TUNDR_S4 + SEDWET_S4 + TUSSK_S3 + TUNDR_S3 + WBAREA_S4_sq + TUSSK_sq - 1 + (1 | stepnum) + (1 | IDYr)
Mixed Grain 2	58831	188908.0	1.1	0.364	189033.8	0.604	case_ ~ WBAREA_sq + WBAREA + LHSHRUB + TUSSK + WBAREA_S3 + SLOPE_sq + BEDBOULD + SLOPE + SEDGEWET + TUNDRA + TUNDRA_sq + TUNDR_S3 + TUSSK_sq - 1 + (1 | stepnum) + (1 | IDYr)
Fine Grain	58831	188919.6	12.7	0.001	189027.4	0.602	case_ ~ WBAREA_sq + WBAREA + LHSHRUB + TUSSK + SLOPE_sq + BEDBOULD + SLOPE + SEDGEWET + TUNDRA + TUNDRA_sq + TUSSK_sq - 1 + (1 | stepnum) + (1 | IDYr)
Coarse Grain	58831	189465.2	558.3	0.000	189555.0	0.594	case_ ~ LHSHRUB + TUSSK + WBAREA_S3 + SLOPE_sq + BEDBOULD + SLOPE + SEDGEWET + TUNDR_S3 + TUSSK_sq - 1 + (1 | stepnum) + (1 | IDYr)

Table C-12b: Model Performance of top Male – Pre-Rut Regional Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.607	2.963	3.600	0.607
test	0.599	2.975	3.597	0.605

Table C-13: Male – Rut Regional Scale 8-hour interval models

Model name	N	AIC	ΔAIC	Wt AIC	BIC	AUC	Formula
Mixed Grain 2	18636	59548.2	0.0	0.614	59673.5	0.634	case_ ~ WBAREA + WBAREA_sq + TUSSK + LHSHRUB + SLOPE_sq + WBAREA_S4 + LHSHRUB_sq + TUNDRA_sq + TUNDRA + TUNDR_S4 + LHSHRUB_S3 + TUSSK_S3_sq + SEDGEWET_sq + SEDGEWET + TUSSK_S3 - 1 + (1 | stepnum) + (1 | IDYr)
Mixed Grain 1	18636	59549.1	0.9	0.386	59690.1	0.637	case_ ~ WBAREA + WBAREA_sq + TUSSK + LHSHRUB + SLOPE_sq + WBAREA_S4 + LHSHRUB_sq + TUNDRA_sq + BEDBLD_S4 + TUNDRA + TUSSK_S4_sq + ELEVATION + TUNDR_S4 + LHSHRUB_S3 + TUSSK_S3_sq + SEDWET_S4_sq + SEDGEWET_sq - 1 + (1 | stepnum) + (1 | IDYr)
Fine Grain	18636	59566.7	18.5	0.000	59652.8	0.625	case_ ~ WBAREA + WBAREA_sq + TUSSK + LHSHRUB + SLOPE_sq + LHSHRUB_sq + TUNDRA_sq + TUNDRA + SEDGEWET_sq + SEDGEWET - 1 + (1 | stepnum) + (1 | IDYr)
Coarse Grain	18636	60077.7	529.5	0.000	60148.2	0.563	case_ ~ SLOPE_sq + WBAREA_S4 + TUNDR_S4 + LHSHRUB_S3 + TUSSK_S3_sq + SEDGEWET_sq + SEDGEWET + TUSSK_S3 - 1 + (1 | stepnum) + (1 | IDYr)

Table C-13b: Model Performance of top Male - Rut Regional Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.634	2.824	3.633	0.635
test	0.623	2.874	3.619	0.625

Table C-14: Male – Post-Rut Regional Scale 8-hour interval models

Model name	N	AIC	ΔAIC	Wt AIC	BIC	AUC	Formula
Mixed Grain 1	50320	161130.2	0.0	0.685	161271.5	0.612	case_ ~ WBAREA + WBAREA_sq + TUSSK + LHSHRUB + SLOPE_sq + WBAREA_S4 + TUNDRA_sq + TUNDRA + SLOPE + SEDGEWET + SEDWET_S3_sq + BEDBOULD_sq + BEDBLD_S3 + BEDBLD_S4 + TUSSK_sq - 1 + (1 | stepnum) + (1 | IDYr)
Mixed Grain 2	50320	161132.0	1.7	0.286	161229.1	0.604	case_ ~ WBAREA + WBAREA_sq + TUSSK + LHSHRUB + TUNDRA + SLOPE + SEDGEWET + BEDBOULD_sq + BEDBLD_S3 + BEDBOULD - 1 + (1 | stepnum) + (1 | IDYr)
Fine Grain	50320	161136.8	6.5	0.026	161225.0	0.607	case_ ~ WBAREA + WBAREA_sq + TUSSK + LHSHRUB + TUNDRA + SLOPE + SEDGEWET + BEDBOULD_sq + BEDBOULD - 1 + (1 | stepnum) + (1 | IDYr)
Coarse Grain	50320	161141.8	11.5	0.002	161221.2	0.602	case_ ~ WBAREA + WBAREA_sq + TUSSK + LHSHRUB + TUNDRA + SLOPE + SEDGEWET + BEDBLD_S3 - 1 + (1 | stepnum) + (1 | IDYr)

Table C-14b: Model Performance of top Male – Post-Rut Regional Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.612	2.924	3.614	0.615
test	0.613	2.924	3.613	0.615

APPENDIX D 8-HOUR INTERVAL STEP SELECTION FUNCTION (SSF) TOP MODELS IN THE REGIONAL STUDY AREA: COVARIATES AND COEFFICIENTS

Tables D-1 to D-14 provide the details on the SSF top model for each season for each sex. The model details include the covariates, their coefficients, exponentiated coefficients, standard errors of the coefficients, z.value (the number of standard errors that the coefficient differs from zero), and p-values associated with the z.value (Pr..z..), a measure of the significance of the covariate in the model.

The rows of the Tables have been colour-coded:

- grey indicates a covariate whose coefficient's 95% confidence interval overlaps zero, indicating that it does not consistently affect the model value in the same direction;
- covariates with positive, significant coefficients are coloured green; and
- covariates with negative, significant coefficients are coloured red.

Table D-1: Female Winter Regional Study Area 8-hour SSF Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
WBAREA_sq	-0.11483	0.89151	0.00853	-13.46487	2.5175E-41
WBAREA	-0.06499	0.93708	0.01331	-4.88158	1.0524E-06
WBAREA_S3	0.06891	1.07134	0.01369	5.03188	4.8568E-07
LHSHRUB	0.08232	1.08580	0.00919	8.95956	3.2598E-19
SLOPE_sq	-0.02805	0.97234	0.00266	-10.54640	5.278E-26
TUSSK	0.06041	1.06227	0.00838	7.21242	5.4965E-13
FOREST	-0.01783	0.98232	0.00714	-2.49826	0.01248055
TUNDRA	0.05560	1.05717	0.00794	6.99974	2.5643E-12
SEDGEWET	-0.03230	0.96822	0.00647	-4.99189	5.9792E-07
TUSSK_S3	-0.06471	0.93734	0.01874	-3.45383	0.00055268
FOREST_S3	0.15832	1.17154	0.03571	4.43308	9.2894E-06
LHSHRUB_S3_sq	-0.04173	0.95913	0.00800	-5.21837	1.8051E-07
FOREST_S4	-0.20258	0.81662	0.06891	-2.93993	0.00328291

Table D-2: Female Spring Migration Regional Study Area 8-hour SSF Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
SLOPE	0.14236	1.15300	0.01401	10.16304	2.8989E-24
WBAREA_sq	-0.07195	0.93058	0.00945	-7.61458	2.6455E-14
TUNDRA	0.09435	1.09894	0.01245	7.57720	3.531E-14
WBAREA_S4	-0.07259	0.92999	0.02926	-2.48047	0.0131208
FOREST_S3	0.35129	1.42090	0.05708	6.15481	7.5168E-10
ELEVATION	0.26061	1.29773	0.03429	7.60001	2.9611E-14
TUSSK_S3_sq	-0.08190	0.92136	0.01269	-6.45459	1.0851E-10
ELEVATION_sq	0.03547	1.03611	0.01051	3.37560	0.00073655
SLOPE_sq	-0.04177	0.95909	0.00403	-10.35537	3.9565E-25
SEDWET_S3_sq	-0.02003	0.98017	0.01269	-1.57849	0.11445363
SEDGEWET	-0.03378	0.96678	0.00949	-3.55846	0.00037304
LHSHRUB_S3_sq	-0.04497	0.95603	0.01080	-4.16502	3.1133E-05
TUNDR_S3	-0.06405	0.93795	0.03085	-2.07666	0.03783257
WBAREA_S4_sq	0.09755	1.10247	0.01491	6.54145	6.0926E-11
TUSSK_S4_sq	0.05018	1.05146	0.01580	3.17565	0.00149503
TUSSK_S3	-0.15294	0.85818	0.02318	-6.59762	4.1781E-11
P_ESKER_S3_sq	0.01385	1.01395	0.00372	3.72553	0.00019491
WBAREA_S3_sq	-0.02923	0.97119	0.01042	-2.80398	0.00504765
SEDWET_S4_sq	0.00456	1.00457	0.01951	0.23398	0.81500285
TUSSK	0.02627	1.02662	0.01231	2.13497	0.03276327
WAT_EDGE	-0.04067	0.96015	0.00934	-4.35592	1.3251E-05
FOREST_S4	-0.67663	0.50833	0.09363	-7.22651	4.9556E-13
BEDBOULD	-0.03672	0.96394	0.00957	-3.83881	0.00012363
BEDBLD_S3_sq	-0.01135	0.98871	0.00484	-2.34687	0.01893185
TUNDR_S4_sq	-0.00257	0.99744	0.02033	-0.12623	0.89954946
LHSHRUB_S3	0.00602	1.00604	0.02752	0.21890	0.82672577

Table D-3: Female Summer Regional Study Area 8-hour SSF Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
WBAREA	-0.50977	0.60063	0.03262	-15.62964	4.574E-55
WBAREA_sq	-0.30581	0.73653	0.02337	-13.08527	3.9976E-39
SEDGEWET	-0.12298	0.88428	0.00894	-13.75730	4.6039E-43
ELEVATION	0.61446	1.84866	0.03412	18.01063	1.608E-72
LHSHRUB	0.05161	1.05297	0.01284	4.01879	5.8498E-05
BEDBOULD	-0.11840	0.88834	0.01123	-10.54587	5.3077E-26
TUNDRA	-0.04324	0.95768	0.01218	-3.55133	0.00038329
BEDBLD_S3	-0.12289	0.88436	0.01554	-7.91067	2.56E-15
SLOPE_sq	-0.00090	0.99910	0.00391	-0.23129	0.81709289
LHSHRUB_S3	0.12831	1.13690	0.01723	7.44710	9.5413E-14
SLOPE	-0.07541	0.92736	0.01207	-6.24722	4.1782E-10
WBAREA:OestIndx_1	0.45072	1.56945	0.07807	5.77332	7.7723E-09
ELEVATION:OestIndx_1	0.05043	1.05173	0.11230	0.44908	0.65337056

Table D-4: Female Late Summer Regional Study Area 8-hour SSF Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
WBAREA_sq	-0.33599	0.71463	0.02304	-14.58444	3.5278E-48
LHSHRUB	0.19723	1.21802	0.01532	12.86988	6.6503E-38
TUSSK	0.11071	1.11707	0.01540	7.18961	6.4977E-13
SEDGEWET	-0.08815	0.91563	0.01196	-7.36936	1.7145E-13
BEDBOULD	-0.09688	0.90766	0.01502	-6.44969	1.1208E-10
ELEVATION	0.54720	1.72840	0.05175	10.57466	3.9058E-26
SLOPE	-0.09023	0.91372	0.01294	-6.97546	3.0488E-12
BEDBLD_S3	-0.06485	0.93720	0.01927	-3.36634	0.00076172
WBAREA	0.02911	1.02954	0.03127	0.93097	0.35186689

Table D-5: Female Pre-Rut Regional Study Area 8-hour SSF Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
WBAREA	-0.20051	0.81831	0.02840	-7.05968	1.6689E-12
LHSHRUB	0.18999	1.20923	0.01213	15.66796	2.505E-55
TUSSK	0.11582	1.12280	0.01249	9.27112	1.8419E-20
WBAREA_sq	-0.32041	0.72585	0.02128	-15.05664	3.1225E-51
SEDGEWET	-0.10072	0.90419	0.00951	-10.58751	3.4053E-26
SLOPE_sq	-0.00774	0.99229	0.00492	-1.57314	0.11568676
SLOPE	-0.11599	0.89048	0.01307	-8.87459	7.0192E-19
BEDBOULD	-0.16288	0.84969	0.02073	-7.85852	3.887E-15
BEDBOULD_sq	0.00832	1.00836	0.00318	2.61801	0.0088443

Table D-6: Female Rut Regional Study Area 8-hour SSF Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
WBAREA	-0.28784	0.74988	0.04326	-6.65354	2.8612E-11
WBAREA_sq	-0.17524	0.83926	0.03110	-5.63524	1.7481E-08
TUSSK	0.21636	1.24156	0.02128	10.16647	2.7988E-24
LHSHRUB	0.22899	1.25733	0.02060	11.11362	1.077E-28
WBAREA_S4	0.11106	1.11746	0.04083	2.72002	0.00652773
SLOPE_sq	-0.01694	0.98321	0.00827	-2.04718	0.04064048
SLOPE	-0.07778	0.92517	0.02353	-3.30572	0.00094732
WBAREA_S4_sq	0.04636	1.04745	0.01875	2.47274	0.01340819
TUSSK_S3_sq	-0.02811	0.97229	0.01476	-1.90355	0.05696917
TUSSK_S3	0.02793	1.02833	0.03301	0.84626	0.39740516

Table D-7: Female Post-Rut Regional Study Area 8-hour SSF Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
WBAREA	-0.25561	0.77444	0.02573	-9.93312	2.9877E-23
WBAREA_sq	-0.17751	0.83735	0.01721	-10.31177	6.2344E-25
TUSSK	0.16832	1.18331	0.01515	11.11124	1.1061E-28
LHSHRUB	0.14742	1.15884	0.01681	8.77058	1.7774E-18
SLOPE	-0.11924	0.88760	0.01472	-8.09987	5.5016E-16
SLOPE_sq	-0.01391	0.98618	0.00540	-2.57613	0.00999124
BEDBOULD	-0.06628	0.93587	0.01040	-6.37428	1.8382E-10
SEDGEWET	-0.03446	0.96612	0.01113	-3.09543	0.00196531
WBAREA_S3	0.02428	1.02457	0.01562	1.55450	0.12006634
TUSSK_S4	-0.04322	0.95770	0.02847	-1.51799	0.12901633
TUNDRA	0.05033	1.05161	0.01358	3.70649	0.00021015
LHSHRUB_S4	0.04731	1.04845	0.03170	1.49236	0.13560349

Table D-8: Male Winter Regional Study Area 8-hour SSF Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
WBAREA	-0.13165	0.87665	0.01923	-6.84680	7.5523E-12
WBAREA_sq	-0.08456	0.91892	0.01176	-7.18904	6.5248E-13
WBAREA_S3	0.06117	1.06308	0.02181	2.80515	0.00502935
SLOPE	0.04734	1.04848	0.01268	3.73327	0.00018901
LHSHRUB	0.07594	1.07890	0.01180	6.43390	1.2437E-10
TUNDRA	0.09201	1.09638	0.01312	7.01250	2.341E-12
TUSSK	0.06057	1.06244	0.01074	5.63994	1.7011E-08
TUSSK_S3_sq	-0.06190	0.93998	0.01031	-6.00284	1.9389E-09
TUSSK_S3	-0.10077	0.90414	0.02870	-3.51145	0.00044567
FOREST_S3	0.06148	1.06341	0.04380	1.40378	0.16038386
SLOPE_sq	-0.02490	0.97541	0.00435	-5.72911	1.0096E-08
WBAREA_S4_sq	0.03055	1.03102	0.01276	2.39366	0.01668113
TUSSK_sq	0.02557	1.02590	0.00740	3.45649	0.00054725
TUNDR_S3	0.01377	1.01387	0.02613	0.52713	0.59810426
TUNDRA_sq	-0.01349	0.98660	0.00789	-1.71027	0.08721668

Table D-9 Male Spring Migration Regional Study Area 8-hour SSF Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
WBAREA	-0.09804	0.90661	0.02736	-3.58306	0.00033959
SLOPE	0.14377	1.15462	0.01646	8.73424	2.453E-18
WBAREA_sq	-0.01937	0.98082	0.01524	-1.27119	0.20366073
ELEVATION	0.56276	1.75551	0.05144	10.93981	7.4358E-28
WBAREA_S4	0.20649	1.22935	0.04794	4.30742	1.6517E-05
SEDGEWET	-0.09693	0.90762	0.01508	-6.42751	1.2971E-10
SEDWET_S3	0.09808	1.10305	0.02383	4.11589	3.8569E-05
TUNDRA	0.09520	1.09988	0.01595	5.96733	2.4117E-09
ELEVATION_sq	0.16198	1.17584	0.01965	8.24378	1.6685E-16
TUSSK	0.08085	1.08421	0.01537	5.26039	1.4375E-07
LHSHRUB	0.07420	1.07702	0.01717	4.32197	1.5465E-05
BEDBLD_S4	-0.02113	0.97909	0.04836	-0.43696	0.66213837
WATEDGE_S3	0.00483	1.00484	0.01859	0.25999	0.7948726
WBAREA_S3	-0.09670	0.90783	0.03245	-2.97997	0.00288274
SLOPE_sq	-0.03256	0.96796	0.00579	-5.62385	1.8675E-08
BEDBLD_S3_sq	-0.03554	0.96508	0.01195	-2.97360	0.00294332
P_ESKER_sq	0.00372	1.00373	0.00069	5.42221	5.8868E-08
SEDGEWET_sq	0.02265	1.02291	0.00865	2.62024	0.00878671
TUSSK_S4	0.08093	1.08429	0.05537	1.46159	0.14385291
TUSSK_S3	-0.17258	0.84149	0.03789	-4.55500	5.2387E-06
TUNDRA_sq	-0.03310	0.96745	0.01103	-3.00105	0.00269047
TUNDR_S4	-0.04677	0.95430	0.04625	-1.01125	0.31189691
TUSSK_S3_sq	-0.04648	0.95458	0.01134	-4.09738	4.1785E-05

Table D-10: Male Summer Regional Study Area 8-hour SSF Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
WBAREA	0.19979	1.22114	0.03544	5.63735	1.7268E-08
WBAREA_sq	-0.35846	0.69875	0.02276	-15.75091	6.7705E-56
LHSHRUB	0.19632	1.21692	0.02114	9.28555	1.6087E-20
TUSSK	0.13342	1.14273	0.01940	6.87774	6.0807E-12
ELEVATION	0.30674	1.35899	0.03831	8.00610	1.184E-15
SLOPE_sq	0.01663	1.01677	0.00424	3.91980	8.8623E-05
WATEDGE_S3	0.04311	1.04405	0.01631	2.64289	0.00822027
SLOPE	-0.03753	0.96316	0.01585	-2.36761	0.01790323
SEDWET_S3	-0.07881	0.92422	0.01923	-4.09739	4.1783E-05
TUNDRA_sq	0.02161	1.02184	0.01088	1.98611	0.04702146
SEDGEWET_sq	0.01767	1.01783	0.00849	2.08104	0.03743035
TUNDRA	0.03099	1.03147	0.02136	1.45060	0.14689154
SEDGEWET	-0.01602	0.98411	0.01702	-0.94136	0.34652284

Table D-11: Male Late Summer Regional Study Area 8-hour SSF Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
WBAREA_sq	-0.18266	0.83305	0.09687	-1.88562	0.05934587
TUSSK	0.16370	1.17786	0.02025	8.08542	6.1952E-16
WAT_EDGE	0.45442	1.57526	0.12541	3.62358	0.00029056
WBAREA_S3	0.14932	1.16105	0.03072	4.86084	1.1689E-06
LHSHRUB	0.14473	1.15572	0.01993	7.26127	3.8348E-13
WAT_EDGE_sq	-0.08089	0.92230	0.02161	-3.74299	0.00018184
SEDGEWET	-0.03319	0.96736	0.01636	-2.02827	0.04253315
BEDBLD_S3	0.08107	1.08444	0.04031	2.01092	0.04433363
BEDBLD_S3_sq	-0.02981	0.97063	0.01093	-2.72869	0.0063587
TUSSK_S3	-0.06580	0.93632	0.03602	-1.82654	0.06776824
TUSSK_S3_sq	-0.02902	0.97140	0.01388	-2.09036	0.03658508
WBAREA	-0.05653	0.94504	0.21888	-0.25828	0.79619428
WBAREA:MosqIndx_1	-0.31529	0.72958	0.24371	-1.29373	0.19575876
WAT_EDGE:MosqIndx_1	-0.23535	0.79030	0.16491	-1.42712	0.15354653

Table D-12: Male Pre-Rut Regional Study Area 8-hour SSF Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
WBAREA_sq	-0.38775	0.67858	0.02285	-16.97133	1.3385E-64
WBAREA	0.21474	1.23954	0.03703	5.79875	6.681E-09
LHSHRUB	0.18377	1.20174	0.02729	6.73317	1.6601E-11
TUSSK	0.13992	1.15018	0.02481	5.63949	1.7056E-08
WBAREA_S3	0.06148	1.06341	0.02598	2.36600	0.01798154
SLOPE_sq	-0.01741	0.98274	0.00765	-2.27454	0.02293383
BEDBOULD	-0.09257	0.91159	0.01542	-6.00405	1.9246E-09
LHSHRUB_S4	-0.00079	0.99921	0.04738	-0.01678	0.9866147
SLOPE	-0.09385	0.91042	0.01867	-5.02719	4.9771E-07
SEDGEWET	-0.08828	0.91550	0.01652	-5.34367	9.1085E-08
ELEVATION	0.08588	1.08967	0.06084	1.41152	0.15809236
TUNDRA	-0.04867	0.95249	0.02364	-2.05898	0.03949629
TUNDRA_sq	0.06702	1.06932	0.01118	5.99723	2.0071E-09
TUNDR_S4	0.15748	1.17055	0.06627	2.37612	0.01749569
SEDWET_S4	0.04052	1.04135	0.03224	1.25696	0.20876677
TUSSK_S3	-0.01227	0.98780	0.02679	-0.45806	0.64691156
TUNDR_S3	-0.10849	0.89719	0.04121	-2.63239	0.00847875
WBAREA_S4_sq	0.01661	1.01675	0.01551	1.07120	0.28408079
TUSSK_sq	0.01975	1.01994	0.01068	1.84824	0.06456749

Table D-13: Male Rut Regional Study Area 8-hour SSF Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
WBAREA	-0.19049	0.82656	0.07163	-2.65923	0.00783198
WBAREA_sq	-0.12702	0.88072	0.04473	-2.83936	0.00452041
TUSSK	0.31046	1.36405	0.04581	6.77699	1.227E-11
LHSHRUB	0.26315	1.30102	0.04641	5.66990	1.4288E-08
SLOPE_sq	-0.06330	0.93866	0.01204	-5.25770	1.4587E-07
WBAREA_S4	0.25355	1.28860	0.06319	4.01261	6.0051E-05
LHSHRUB_sq	0.04939	1.05063	0.01869	2.64235	0.00823339
TUNDRA_sq	0.05474	1.05627	0.01980	2.76424	0.00570553
TUNDRA	0.05638	1.05800	0.03869	1.45725	0.1450461
TUNDR_S4	0.15120	1.16322	0.08731	1.73172	0.08332401
LHSHRUB_S3	0.14940	1.16114	0.05263	2.83850	0.00453258
TUSSK_S3_sq	-0.03579	0.96485	0.02035	-1.75853	0.07865722
SEDGEWET_sq	0.03169	1.03219	0.01890	1.67650	0.09364026
SEDGEWET	0.01025	1.01030	0.03389	0.30244	0.76231665
TUSSK_S3	-0.04222	0.95866	0.04429	-0.95329	0.34044329

Table D-14: Male Post-Rut Regional Study Area 8-hour SSF Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
WBAREA	-0.21125	0.80957	0.03716	-5.68526	1.3061E-08
WBAREA_sq	-0.19306	0.82443	0.02430	-7.94553	1.9336E-15
TUSSK	0.16648	1.18114	0.02307	7.21641	5.3376E-13
LHSHRUB	0.17386	1.18989	0.02648	6.56643	5.1536E-11
SLOPE_sq	-0.01087	0.98919	0.00714	-1.52164	0.12809956
WBAREA_S4	0.08853	1.09257	0.03430	2.58118	0.00984623
TUNDRA_sq	0.01671	1.01685	0.01258	1.32892	0.18387438
TUNDRA	0.05465	1.05617	0.02181	2.50537	0.01223218
SLOPE	-0.07997	0.92314	0.02090	-3.82627	0.0001301
SEDGEWET	-0.03465	0.96594	0.01703	-2.03480	0.0418707
SEDWET_S3_sq	0.01381	1.01391	0.01823	0.75732	0.44886105
BEDBOULD_sq	-0.01045	0.98961	0.00324	-3.22431	0.00126279
BEDBLD_S3	-0.07212	0.93042	0.03297	-2.18751	0.02870549
BEDBLD_S4	0.01313	1.01322	0.05757	0.22805	0.81960492
TUSSK_sq	0.01259	1.01267	0.01145	1.09961	0.27150332

APPENDIX E COMPARISON OF COVARIATE COEFFICIENTS FOR REGIONAL STUDY AREA 8-HOUR INTERVAL STEP SELECTION MODELS - WITH AND WITHOUT MOVEMENT COVARIATES

The results of step-selection function analyses of 8-hour movement data from the regional study area outside the Ekati/Divik 30 km halo (Report Section 3.6) are presented in Appendices C and D; the models presented in Appendices C and D include random intercepts but do not include movement covariates.

The objective of the analyses of data from outside the Ekati/Diavik 30 km halo was to permit the prediction of relative habitat selection values of landscape cells inside the Ekati/Diavik 30 km halo. Analyses of 8-hour and 1-hour interval movements inside the Ekati/Diavik 30 km halo incorporated those predicted relative habitat selection value as well as distances to mining roads and infrastructure.

The prediction of relative habitat selection values was through the application of outside the halo 8-hour model coefficients to the 3.1 ha hexagon cells inside the halo; a calculation that excluded movement parameters (Report Section 3.7). Figures E-1 to E-14 provide a comparison of the coefficients from the best 8-hour models from outside the halo, one set including movement covariates and the other excluding them. The comparisons of 95% confidence intervals in this set of figures demonstrates the comparability of coefficient values from the two sets of models.

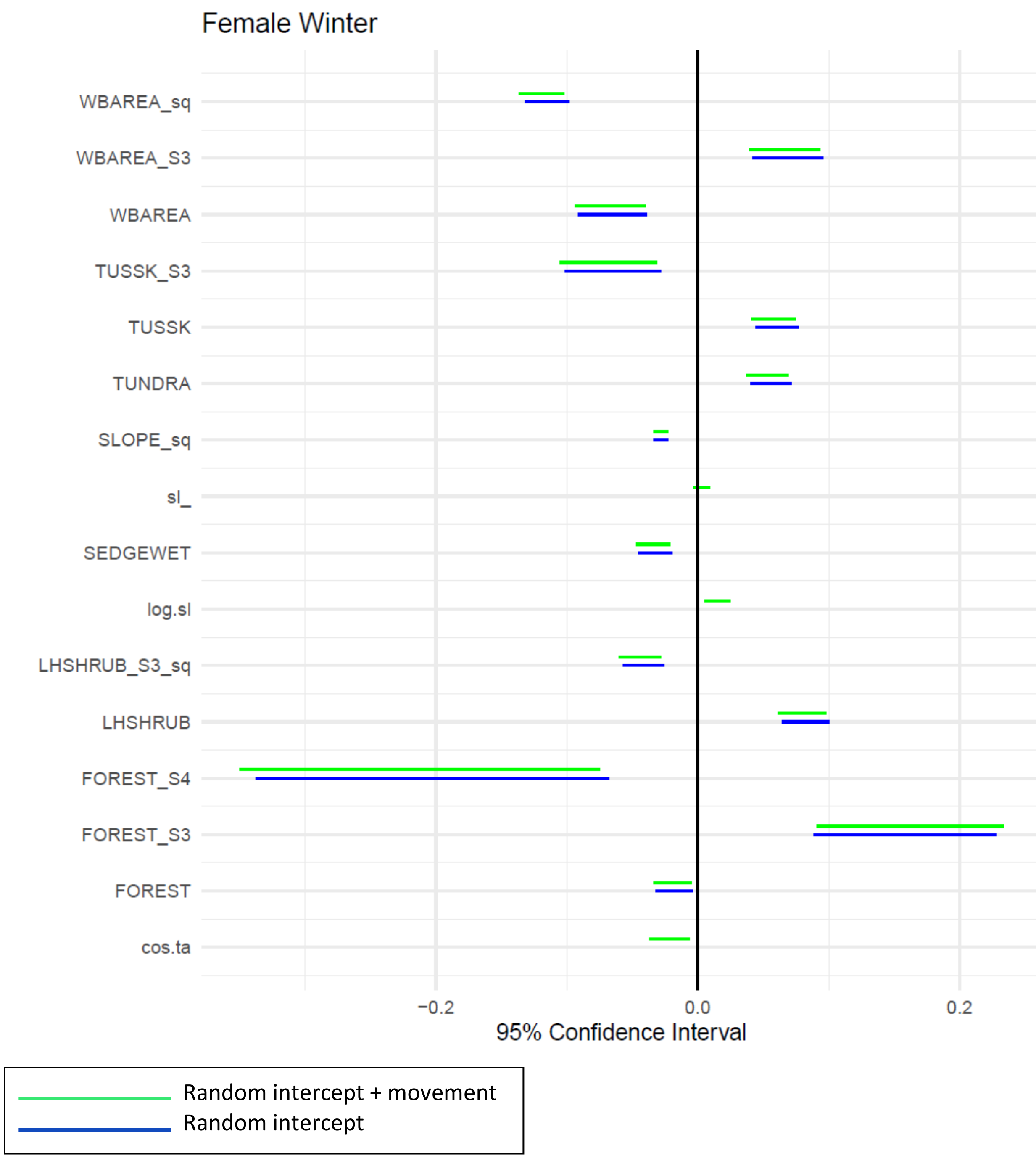


Figure E-1: Female Winter Regional Study Area 8-hour Model Covariates

Comparison of 95% Confidence Intervals for coefficients for random intercept conditional logistic regression top models including or excluding movement parameters

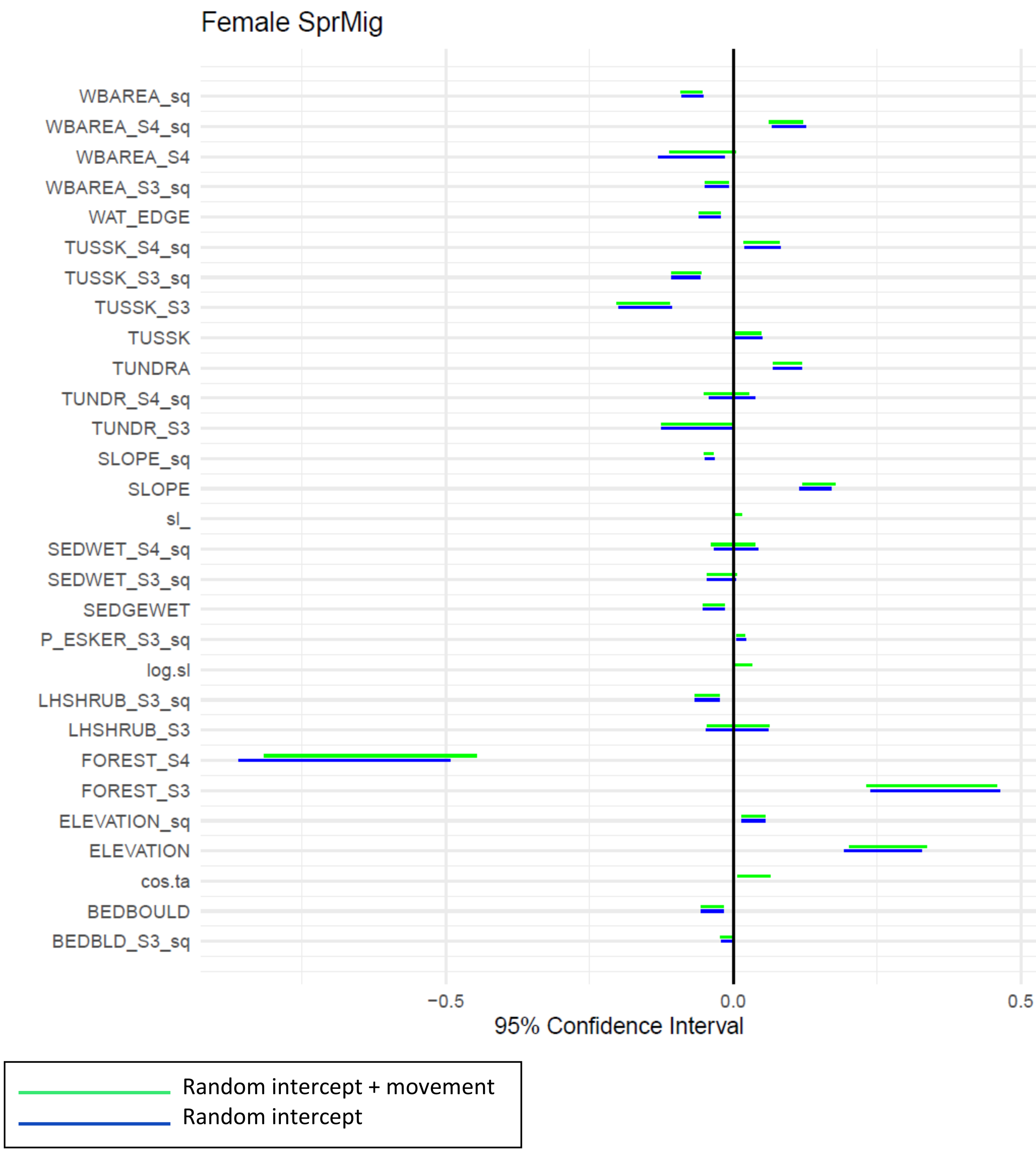


Figure E-2: Female Spring Migration Regional Study Area 8-hour Model Covariates

Comparison of 95% Confidence Intervals for coefficients for random intercept conditional logistic regression top models including or excluding movement parameters

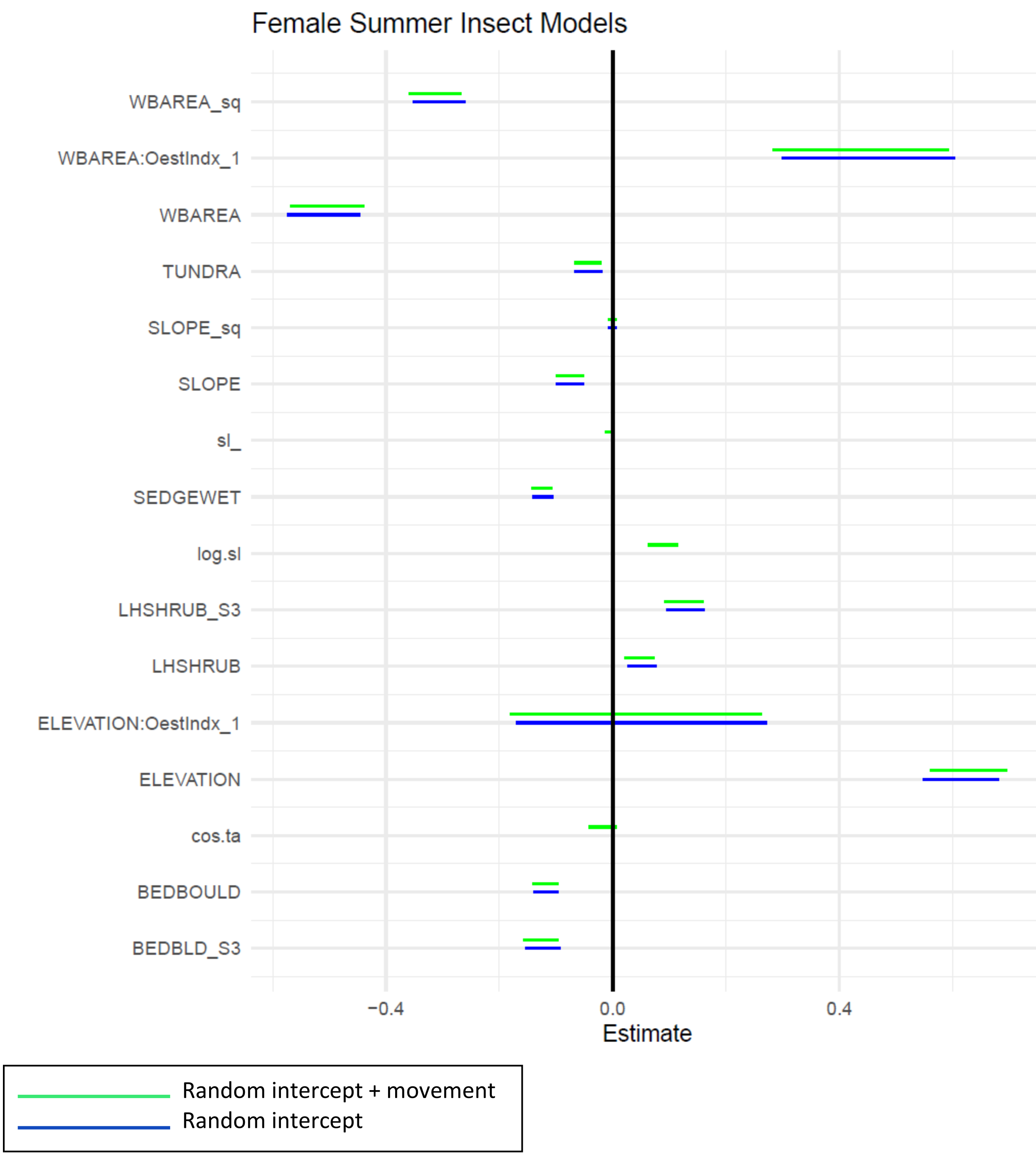


Figure E-3: Female Summer Regional Study Area 8-hour Model Covariates

Comparison of 95% Confidence Intervals for coefficients for random intercept conditional logistic regression top models including or excluding movement parameters

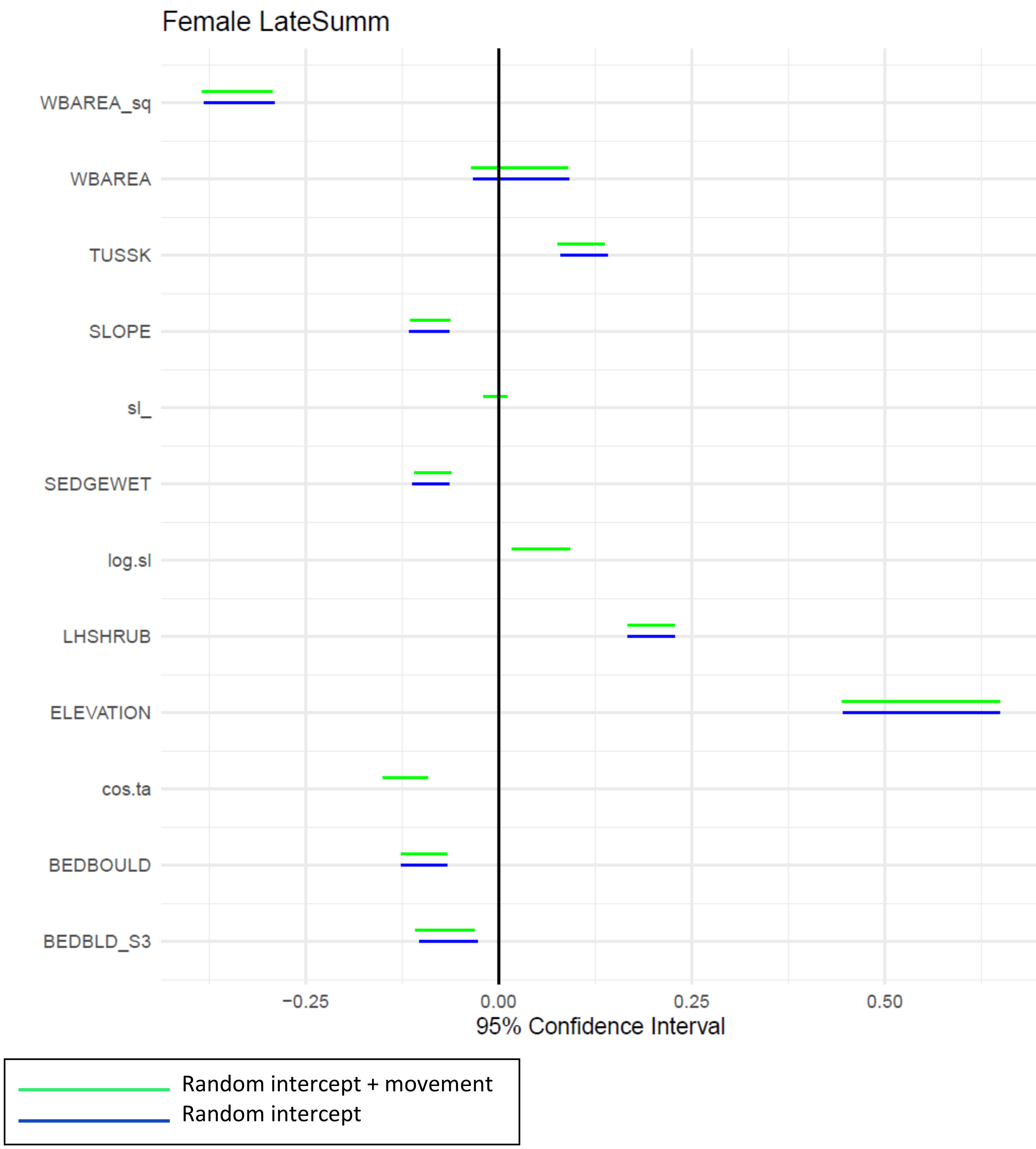


Figure E-4: Female Late Summer Regional Study Area 8-hour Model Covariates

Comparison of 95% Confidence Intervals for coefficients for random intercept conditional logistic regression top models including or excluding movement parameters

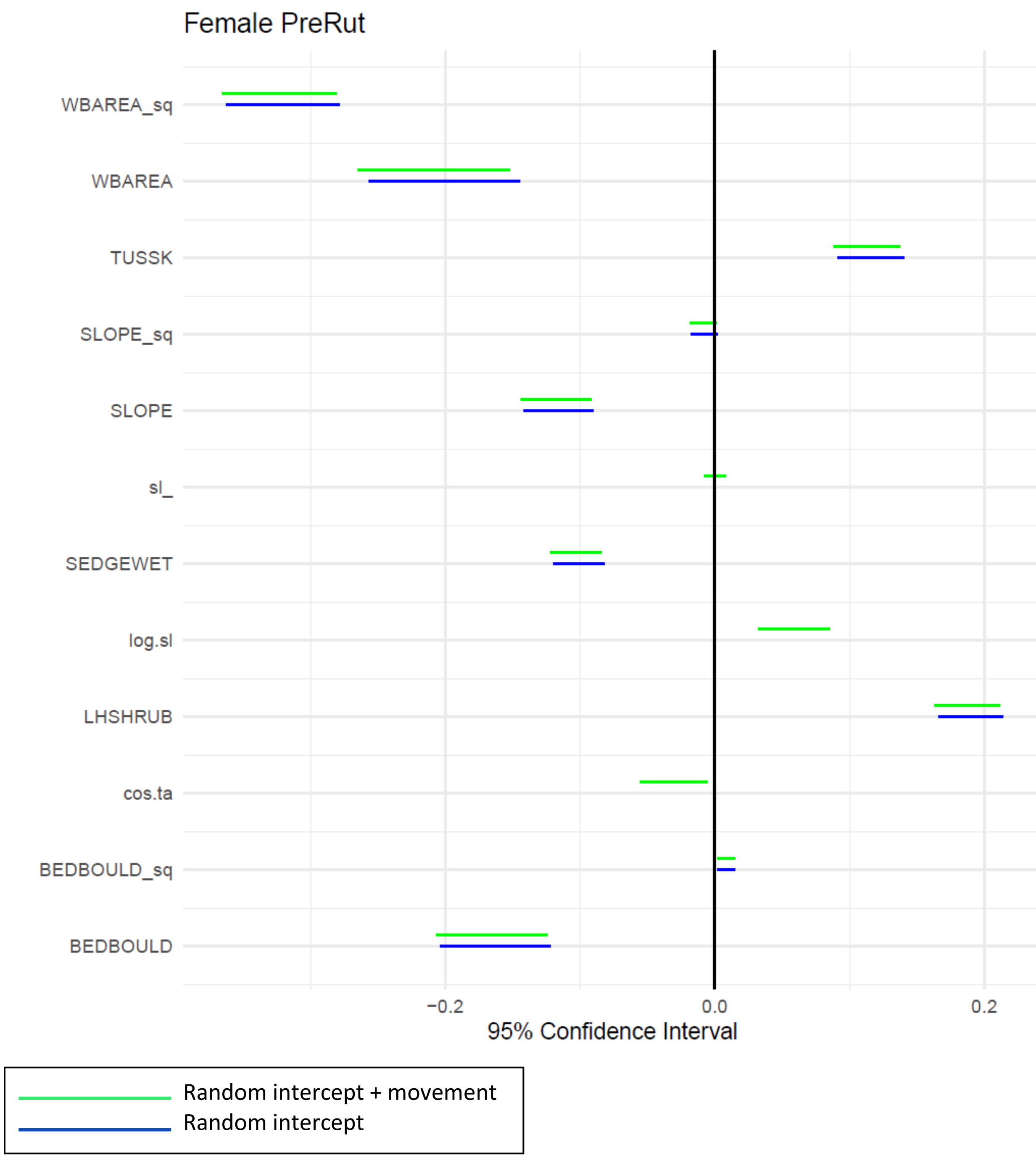


Figure E-5: Female Pre-Rut Regional Study Area 8-hour Model Covariates

Comparison of 95% Confidence Intervals for coefficients for random intercept conditional logistic regression top models including or excluding movement parameters

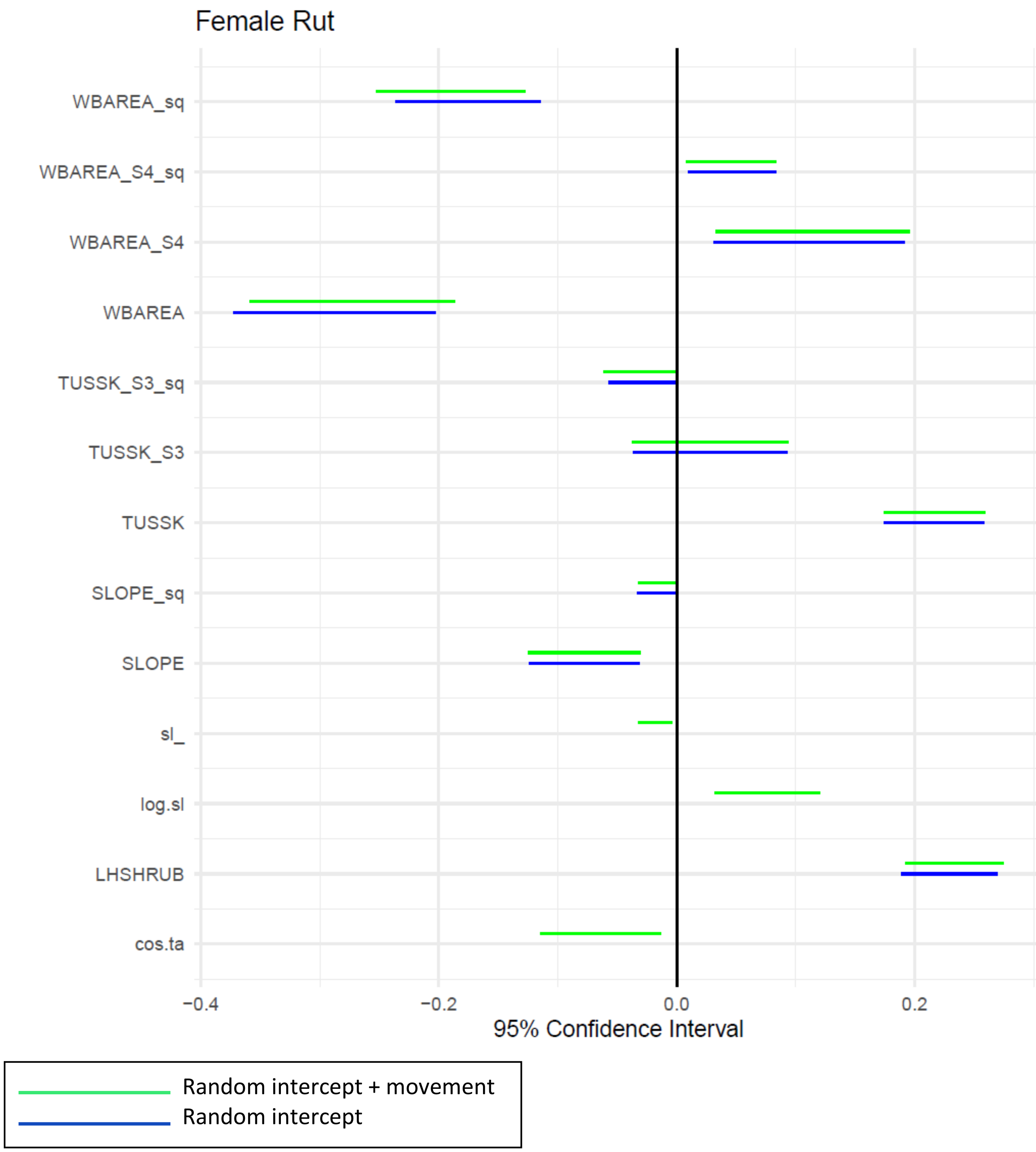


Figure E-6: Female Rut Regional Study Area 8-hour Model Covariates

Comparison of 95% Confidence Intervals for coefficients for random intercept conditional logistic regression top models including or excluding movement parameters

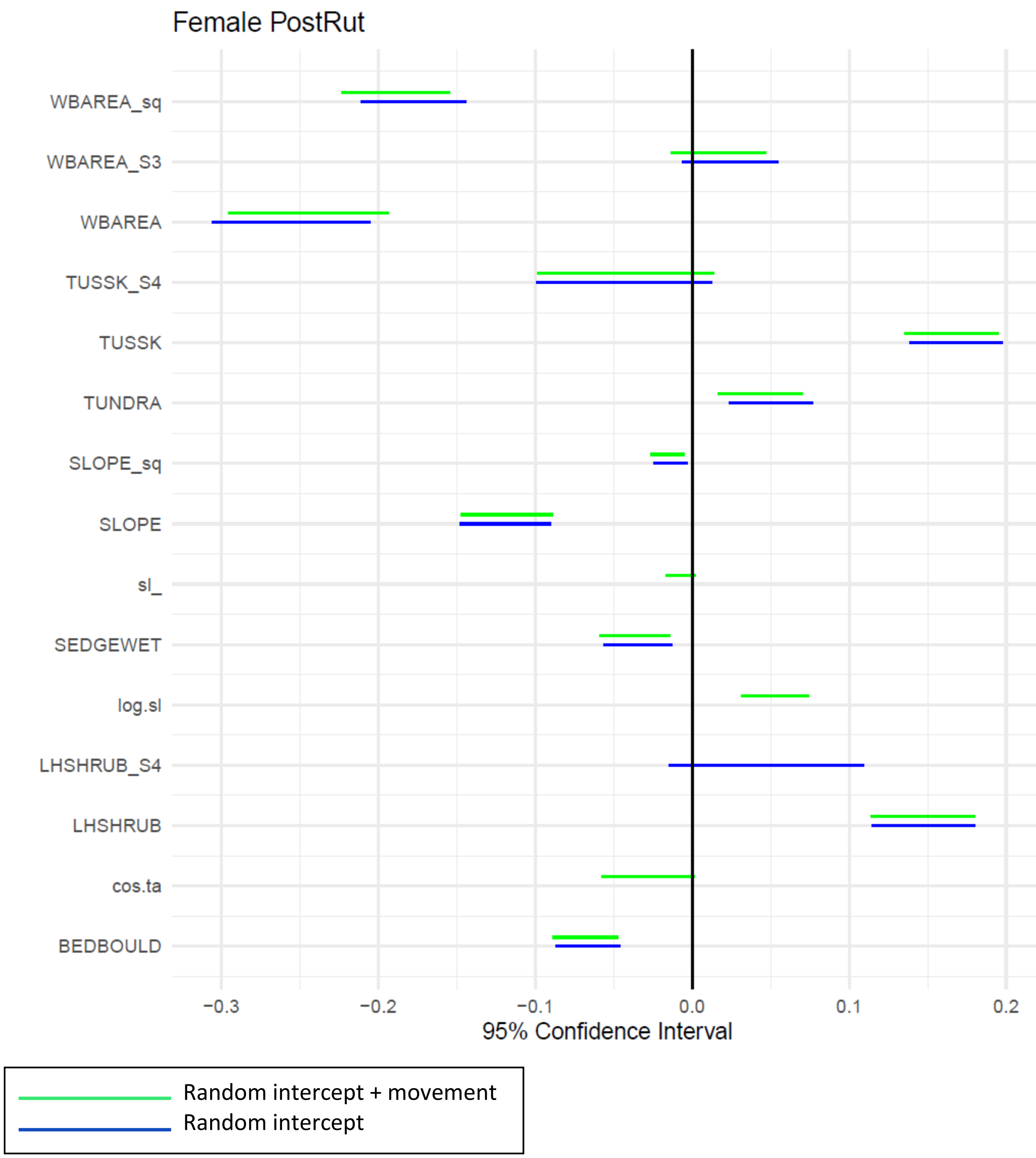


Figure E-7: Female Post-Rut Regional Study Area 8-hour Model Covariates

Comparison of 95% Confidence Intervals for coefficients for random intercept conditional logistic regression top models including or excluding movement parameters

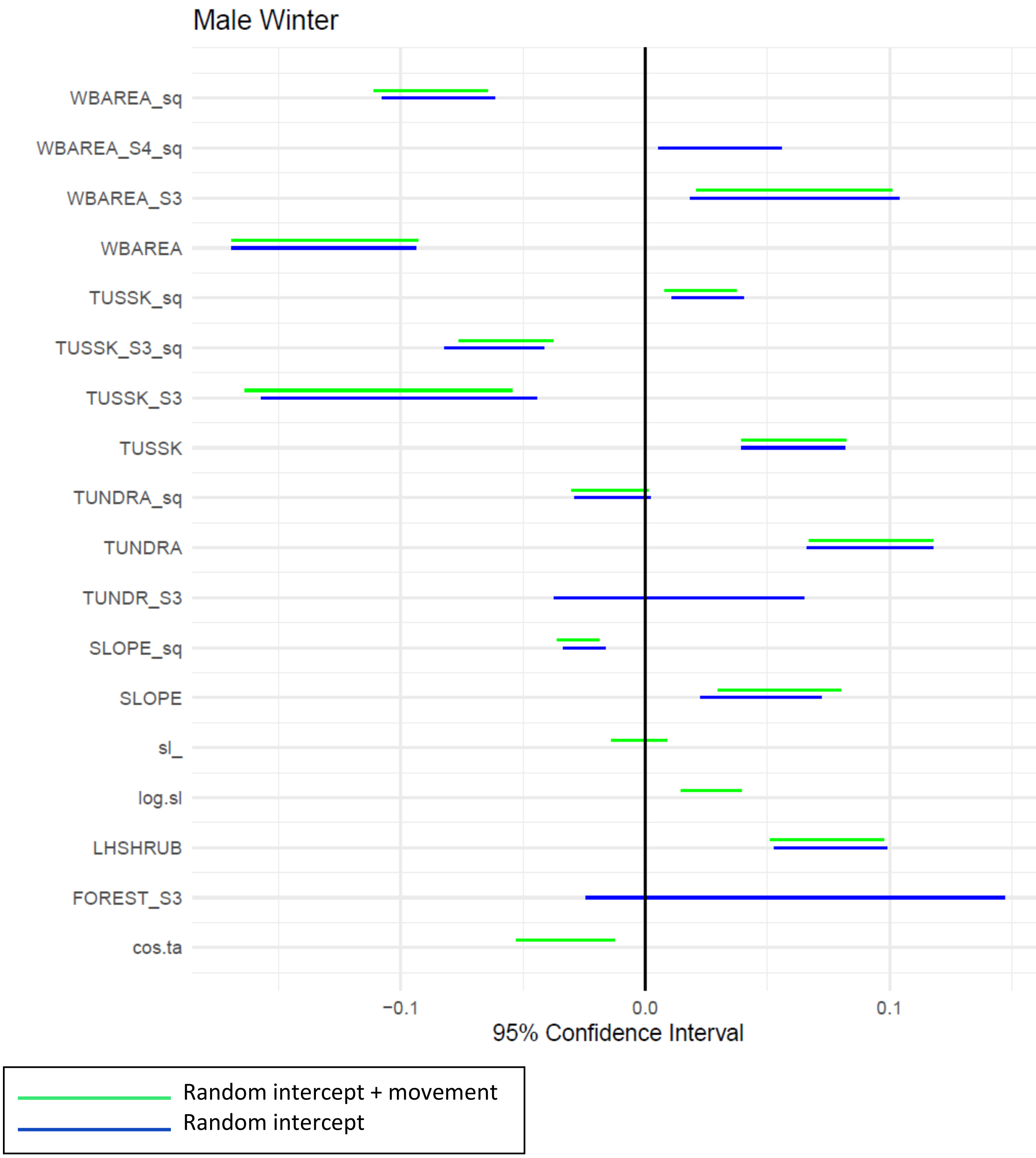


Figure E-8: Male Winter Regional Study Area 8-hour Model Covariates

Comparison of 95% Confidence Intervals for coefficients for random intercept conditional logistic regression top models including or excluding movement parameters

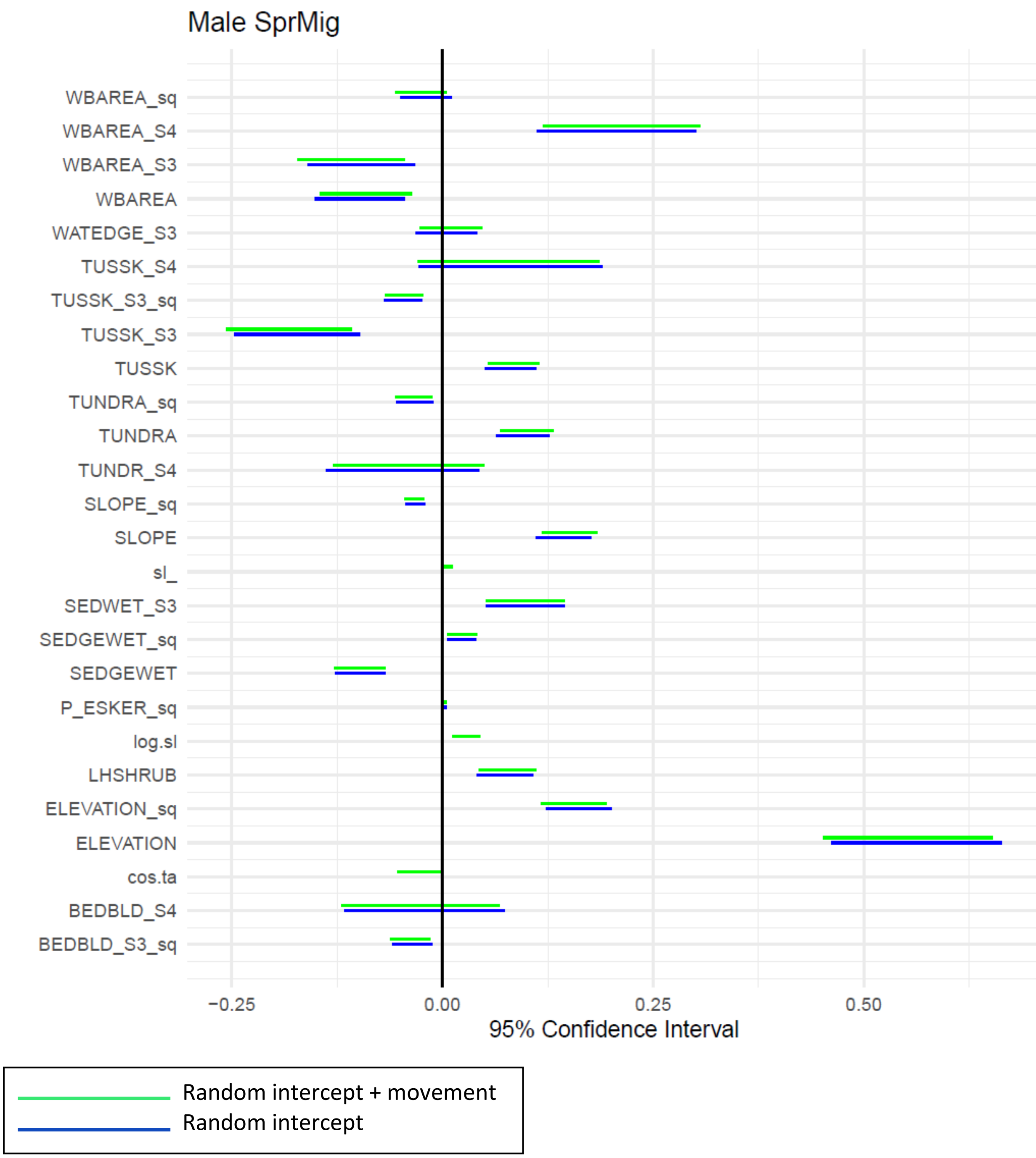


Figure E-9: Male Spring Migration Regional Study Area 8-hour Model Covariates

Comparison of 95% Confidence Intervals for coefficients for random intercept conditional logistic regression top models including or excluding movement parameters

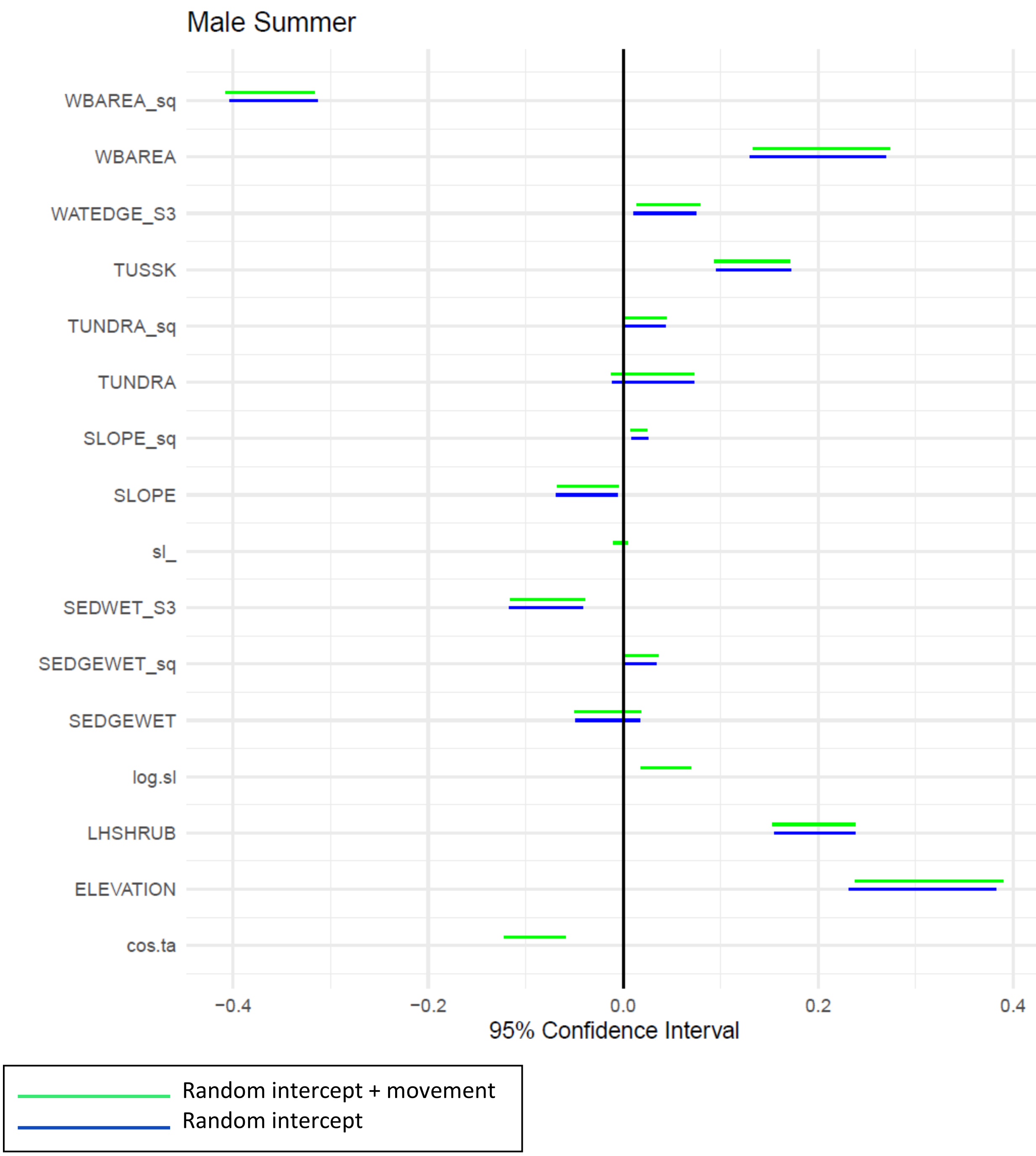


Figure E-10: Male Summer Regional Study Area 8-hour Model Covariates

Comparison of 95% Confidence Intervals for coefficients for random intercept conditional logistic regression top models including or excluding movement parameters

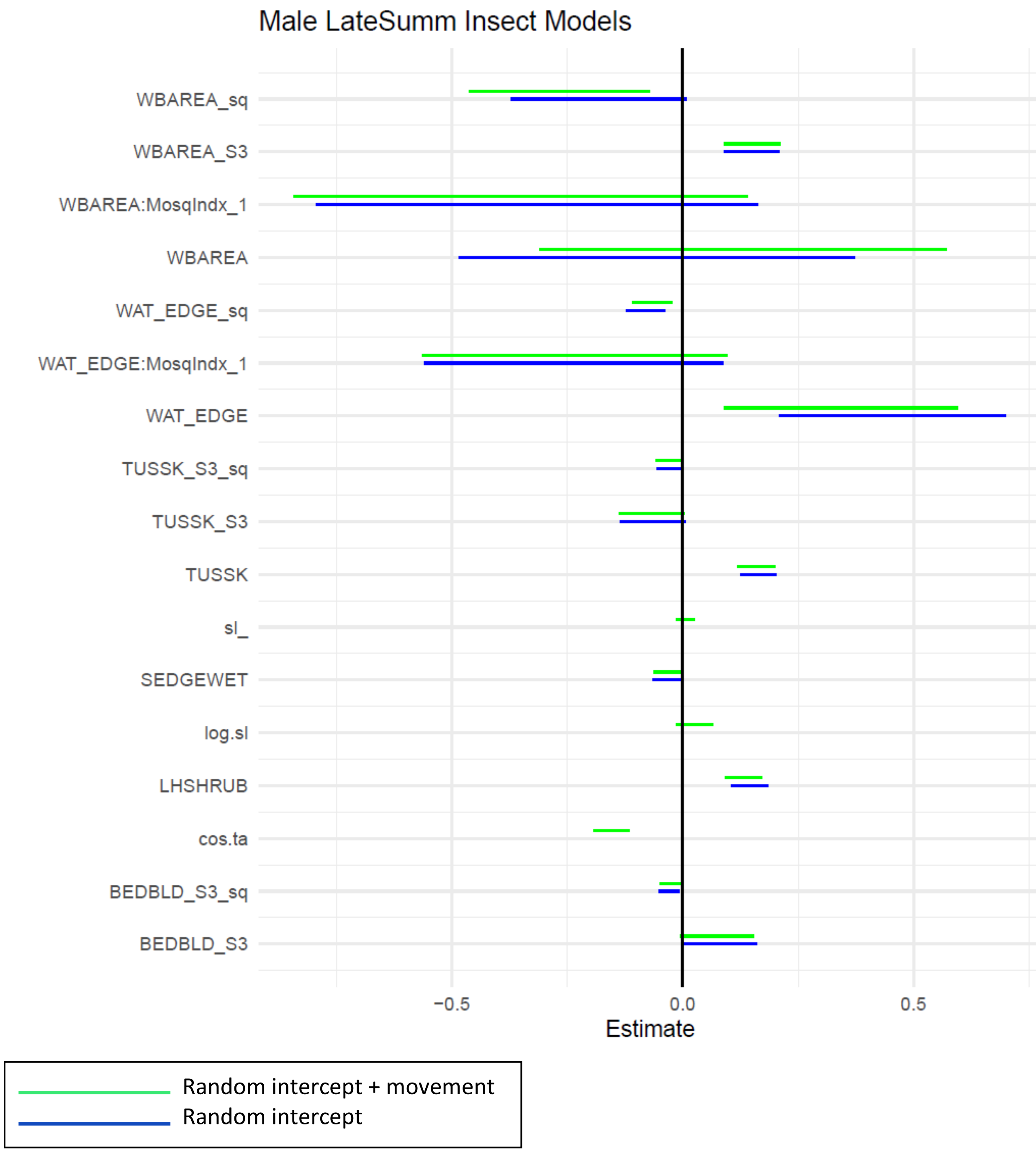


Figure E-11: Male Late Summer Regional Study Area 8-hour Model Covariates

Comparison of 95% Confidence Intervals for coefficients for random intercept conditional logistic regression top models including or excluding movement parameters

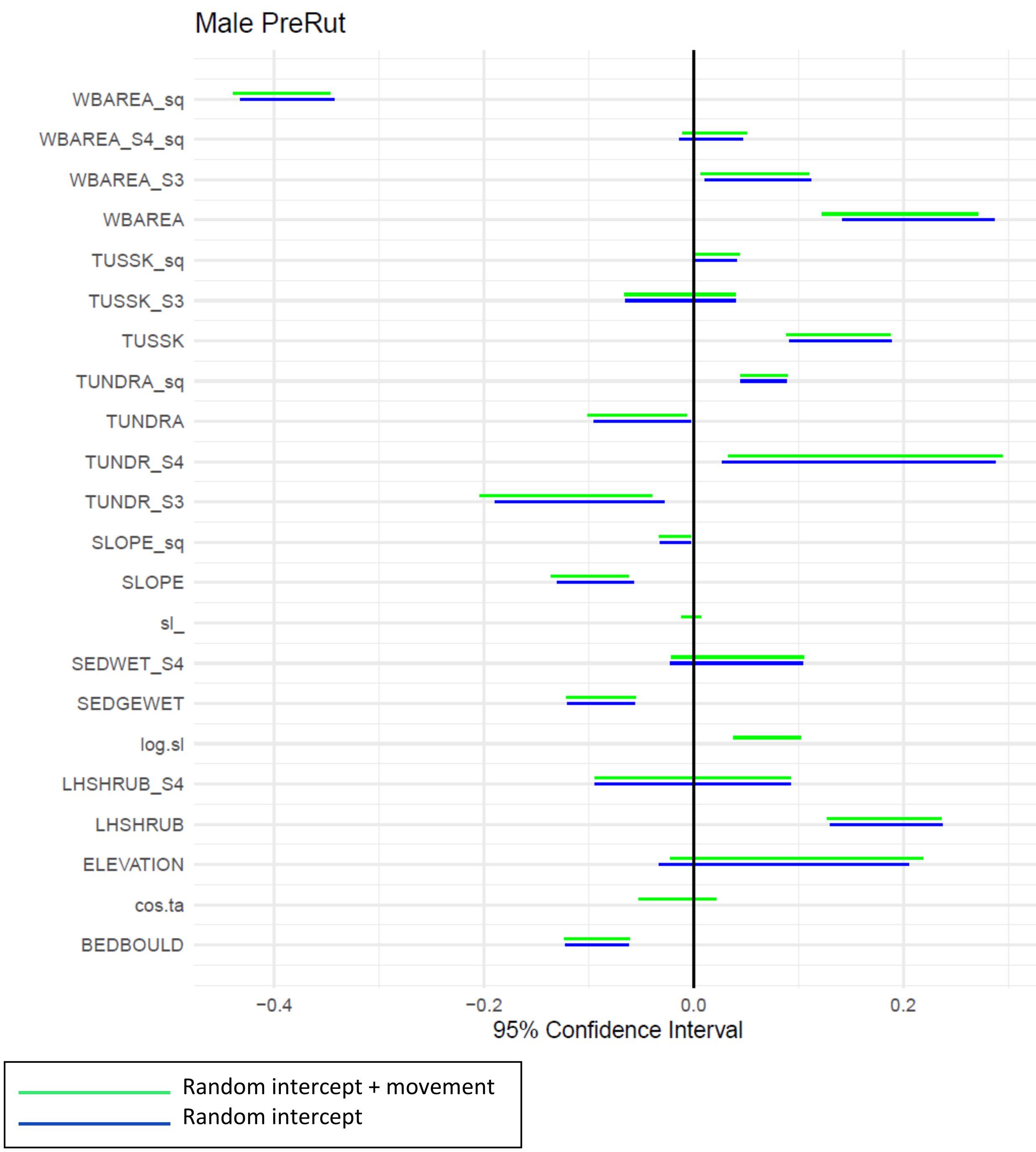


Figure E-12: Male Pre-Rut Regional Study Area 8-hour Model Covariates

Comparison of 95% Confidence Intervals for coefficients for random intercept conditional logistic regression top models including or excluding movement parameters

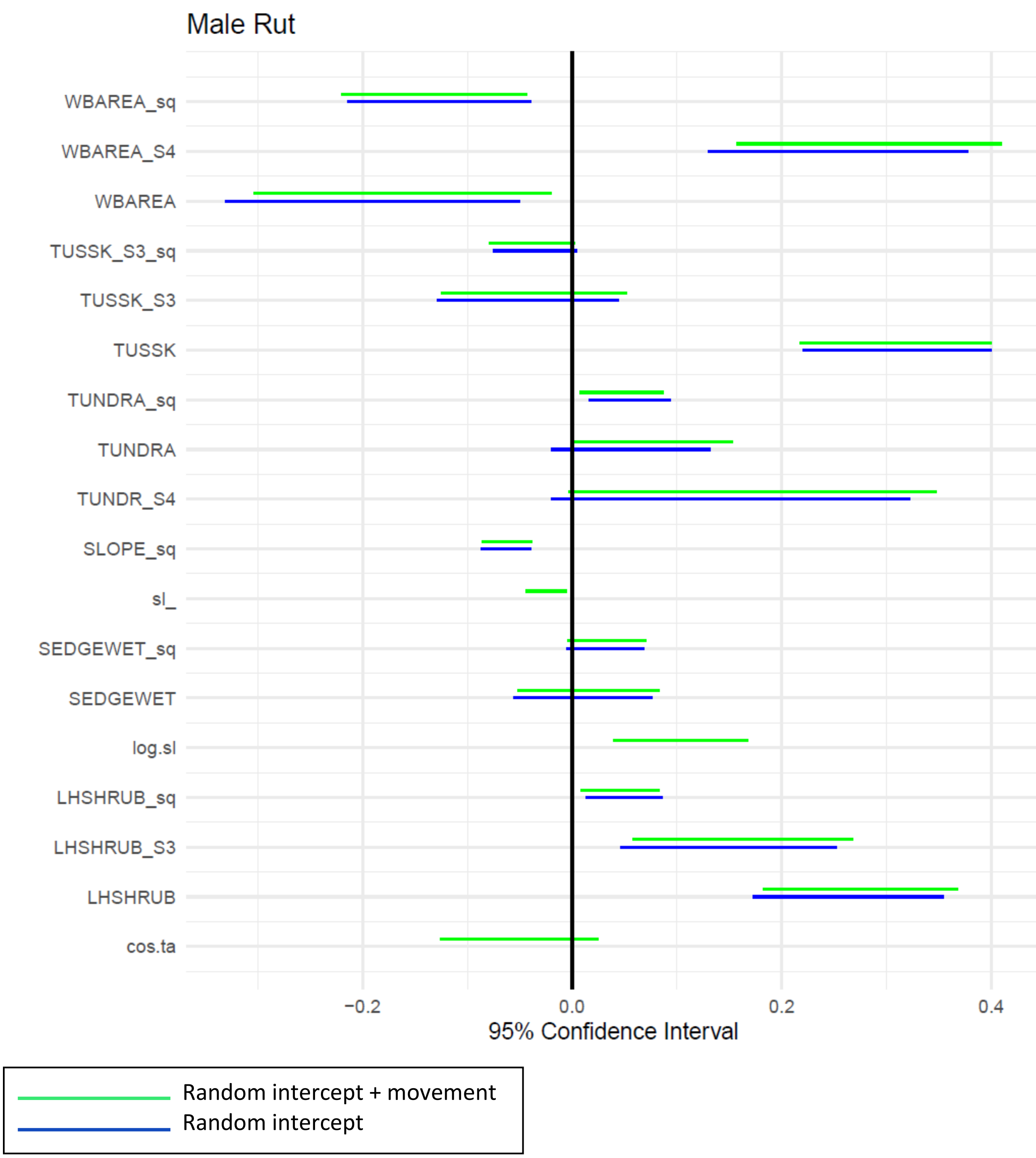


Figure E-13: Male Rut Regional Study Area 8-hour Model Covariates

Comparison of 95% Confidence Intervals for coefficients for random intercept conditional logistic regression top models including or excluding movement parameters

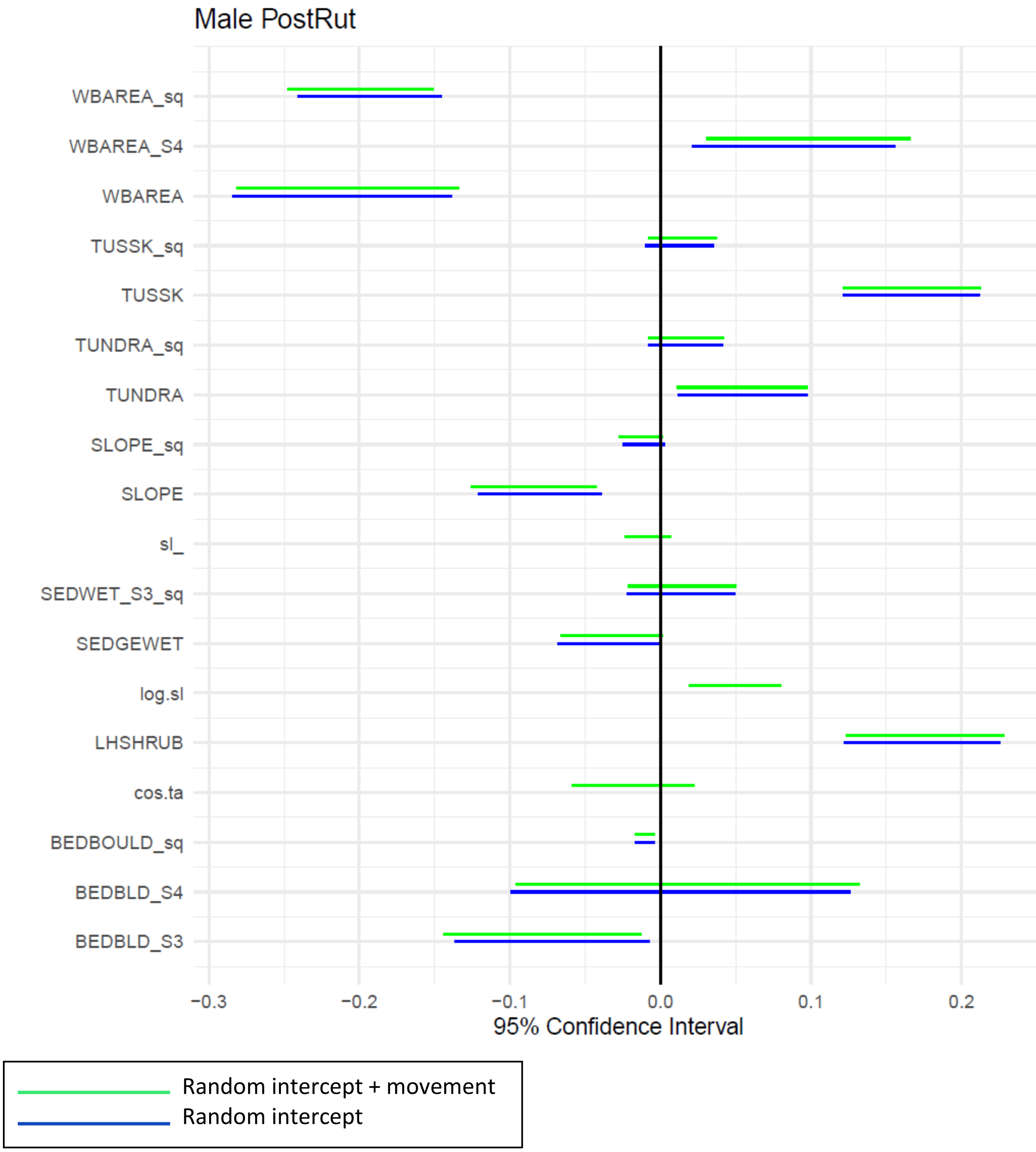


Figure E-14: Male Post-Rut Regional Study Area 8-hour Model Covariates

Comparison of 95% Confidence Intervals for coefficients for random intercept conditional logistic regression top models including or excluding movement parameters

APPENDIX F 8-HOUR INTERVAL INTEGRATED STEP SELECTION ANALYSIS MODELS IN THE EKATI/DIAVIK 30 KM HALO

Halo scale analyses were conducted separately for each sex in each of seven seasons. Data from both the Beverly and Bathurst herds were combined in each sex x season combination. Details are provided in the body of the report (Section 2.8). Candidate models for each sex in each season are presented, with their rankings and scores, in Tables F-1 to F-14 below. Comparisons of train vs test model performance are presented in Tables F-1b to F-14b that accompany the main tables in this Appendix.

Model performance criteria:

AIC – Akaike's Information Criterion.

BIC – Bayesian Information Criterion.

AUC - Area under the curve.

Caserank – the mean rank of used movement steps.

Randomrank – the mean rank of random movement steps.

Caseprob – Case probability: A measure of concordance based on the mean rank of the used step within a stratum. A generalization of ROC AUC for stratified models. This is the model performance criterion used for model ranking in the Tables in this Appendix.

#N/A – When #NA appears for a performance criterion in a Table, it indicates that the model failed to converge on a solution (See Report Section 3.8).

Table F-1: Female - Winter 30 km Halo Scale 8-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
Base Model	26598	85757.5	85806.6	0.564	3.1545	0.5691	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)
DFMines	26598	85754.6	85852.9	0.559	3.1570	0.5686	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)
MinDF	26598	85756.0	85854.2	0.559	3.1581	0.5684	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)
DFMineRoads	26598	85760.1	85858.4	0.559	3.1669	0.5666	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)

Table F-1b: Model Performance of top Female - Winter 30 km Halo Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.564	3.1545	3.5691	0.5691
test	0.576	3.0985	3.5666	0.5803

Table F-2: Female – Spring Migration 30 km Halo Scale 8-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
Base Model	12510	40074.7	40119.3	0.609	2.8950	0.6210	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)
DFMineRoads	12510	40082.5	40171.7	0.607	2.8978	0.6204	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)
MinDF	12510	40080.6	40169.8	0.607	2.8978	0.6204	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)
DFMines	12510	40078.7	40167.9	0.607	2.8988	0.6202	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)

Table F-2b: Model Performance of top Female – Spring Migration 30 km Halo Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.609	2.8950	3.6210	0.6210
test	0.588	3.0502	3.5741	0.5900

Table F-3: Female – Summer 30 km Halo Scale 8-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
DFMines	10134	31806.5	31893.2	0.701	2.4168	0.7166	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)
MinDF	10134	31808.2	31894.8	0.703	2.4198	0.7160	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)
DFMineRoads	10134	31815.7	31902.4	0.703	2.4245	0.7151	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)
Base Model	10134	31886.3	31929.6	0.696	2.4742	0.7052	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)

Table F-3b: Model Performance of top Female - Summer 30 km Halo Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.701	2.4168	3.7166	0.7166
test	0.674	2.5264	3.6906	0.6947

Table F-4: Female – Late Summer 30 km Halo Scale 8-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
DFMineRoads	15726	50079.7	50171.7	0.642	2.6726	0.6655	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)
DFMines	15726	50075.0	50167.0	0.642	2.6810	0.6638	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)
Base Model	15726	50074.6	50120.6	0.646	2.6902	0.6620	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)
MinDF	15726	#N/A	#N/A	#N/A	#N/A	#N/A	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)

Table F-4b: Model Performance of top Female – Late Summer 30 km Halo Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.642	2.6726	3.6655	0.6655
test	0.665	2.5783	3.6718	0.6843

Table F-5: Female – Pre-Rut 30 km Halo Scale 8-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
MinDF	16602	52856.8	52949.4	0.656	2.7217	0.6557	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)
DFMines	16602	52857.8	52950.4	0.656	2.7239	0.6552	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)
DFMineRoads	16602	52854.5	52947.1	0.656	2.7239	0.6552	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)
Base Model	16602	52850.6	52896.9	0.656	2.7289	0.6542	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)

Table F-5b: Model Performance of top Female – Pre-Rut 30 km Halo Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.656	2.7217	3.6557	0.6557
test	0.640	2.7502	3.6392	0.6500

Table F-6: Female – Rut 30 km Halo Scale 8-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
MinDF	6684	21220.0	21301.7	0.665	2.5996	0.6801	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)
DFMineRoads	6684	21224.6	21306.3	0.665	2.6185	0.6763	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)
DFMines	6684	21223.5	21305.2	0.659	2.6248	0.6750	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)
Base Model	6684	21244.6	21285.4	0.663	2.6284	0.6743	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)

Table F-6b: Model Performance of top Female - Rut 30 km Halo Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.655	2.5996	3.6801	0.6801
test	0.666	2.6786	3.6453	0.6643

Table F-7: Female – Post-Rut 30 km Halo Scale 8-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
DFMines	6264	19982.3	20063.2	0.621	2.8247	0.6351	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)
MinDF	6264	19982.0	20062.9	0.619	2.8391	0.6322	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)
DFMineRoads	6264	19980.5	20061.5	0.619	2.8573	0.6285	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)
Base Model	6264	19978.2	20018.7	0.617	2.9033	0.6193	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)

Table F-7b: Model Performance of top Female – Post-Rut 30 km Halo Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.621	2.8247	3.6351	0.6351
test	0.602	2.8194	3.6114	0.6361

Table F-8: Male - Winter 30 km Halo Scale 8-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
DFMineRoads	13362	43018.8	43108.8	0.583	3.0305	0.5939	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)
Base Model	13362	43027.1	43072.1	0.577	3.0669	0.5866	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)
DFMines	13362	#N/A	#N/A	#N/A	#N/A	#N/A	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)
MinDF	13362	#N/A	#N/A	#N/A	#N/A	#N/A	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)

Table F-8b: Model Performance of top Male - Winter 30 km Halo Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.583	3.0305	3.5939	0.5939
test	0.576	3.0869	3.5765	0.5826

Table F-9: Male – Spring Migration 30 km Halo Scale 8-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
DFMines	11652	37152.6	37241.0	0.578	3.1061	0.5788	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)
MinDF	11652	37154.0	37242.3	0.575	3.1107	0.5779	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)
Base Model	11652	37154.8	37199.0	0.575	3.1128	0.5774	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)
DFMineRoads	11652	37162.3	37250.7	0.575	3.1169	0.5766	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)

Table F-9b: Model Performance of top Male – Spring Migration 30 km Halo Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.578	3.1061	3.5788	0.5788
test	0.599	3.0078	3.5929	0.5984

Table F-10: Male – Summer 30 km Halo Scale 8-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
MinDF	7236	23072.6	23155.3	0.614	2.8176	0.6365	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)
DFMines	7236	23083.3	23165.9	0.615	2.8250	0.6350	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)
DFMineRoads	7236	23073.2	23155.8	0.614	2.8350	0.6330	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)
Base Model	7236	23095.1	23136.4	0.628	2.8449	0.6310	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)

Table F-10b: Model Performance of top Male - Summer 30 km Halo Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.613	2.8176	3.6365	0.6365
test	0.617	2.7118	3.6476	0.6576

Table F-11: Male – Late Summer 30 km Halo Scale 8-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
MinDF	6786	21691.0	21772.9	0.632	2.7878	0.6424	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)
DFMineRoads	6786	21691.5	21773.3	0.632	2.7958	0.6408	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)
Base Model	6786	21682.4	21723.3	0.644	2.7984	0.6403	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)
DFMines	6786	#N/A	#N/A	#N/A	#N/A	#N/A	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)

Table F-11b: Model Performance of top Male – Late Summer 30 km Halo Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.630	2.7878	3.6424	0.6424
test	0.616	2.8842	3.6089	0.6232

Table F-12: Male – Pre-Rut 30 km Halo Scale 8-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
DFMines	6456	20599.6	20680.8	0.651	2.7491	0.6502	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)
DFMineRoads	6456	20601.0	20682.3	0.653	2.7491	0.6502	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)
Base Model	6456	20590.3	20630.9	0.654	2.7556	0.6489	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)
MinDF	6456	20600.4	20681.7	0.653	2.7574	0.6485	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)

Table F-12b: Model Performance of top Male – Pre-Rut 30 km Halo Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.651	2.7491	3.6502	0.6502
test	0.652	2.6139	3.6416	0.6772

Table F-13: Male – Rut 30 km Halo Scale 8-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
MinDF	2358	7535.7	7604.9	0.632	2.6896	0.6621	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)
DFMineRoads	2358	7547.5	7616.7	0.632	2.7226	0.6555	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)
Base Model	2358	7546.8	7581.4	0.641	2.7812	0.6438	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)
DFMines	2358	#N/A	#N/A	#N/A	#N/A	#N/A	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)

Table F-13b: Model Performance of top Male - Rut 30 km Halo Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.616	2.6896	3.6621	0.6621
test	0.573	2.9073	3.6000	0.6185

Table F-14: Male – Post-Rut 30 km Halo Scale 8-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
DFMines	5616	17990.1	18069.7	0.611	2.9690	0.6062	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)
Base Model	5616	17985.8	18025.6	0.612	2.9754	0.6049	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)
DFMineRoads	5616	17987.4	18067.0	0.611	2.9786	0.6043	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)
MinDF	5616	17988.5	18068.1	0.611	2.9861	0.6028	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)

Table F-14b: Model Performance of top Male – Post-Rut 30 km Halo Scale 8-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.611	2.9690	3.6062	0.6062
test	0.599	3.0537	3.5731	0.5893

APPENDIX G 8-HOUR INTERVAL INTEGRATED STEP SELECTION ANALYSIS (ISSA) TOP MODELS IN THE EKATI/DIAVIK 30 KM HALO: COVARIATES AND COEFFICIENTS

Tables G-1 to G-14 provide the details on the iSSA top model for each season for each sex. The model details include the covariates, their coefficients, exponentiated coefficients, standard errors of the coefficients, z.value (the number of standard errors that the coefficient differs from zero), and p-values associated with the z.value (Pr..z..), a measure of the significance of the covariate in the model.

The rows of the Tables have been colour-coded:

- grey indicates a covariate whose coefficient's 95% confidence interval overlaps zero, indicating that it does not consistently affect the model value in the same direction;
- covariates with positive, significant coefficients are coloured green; and
- covariates with negative, significant coefficients are coloured red.

Table G-1: Female Winter 30 km Halo Scale 8-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	0.73783	2.09138	0.09965	7.40412	1.32025E-13
log.sl.km	0.12141	1.12908	0.02546	4.76906	1.85087E-06
cos.ta	-0.11077	0.89514	0.02472	-4.48107	7.42687E-06
sl.km	-0.06142	0.94043	0.01246	-4.93000	8.22283E-07

Table G-2: Female Spring Migration 30 km Halo Scale 8-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	0.58465	1.79436	0.12593	4.64270	3.4388E-06
log.sl.km	0.17992	1.19712	0.05167	3.48198	0.000497725
cos.ta	-0.29610	0.74371	0.03742	-7.91359	2.50064E-15
sl.km	-0.13055	0.87761	0.01357	-9.62300	6.39364E-22

Table G-3: Female Summer 30 km Halo Scale 8-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	1.02948	2.79962	0.25569	4.02622	5.6681E-05
log.sl.km	-1.50952	0.22102	0.20943	-7.20770	5.69035E-13
cos.ta	-0.09732	0.90726	0.04512	-2.15698	0.031007199
sl.km	-0.09349	0.91075	0.01874	-4.98923	6.062E-07
log.dfmines	-1.40394	0.24563	0.23363	-6.00929	1.86334E-09
log.sl.km:log.dfmines	0.61693	1.85323	0.07232	8.53063	1.45559E-17
PRHSV:log.dfmines	0.06280	1.06481	0.08878	0.70735	0.479351337

Table G-4: Female Late Summer 30 km Halo Scale 8-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	1.13150	3.10031	0.22327	5.06779	4.0247E-07
log.sl.km	0.26216	1.29974	0.10965	2.39078	0.01681243
cos.ta	-0.13911	0.87013	0.03172	-4.38578	1.15568E-05
sl.km	-0.04228	0.95860	0.02048	-2.06488	0.038934825
log.dfproads	0.28008	1.32323	0.18680	1.49933	0.133788144
log.sl.km:log.dfproads	-0.04696	0.95412	0.03841	-1.22271	0.221437817
PRHSV:log.dfproads	0.02306	1.02333	0.08085	0.28526	0.775445305

Table G-5: Female Pre-Rut 30 km Halo Scale 8-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	1.76884	5.86403	0.27807	6.36114	2.00267E-10
log.sl.km	-0.01613	0.98400	0.10330	-0.15613	0.875933922
cos.ta	-0.14257	0.86713	0.03116	-4.57550	4.75084E-06
sl.km	-0.04037	0.96043	0.01730	-2.33429	0.019580782
log.minDF	-0.11009	0.89575	0.19125	-0.57563	0.564864948
log.sl.km:log.minDF	0.04681	1.04792	0.03835	1.22048	0.222284032
PRHSV:log.minDF	-0.09925	0.90552	0.09778	-1.01500	0.310106068

Table G-6: Female Rut 30 km Halo Scale 8-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	1.08842	2.96957	0.21471	5.06925	3.9939E-07
log.sl.km	-0.16146	0.85090	0.07093	-2.27623	0.02283252
cos.ta	-0.19057	0.82649	0.05394	-3.53327	0.000410455
sl.km	-0.00043	0.99957	0.01973	-0.02197	0.9824699
log.minDF	-0.65051	0.52178	0.14981	-4.34220	1.4106E-05
log.sl.km:log.minDF	0.14647	1.15775	0.03040	4.81859	1.44579E-06
PRHSV:log.minDF	0.15210	1.16428	0.08535	1.78209	0.074734149

Table G-7: Female Post-Rut 30 km Halo Scale 8-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	1.58911	4.89938	0.45935	3.45950	0.000541187
log.sl.km	-0.18159	0.83395	0.23157	-0.78415	0.43295283
cos.ta	-0.18388	0.83204	0.05983	-3.07341	0.002116306
sl.km	-0.07124	0.93124	0.02098	-3.39587	0.000684097
log.dfmines	0.14937	1.16110	0.26252	0.56896	0.569385312
log.sl.km:log.dfmines	0.19405	1.21415	0.08668	2.23871	0.025174752
PRHSV:log.dfmines	-0.07895	0.92409	0.16471	-0.47931	0.631717294

Table G-8: Male Winter 30 km Halo Scale 8-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	2.04984	7.76665	0.70312	2.91535	0.003552854
log.sl.km	0.62641	1.87088	0.14466	4.33010	1.49042E-05
cos.ta	-0.13496	0.87375	0.03375	-3.99922	6.35508E-05
sl.km	-0.03709	0.96359	0.01996	-1.85765	0.063218598
log.dfproads	0.51509	1.67379	0.30676	1.67912	0.093128049
log.sl.km:log.dfproads	-0.18839	0.82829	0.04439	-4.24431	2.19264E-05
PRHSV:log.dfproads	-0.26154	0.76987	0.23347	-1.12023	0.262615993

Table G-9: Male Spring Migration 30 km Halo Scale 8-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	0.98677	2.68257	0.24566	4.01685	5.89802E-05
log.sl.km	0.27329	1.31428	0.18924	1.44414	0.148698914
cos.ta	-0.17074	0.84304	0.03783	-4.51323	6.38474E-06
sl.km	-0.15406	0.85722	0.01710	-9.00893	2.08082E-19
log.dfmines	-0.02702	0.97335	0.21274	-0.12699	0.898947775
log.sl.km:log.dfmines	0.16812	1.18308	0.05628	2.98704	0.002816928
PRHSV:log.dfmines	-0.05643	0.94513	0.08735	-0.64610	0.518212922

Table G-10: Male Summer 30 km Halo Scale 8-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	0.85648	2.35487	0.71498	1.19791	0.23095304
log.sl.km	-0.55666	0.57312	0.18495	-3.00986	0.002613656
cos.ta	-0.32488	0.72261	0.04693	-6.92327	4.41334E-12
sl.km	-0.17333	0.84086	0.02979	-5.81915	5.91472E-09
log.minDF	-1.49201	0.22492	0.39832	-3.74573	0.000179871
log.sl.km:log.minDF	0.31921	1.37605	0.07317	4.36289	1.28355E-05
PRHSV:log.minDF	0.22209	1.24868	0.24159	0.91927	0.357952372

Table G-11: Male Late Summer 30 km Halo Scale 8-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	1.25024	3.49118	0.31672	3.94743	7.89961E-05
log.sl.km	0.14129	1.15176	0.11658	1.21199	0.225517903
cos.ta	-0.31666	0.72857	0.04823	-6.56588	5.1727E-11
sl.km	-0.04220	0.95868	0.03151	-1.33944	0.180428724
log.minDF	0.35680	1.42875	0.20489	1.74139	0.081614906
log.sl.km:log.minDF	-0.02031	0.97990	0.03889	-0.52216	0.601560062
PRHSV:log.minDF	-0.04474	0.95625	0.10999	-0.40673	0.684205433

Table G-12: Male Pre-Rut 30 km Halo Scale 8-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	0.91720	2.50227	0.50179	1.82785	0.067571819
log.sl.km	-0.01026	0.98979	0.18965	-0.05412	0.956839087
cos.ta	-0.18245	0.83323	0.04947	-3.68808	0.000225954
sl.km	-0.12073	0.88627	0.02718	-4.44172	8.92424E-06
log.dfmines	0.00780	1.00784	0.27291	0.02860	0.977185135
log.sl.km:log.dfmines	0.03268	1.03321	0.06515	0.50156	0.615978023
PRHSV:log.dfmines	0.15259	1.16484	0.17756	0.85934	0.390154843

Table G-13: Male Rut 30 km Halo Scale 8-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	1.39314	4.02747	0.39676	3.51124	0.000446014
log.sl.km	-0.43847	0.64502	0.18004	-2.43545	0.014873181
cos.ta	0.08021	1.08352	0.10074	0.79622	0.425905048
sl.km	0.01237	1.01245	0.03570	0.34664	0.728864006
log.minDF	-0.78705	0.45519	0.29875	-2.63451	0.008425814
log.sl.km:log.minDF	0.23483	1.26470	0.07808	3.00754	0.002633679
PRHSV:log.minDF	-0.16616	0.84691	0.14973	-1.10972	0.267120628

Table G-14: Male Post-Rut 30 km Halo Scale 8-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	0.84345	2.32437	0.36814	2.29112	0.021956308
log.sl.km	0.05383	1.05531	0.11062	0.48664	0.626509945
cos.ta	0.00809	1.00812	0.06081	0.13296	0.894223748
sl.km	-0.01847	0.98170	0.02664	-0.69318	0.48819625
log.dfmines	-0.12402	0.88336	0.30323	-0.40899	0.682547593
log.sl.km:log.dfmines	0.07928	1.08250	0.05045	1.57130	0.116112526
PRHSV:log.dfmines	0.16858	1.18362	0.13517	1.24714	0.212344572

APPENDIX H 1-HOUR INTERVAL INTEGRATED STEP SELECTION ANALYSIS MODELS INSIDE GEOFENCE 112 NORTH

Geofence 112 north, 1-hour scale analyses were conducted separately for each sex in each of 7 seasons. Data from both the Beverly and Bathurst herds were combined in each sex x season combination. Details are provided in the body of the report (Section 2.8). Final candidate model sets for each sex in each season are presented, with their rankings and scores, in Tables H-1 to H-14 below. Comparisons of train vs test model performance are presented in Tables H-1b to H-14b that accompany the main tables in this Appendix.

Model performance criteria:

AIC – Akaike's Information Criterion.

BIC – Bayesian Information Criterion.

AUC - Area under the curve.

Caserank – the mean rank of used movement steps.

Randomrank – the mean rank of random movement steps.

Caseprob – Case probability: A measure of concordance based on the mean rank of the used step within a stratum. A generalization of ROC AUC for stratified models. This is the model performance criterion used for model ranking in the Tables in this Appendix.

#N/A – When #NA appears for a performance criterion in a Table, it indicates that the model failed to converge on a solution (See Report Section 3.8).

Table H-1: Female - Winter Geofence 112 North 1-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
DFMines	130230	420835.7	420953.0	0.516	3.2788	0.5442	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)
Base Model	130230	420829.7	420888.3	0.523	3.2810	0.5438	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)
MinDF	130230	420835.0	420952.3	0.514	3.2949	0.5410	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)
DFMineRoads	130230	#N/A	#N/A	#N/A	#N/A	#N/A	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)

Table H-1b: Model Performance of top Female - Winter Geofence 112 North 1-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.516	3.2788	3.5442	0.5442
test	0.513	3.3246	3.5208	0.5351

Table H-2: Female – Spring Migration Geofence 112 North 1-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
Base Model	73368	236943.3	236998.5	0.526	3.2371	0.5526	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)
DFMineRoads	73368	236947.3	237057.7	0.521	3.2387	0.5523	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)
MinDF	73368	236948.7	237059.1	0.521	3.2463	0.5507	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)
DFMines	73368	236947.9	237058.3	0.525	3.2467	0.5507	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)

Table H-2b: Model Performance of top Female – Spring Migration Geofence 112 North 1-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.526	3.2371	3.5526	0.5526
test	0.527	3.2211	3.5466	0.5558

Table H-3: Female – Summer Geofence 112 North 1-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
DFMineRoads	32130	103115.8	103216.3	0.577	2.9472	0.6106	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)
MinDF	32130	103116.9	103217.4	0.577	2.9477	0.6105	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)
Base Model	32130	103112.6	103162.9	0.581	2.9595	0.6081	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)
DFMines	32130	#N/A	#N/A	#N/A	#N/A	#N/A	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)

Table H-3b: Model Performance of top Female - Summer Geofence 112 North 1-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.577	2.9472	3.6106	0.6106
test	0.572	2.9498	3.5986	0.6100

Table H-4: Female – Late Summer Geofence 112 North 1-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
DFMines	79910	257292.9	257404.4	0.553	3.0825	0.5835	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)
DFMineRoads	79910	257299.3	257410.7	0.555	3.0839	0.5832	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)
MinDF	79910	257295.5	257407.0	0.555	3.0839	0.5832	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)
Base Model	79910	257293.7	257349.4	0.558	3.0844	0.5831	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)

Table H-4b: Model Performance of top Female – Late Summer Geofence 112 North 1-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.553	3.0825	3.5834	0.5835
test	0.563	3.0534	3.5768	0.5893

Table H-5: Female – Pre-Rut Geofence 112 North 1-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
MinDF	80820	260262.9	260374.5	0.565	3.0812	0.5838	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)
DFMineRoads	80820	260264.8	260376.4	0.565	3.0832	0.5834	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)
Base Model	80820	260257.8	260313.6	0.565	3.0835	0.5833	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)
DFMines	80820	#N/A	#N/A	#N/A	#N/A	#N/A	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)

Table H-5b: Model Performance of top Female – Pre-Rut Geofence 112 North 1-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.564	3.0812	3.5838	0.5838
test	0.561	3.0930	3.5707	0.5814

Table H-6: Female – Rut Geofence 112 North 1-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
DFMineRoads	35496	114148.4	114250.1	0.574	2.9932	0.6014	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)
Base Model	35496	114144.9	114195.7	0.574	2.9936	0.6013	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)
MinDF	35496	114153.6	114255.3	0.574	2.9948	0.6010	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)
DFMines	35496	114152.6	114254.3	0.574	2.9973	0.6005	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)

Table H-6b: Model Performance of top Female - Rut Geofence 112 North 1-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.574	2.9932	3.6014	0.6014
test	0.582	3.0052	3.5875	0.5990

Table H-7: Female – Post-Rut Geofence 112 North 1-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
DFMines	22818	73448.0	73544.4	0.531	2.9653	0.6069	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)
MinDF	22818	73452.1	73548.5	#N/A	2.9737	0.6053	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)
DFMineRoads	22818	73457.3	73553.7	#N/A	2.9779	0.6044	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)
Base Model	22818	73469.9	73518.1	#N/A	3.0013	0.5997	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)

Table H-7b: Model Performance of top Female – Post-Rut Geofence 112 North 1-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.531	2.9653	3.6069	0.6069
test	0.511	3.1706	3.5487	0.5659

Table H-8: Male - Winter Geofence 112 North 1-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
Base Model	107232	346495.1	346552.6	0.522	3.2871	0.5426	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)
MinDF	107232	346497.6	346612.6	0.519	3.3045	0.5391	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)
DFMines	107232	346496.8	346611.8	0.518	3.3066	0.5387	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)
DFMineRoads	107232	#N/A	#N/A	#N/A	#N/A	#N/A	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)

Table H-8b: Model Performance of top Male - Winter Geofence 112 North 1-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.522	3.2871	3.5426	0.5426
test	0.532	3.2078	3.5499	0.5584

Table H-9: Male – Spring Migration Geofence 112 North 1-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
DFMineRoads	76590	247103.7	247214.7	0.544	3.1675	0.5665	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)
Base Model	76590	247093.8	247149.3	0.544	3.1688	0.5662	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)
MinDF	76590	247101.5	247212.5	0.544	3.1720	0.5656	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)
DFMines	76590	247100.6	247211.5	0.543	3.1736	0.5653	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)

Table H-9b: Model Performance of top Male – Spring Migration Geofence 112 North 1-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.544	3.1675	3.5665	0.5665
test	0.563	3.0723	3.5750	0.5855

Table H-10: Male – Summer Geofence 112 North 1-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
DFMines	30360	97896.9	97996.7	0.530	3.2289	0.5542	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)
Base Model	30360	97897.5	97947.4	0.538	3.2423	0.5515	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)
DFMineRoads	30360	97896.4	97996.3	0.517	3.2528	0.5494	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)
MinDF	30360	97896.8	97996.7	0.517	3.2553	0.5489	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)

Table H-10b: Model Performance of top Male - Summer Geofence 112 North 1-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.530	3.2289	3.5542	0.5542
test	0.525	3.1810	3.5502	0.5638

Table H-11: Male – Late Summer Geofence 112 North 1-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
MinDF	41130	132478.9	132582.4	0.556	3.0645	0.5871	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)
Base Model	41130	132471.7	132523.4	0.572	3.0699	0.5860	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)
DFMines	41130	132479.8	132583.3	0.558	3.0708	0.5858	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)
DFMineRoads	41130	#N/A	#N/A	#N/A	#N/A	#N/A	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)

Table H-11b: Model Performance of top Male – Late Summer Geofence 112 North 1-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.556	3.0645	3.5871	0.5871
test	0.553	3.0824	3.5667	0.5835

Table H-12: Male – Pre-Rut Geofence 112 North 1-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
DFMineRoads	38148	122916.8	123019.4	0.553	3.1043	0.5791	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)
Base Model	38148	122906.9	122958.2	0.560	3.1073	0.5785	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)
DFMines	38148	122915.2	123017.8	0.550	3.1107	0.5779	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)
MinDF	38148	122912.7	123015.3	0.553	3.1109	0.5778	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)

Table H-12b: Model Performance of top Male – Pre-Rut Geofence 112 North 1-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.553	3.1043	3.5791	0.5791
test	0.563	3.0146	3.5796	0.5971

Table H-13: Male – Rut Geofence 112 North 1-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
DFMines	16056	51664.4	51756.6	0.560	3.0747	0.5851	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)
Base Model	16056	51656.7	51702.8	0.570	3.0826	0.5835	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)
MinDF	16056	51663.7	51755.9	0.570	3.0845	0.5831	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)
DFMineRoads	16056	51666.6	51758.8	0.570	3.0859	0.5828	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)

Table H-13b: Model Performance of top Male - Rut Geofence 112 North 1-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.560	3.0747	3.5851	0.5851
test	0.562	3.0479	3.5815	0.5904

Table H-14: Male – Post-Rut Geofence 112 North 1-hour interval models

Model name	N	AIC	BIC	AUC	caserank	caseprob	Formula
DFMineRoads	21852	70475.1	70571.0	0.534	3.1222	0.5756	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfproads + log.dfproads * log.sl.km + log.dfproads * PRHSV + (1 | stepnum) + (0 + log.dfproads | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfproads:log.sl.km | IDYr) + (0 + log.dfproads:PRHSV | IDYr)
Base Model	21852	70467.8	70515.7	0.549	3.1266	0.5747	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + (1 | stepnum) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr)
DFMines	21852	70476.0	70571.9	0.536	3.1277	0.5745	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.dfmines + log.dfmines * log.sl.km + log.dfmines * PRHSV + (1 | stepnum) + (0 + log.dfmines | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.dfmines:log.sl.km | IDYr) + (0 + log.dfmines:PRHSV | IDYr)
MinDF	21852	#N/A	#N/A	#N/A	#N/A	#N/A	case_ ~ -1 + PRHSV + log.sl.km + cos.ta + sl.km + log.minDF + log.minDF * log.sl.km + log.minDF * PRHSV + (1 | stepnum) + (0 + log.minDF | IDYr) + (0 + log.sl.km | IDYr) + (0 + PRHSV | IDYr) + (0 + log.minDF:log.sl.km | IDYr) + (0 + log.minDF:PRHSV | IDYr)

Table H-14b: Model Performance of top Male – Post-Rut Geofence 112 North 1-hour interval model

Data	AUC	caserank	randomrank	caseprob
train	0.534	3.1222	3.5756	0.5756
test	0.540	3.1143	3.5616	0.5771

APPENDIX I 1-HOUR INTERVAL INTEGRATED STEP SELECTION ANALYSIS (ISSA) TOP MODELS INSIDE GEOFENCE 112 NORTH: COVARIATES AND COEFFICIENTS

Tables I-1 to I-14 provide the details on the iSSA top model for each season for each sex. The model details include the covariates, their coefficients, exponentiated coefficients, standard errors of the coefficients, z.value (the number of standard errors that the coefficient differs from zero), and p-values associated with the z.value (Pr..z..), a measure of the significance of the covariate in the model.

The rows of the Tables have been colour-coded:

- grey indicates a covariate whose coefficient's 95% confidence interval overlaps zero, indicating that it does not consistently affect the model value in the same direction;
- covariates with positive, significant coefficients are coloured green; and
- covariates with negative, significant coefficients are coloured red.

Table I-1: Female Winter Geofence 112 North 1-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	0.50640	1.65931	0.17124	2.95724	0.00310405
log.sl.km	0.00058	1.00058	0.01279	0.04569	0.96355563
cos.ta	-0.00588	0.99413	0.01082	-0.54399	0.58645012
sl.km	0.01702	1.01717	0.01910	0.89092	0.37296955
log.dfmines	-0.30680	0.73580	0.15765	-1.94609	0.05164362
log.sl.km:log.dfmines	-0.00026	0.99974	0.00503	-0.05213	0.95842188
PRHSV:log.dfmines	0.00805	1.00809	0.06992	0.11517	0.90830676

Table I-2: Female Spring Migration Geofence 112 North 1-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	0.58841	1.80111	0.08161	7.20963	5.6104E-13
log.sl.km	0.00425	1.00426	0.00547	0.77766	0.43676962
cos.ta	-0.01506	0.98505	0.01468	-1.02618	0.30480717
sl.km	0.02007	1.02028	0.01978	1.01474	0.31022961

Table I-3: Female Summer Geofence 112 North 1-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	0.73460	2.08465	0.24007	3.05990	0.0022141
log.sl.km	-0.07785	0.92510	0.05504	-1.41452	0.15721006
cos.ta	-0.03823	0.96249	0.02260	-1.69158	0.09072668
sl.km	0.06196	1.06392	0.03195	1.93935	0.05245863
log.dfproads	-0.69689	0.49813	0.30343	-2.29672	0.02163501
log.sl.km:log.dfproads	0.04044	1.04127	0.01987	2.03533	0.04181726
PRHSV:log.dfproads	0.06763	1.06997	0.08811	0.76761	0.44271708

Table I-4: Female Late Summer Geofence 112 North 1-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	0.62109	1.86095	0.12954	4.79455	1.6304E-06
log.sl.km	0.01031	1.01036	0.02340	0.44053	0.65955526
cos.ta	-0.03442	0.96616	0.01404	-2.45245	0.01418873
sl.km	0.05016	1.05144	0.02518	1.99210	0.04636009
log.dfmines	0.33501	1.39796	0.18489	1.81199	0.06998758
log.sl.km:log.dfmines	0.00189	1.00189	0.00855	0.22076	0.82527777
PRHSV:log.dfmines	0.08563	1.08941	0.05048	1.69625	0.0898386

Table I-5: Female Pre-Rut Geofence 112 North 1-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	1.08431	2.95740	0.18399	5.89323	3.7872E-09
log.sl.km	0.05199	1.05336	0.02538	2.04863	0.04049802
cos.ta	-0.01903	0.98115	0.01393	-1.36565	0.17204827
sl.km	0.05615	1.05776	0.02268	2.47542	0.01330784
log.minDF	0.16850	1.18353	0.27830	0.60549	0.54485558
log.sl.km:log.minDF	-0.01435	0.98575	0.00909	-1.57851	0.11444938
PRHSV:log.minDF	-0.04020	0.96060	0.06513	-0.61712	0.53715672

Table I-6: Female Rut Geofence 112 North 1-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	1.48281	4.40529	0.18546	7.99518	1.2938E-15
log.sl.km	-0.00596	0.99406	0.02088	-0.28553	0.77524134
cos.ta	-0.12545	0.88210	0.02207	-5.68450	1.312E-08
sl.km	0.05151	1.05286	0.02468	2.08734	0.03685775
log.dfproads	0.09064	1.09487	0.16776	0.54026	0.5890172
log.sl.km:log.dfproads	0.01018	1.01024	0.00774	1.31634	0.18806136
PRHSV:log.dfproads	-0.15665	0.85501	0.06549	-2.39198	0.01675761

Table I-7: Female Post-Rut Geofence 112 North 1-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	0.79456	2.21347	0.35947	2.21038	0.02707901
log.sl.km	-0.04371	0.95724	0.03434	-1.27263	0.20314983
cos.ta	-0.29436	0.74501	0.02674	-11.00955	3.4372E-28
sl.km	0.00350	1.00350	0.03308	0.10575	0.91578024
log.dfmines	2.11711	8.30711	0.66400	3.18844	0.00143044
log.sl.km:log.dfmines	0.02406	1.02435	0.01320	1.82260	0.06836437
PRHSV:log.dfmines	0.11802	1.12527	0.12958	0.91083	0.36238657

Table I-8: Male Winter Geofence 112 North 1-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	0.66432	1.94316	0.07305	9.09401	9.5454E-20
log.sl.km	-0.00064	0.99936	0.00423	-0.15212	0.87909224
cos.ta	-0.00663	0.99339	0.01172	-0.56611	0.57132219
sl.km	0.03964	1.04043	0.02498	1.58691	0.1125325

Table I-9: Male Spring Migration Geofence 112 North 1-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	0.46470	1.59154	0.13459	3.45281	0.00055478
log.sl.km	-0.01863	0.98154	0.02208	-0.84376	0.39880147
cos.ta	-0.00884	0.99120	0.01413	-0.62515	0.53187366
sl.km	0.03931	1.04009	0.01993	1.97237	0.04856691
log.dfproads	-0.05832	0.94335	0.22405	-0.26029	0.79464015
log.sl.km:log.dfproads	0.00844	1.00847	0.00742	1.13715	0.2554767
PRHSV:log.dfproads	0.01929	1.01948	0.04828	0.39963	0.68942695

Table I-10: Male Summer Geofence 112 North 1-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	0.92434	2.52020	0.46779	1.97598	0.04815657
log.sl.km	-0.09001	0.91392	0.05156	-1.74575	0.08085397
cos.ta	-0.08030	0.92284	0.02199	-3.65155	0.00026066
sl.km	0.05362	1.05508	0.04345	1.23402	0.2171941
log.dfmines	-1.17921	0.30752	0.54642	-2.15808	0.03092157
log.sl.km:log.dfmines	0.03031	1.03077	0.01678	1.80649	0.07084186
PRHSV:log.dfmines	0.08281	1.08634	0.18003	0.45998	0.64553061

Table I-11: Male Late Summer Geofence 112 North 1-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	0.69652	2.00676	0.14064	4.95238	7.3311E-07
log.sl.km	0.03178	1.03229	0.02477	1.28300	0.19949267
cos.ta	-0.04705	0.95404	0.01942	-2.42236	0.01542002
sl.km	0.06508	1.06725	0.03979	1.63572	0.10189755
log.minDF	0.29943	1.34909	0.19818	1.51089	0.13081616
log.sl.km:log.minDF	-0.00797	0.99206	0.00912	-0.87405	0.38208935
PRHSV:log.minDF	0.04198	1.04287	0.05347	0.78514	0.43237403

Table I-12: Male Pre-Rut Geofence 112 North 1-hour Interval ISSA Covariates and Coefficients

Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	0.82434	2.28039	0.25905	3.18217	0.00146178
log.sl.km	0.01972	1.01991	0.03430	0.57493	0.56533656
cos.ta	-0.01843	0.98174	0.02013	-0.91574	0.35980243
sl.km	0.02015	1.02035	0.03206	0.62850	0.52967747
log.dfproads	0.39825	1.48922	0.49634	0.80238	0.42233261
log.sl.km:log.dfproads	-0.00301	0.99699	0.01201	-0.25080	0.8019651
PRHSV:log.dfproads	0.01461	1.01471	0.09264	0.15768	0.87470855

Table I-13: Male Rut Geofence 112 North 1-hour Interval ISSA Covariates and Coefficients

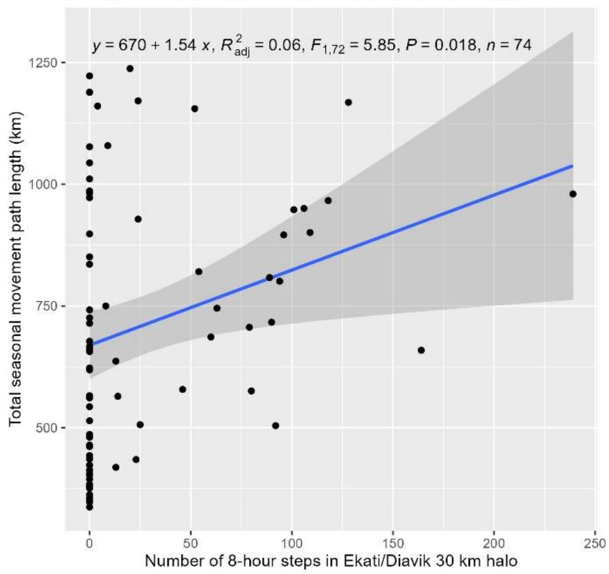
Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	0.97038	2.63896	0.27248	3.56137	0.00036893
log.sl.km	-0.01279	0.98729	0.03466	-0.36910	0.71205682
cos.ta	-0.00845	0.99158	0.03238	-0.26105	0.79405257
sl.km	0.04425	1.04524	0.03642	1.21481	0.22443813
log.dfmines	-0.38815	0.67831	0.25204	-1.54000	0.12355972
log.sl.km:log.dfmines	0.01100	1.01106	0.01248	0.88123	0.37819149
PRHSV:log.dfmines	-0.01150	0.98857	0.09924	-0.11585	0.90777235

Table I-14: Male Post-Rut Geofence 112 North 1-hour Interval ISSA Covariates and Coefficients

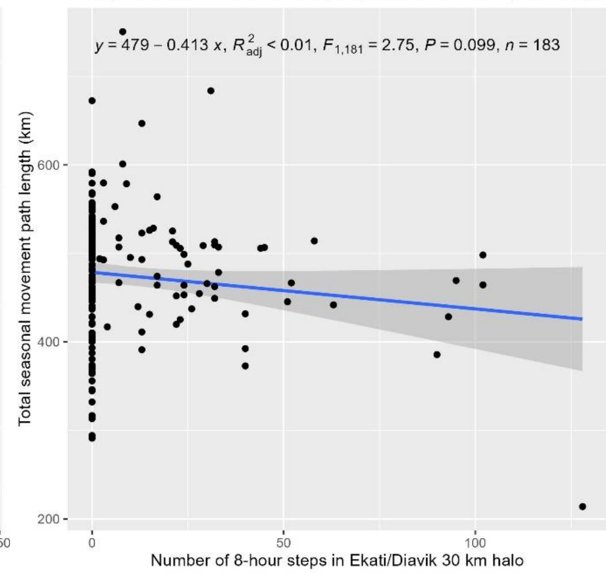
Covariate	coef	exp.coef	se.coef	z.value	Pr...z..
PRHSV	0.63935	1.89524	0.26198	2.44046	0.0146685
log.sl.km	0.00087	1.00087	0.02446	0.03541	0.97174921
cos.ta	-0.02911	0.97131	0.02722	-1.06928	0.28494424
sl.km	-0.01119	0.98887	0.04356	-0.25681	0.79732368
log.dfproads	0.32334	1.38173	0.32465	0.99597	0.3192659
log.sl.km:log.dfproads	0.00456	1.00457	0.00890	0.51251	0.60829538
PRHSV:log.dfproads	0.13855	1.14861	0.09665	1.43350	0.15171524

APPENDIX J 8-HOUR SEASONAL MOVEMENT PATH LENGTH VS. EXPOSURE IN EKATI/DIAVIK HALO

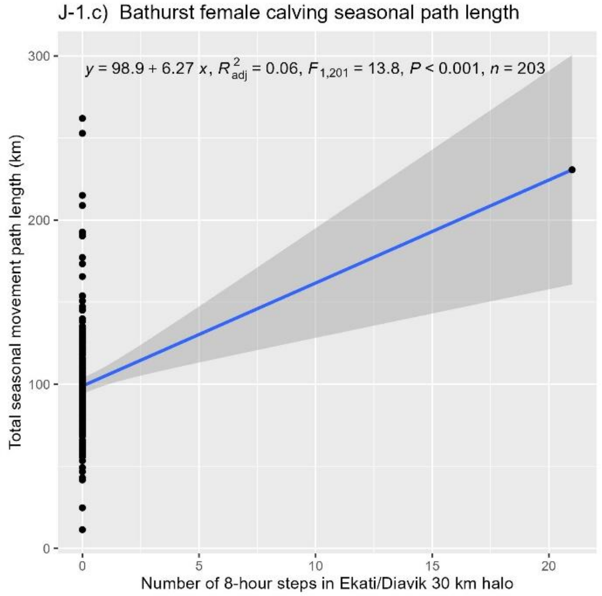
J-1.a) Bathurst female winter seasonal path length



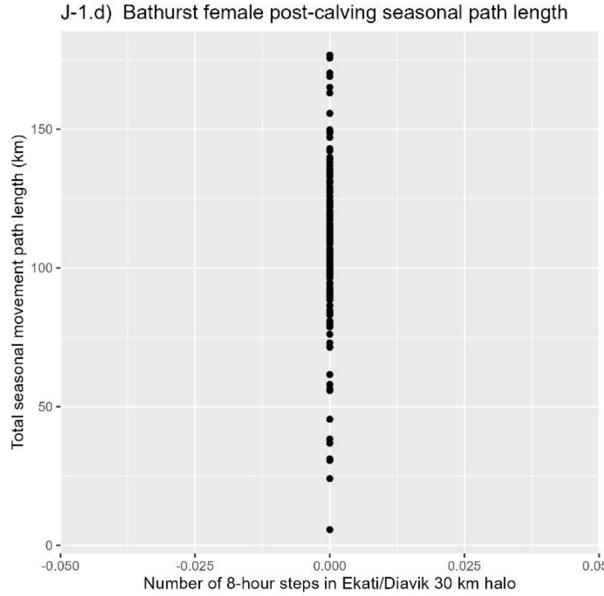
J-1.b) Bathurst female spring migration seasonal path length



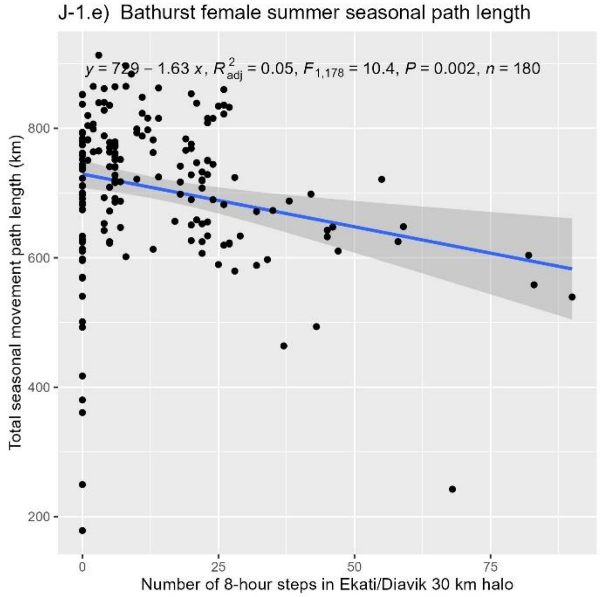
J-1.c) Bathurst female calving seasonal path length



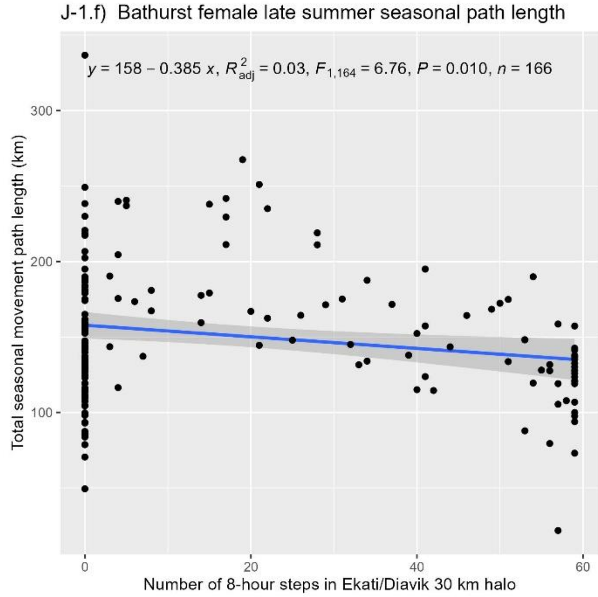
J-1.d) Bathurst female post-calving seasonal path length



J-1.e) Bathurst female summer seasonal path length



J-1.f) Bathurst female late summer seasonal path length



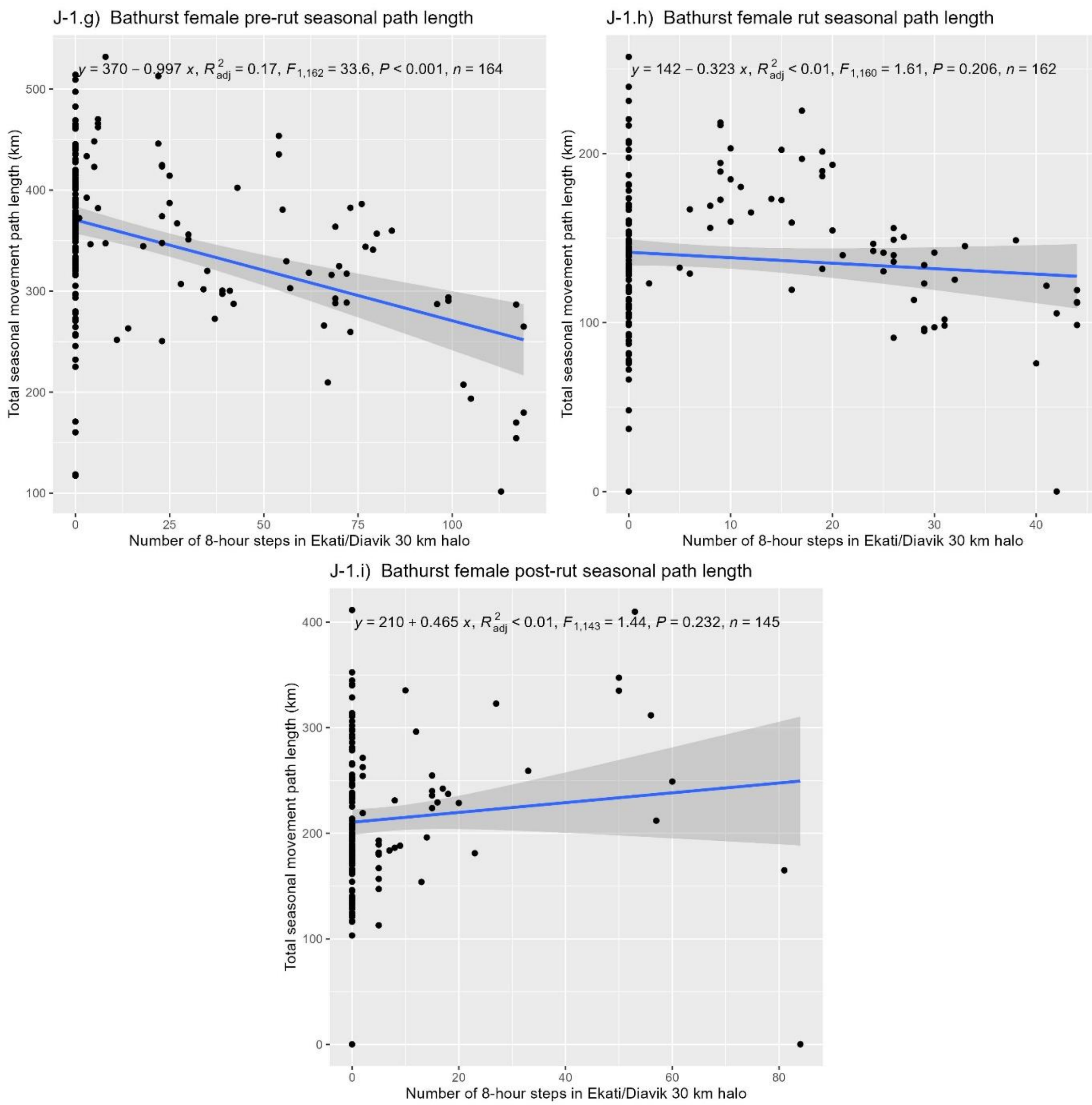
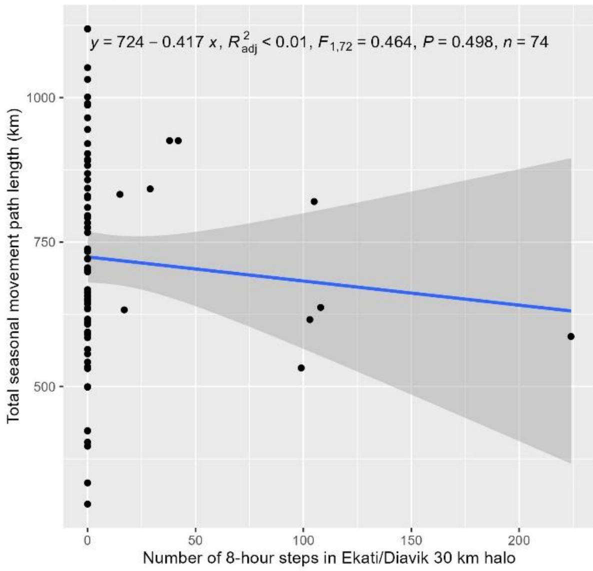
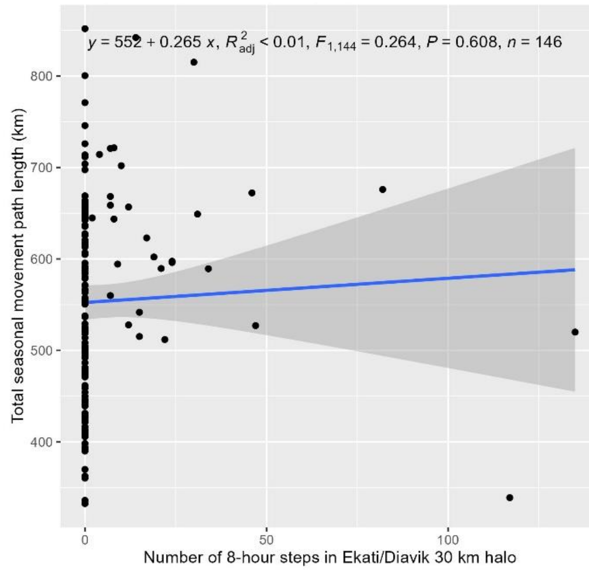


Figure J-1: Relationship of total seasonal 8-hour movement path length of female Bathurst herd caribou to their exposure (number of 8-hour movement steps) to the Ekati/Diavik 30 km halo.

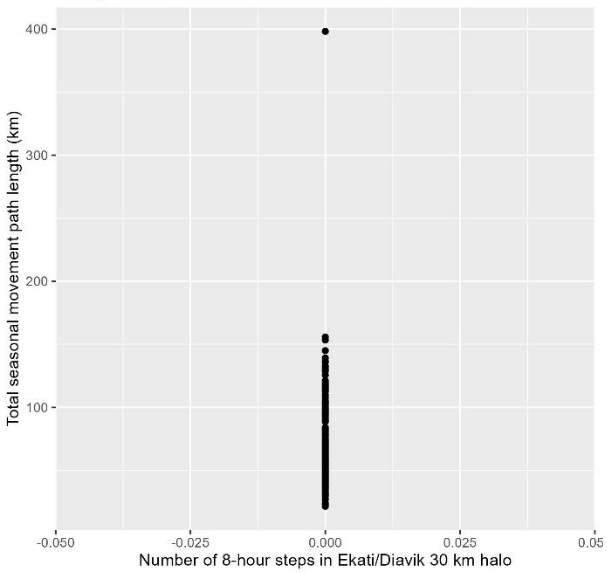
J-2.a) Beverly female winter seasonal path length



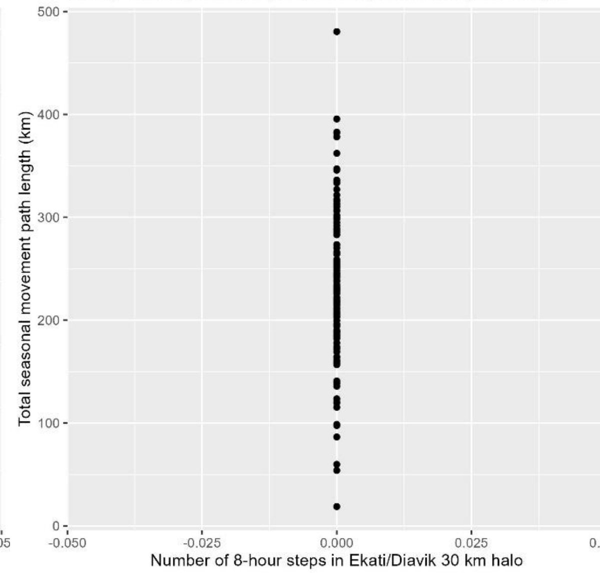
J-2.b) Beverly female spring migration seasonal path length



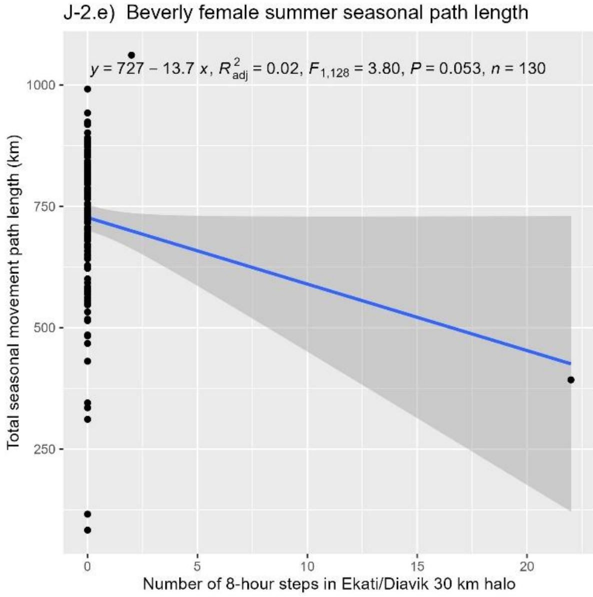
J-2.c) Beverly female calving seasonal path length



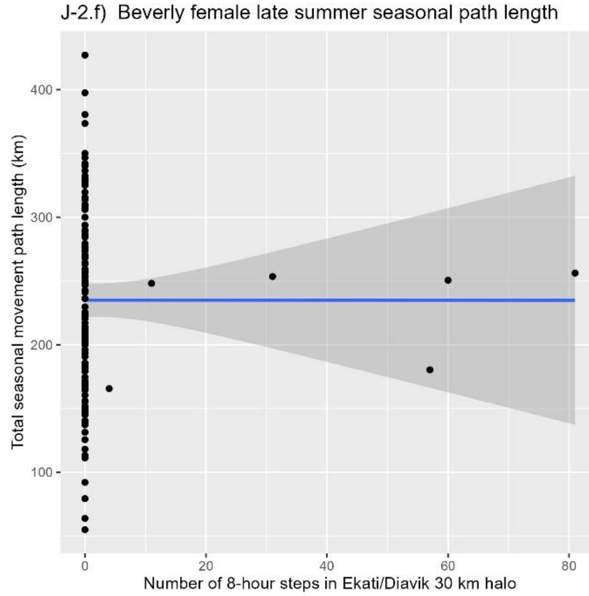
J-2.d) Beverly female post-calving seasonal path length



J-2.e) Beverly female summer seasonal path length



J-2.f) Beverly female late summer seasonal path length



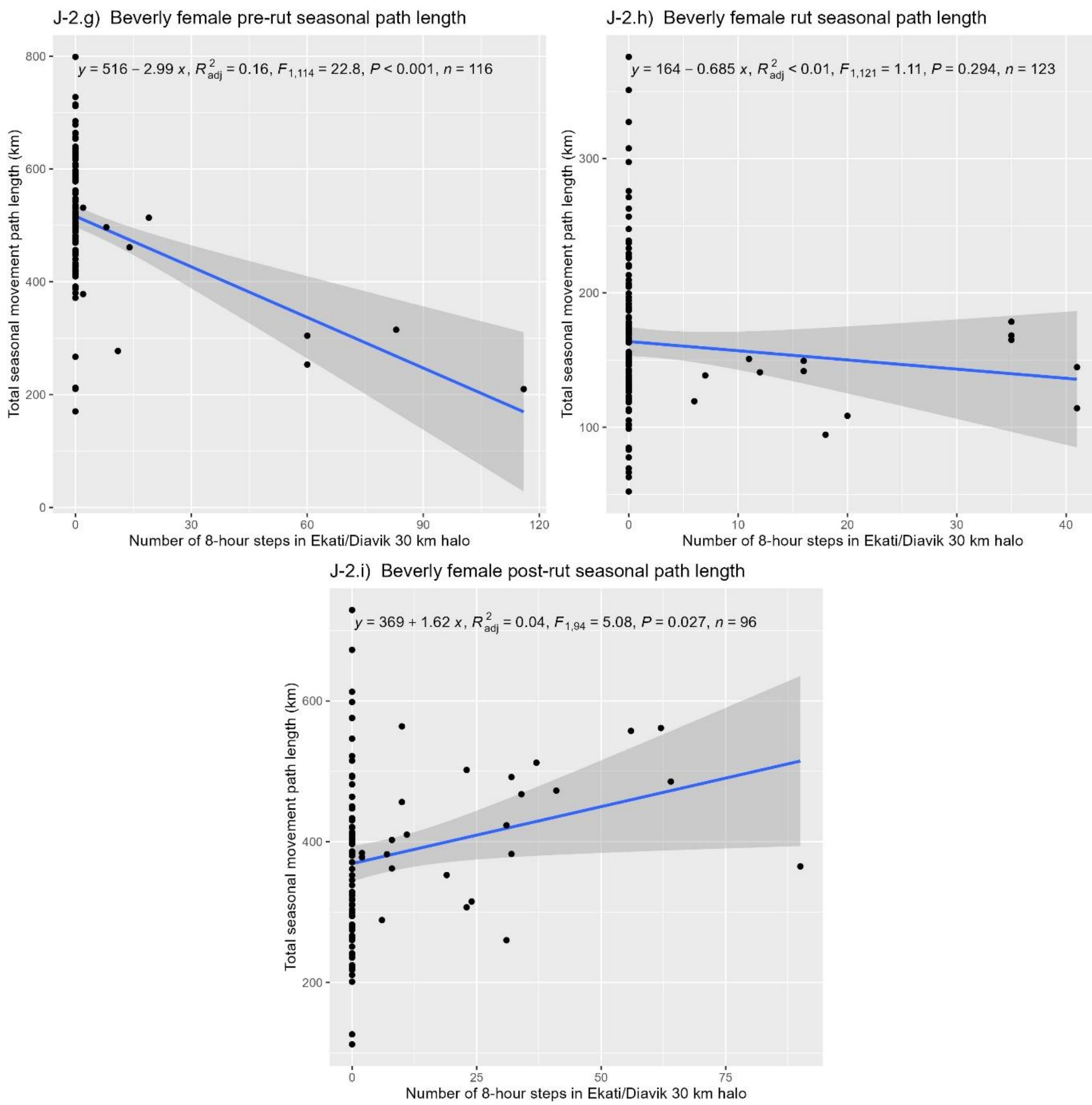
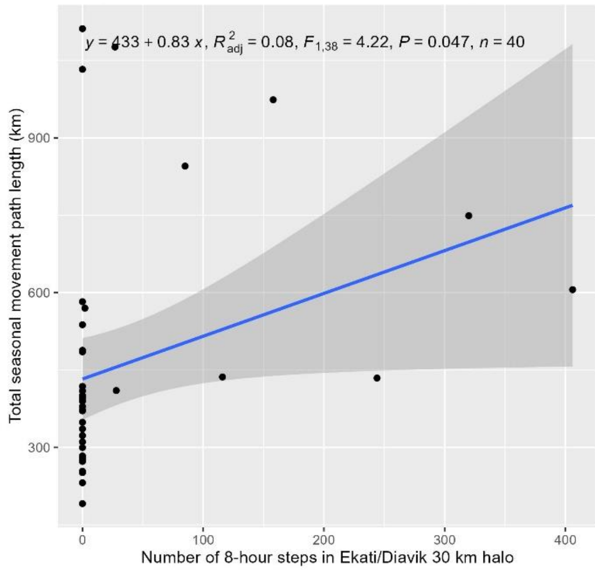
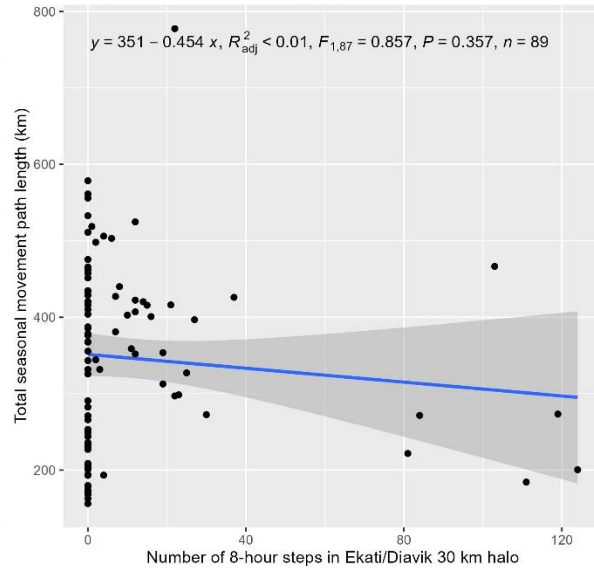


Figure J-2: Relationship of total seasonal 8-hour movement path length of female Beverly herd caribou to their exposure (number of 8-hour movement steps) to the Ekati/Diavik 30 km halo.

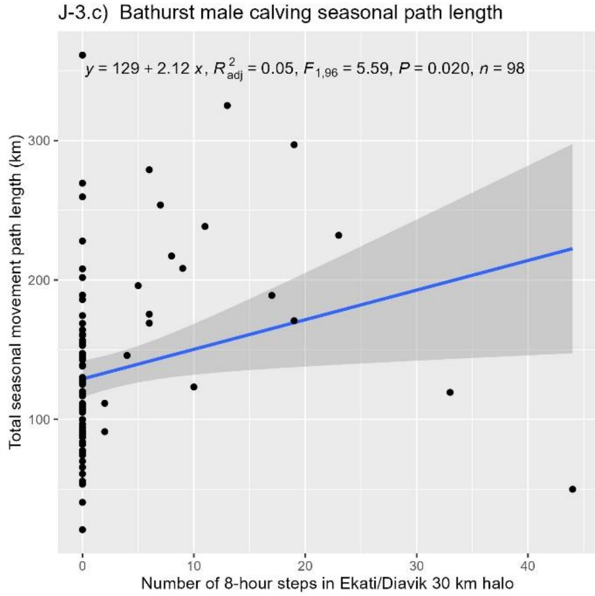
J-3.a) Bathurst male winter seasonal path length



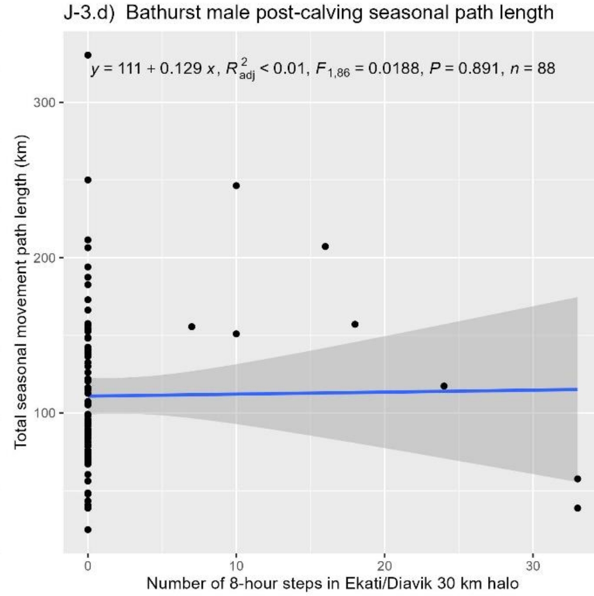
J-3.b) Bathurst male spring migration seasonal path length



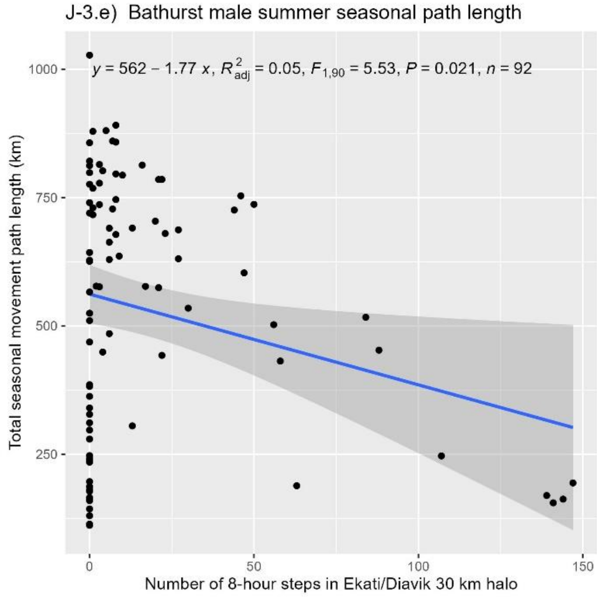
J-3.c) Bathurst male calving seasonal path length



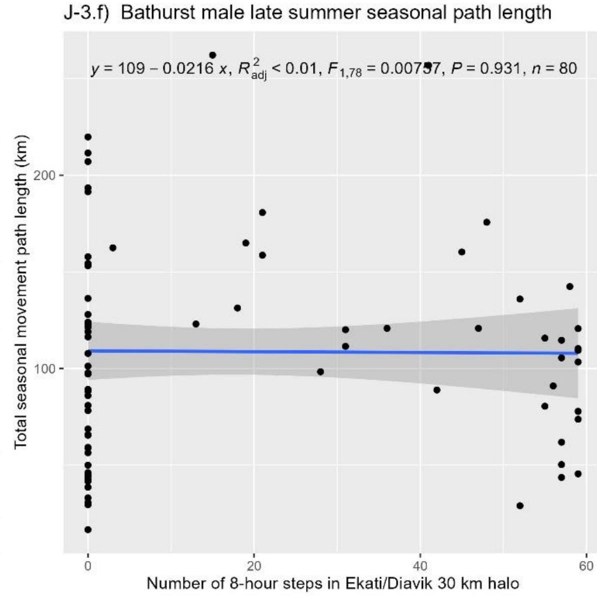
J-3.d) Bathurst male post-calving seasonal path length



J-3.e) Bathurst male summer seasonal path length



J-3.f) Bathurst male late summer seasonal path length



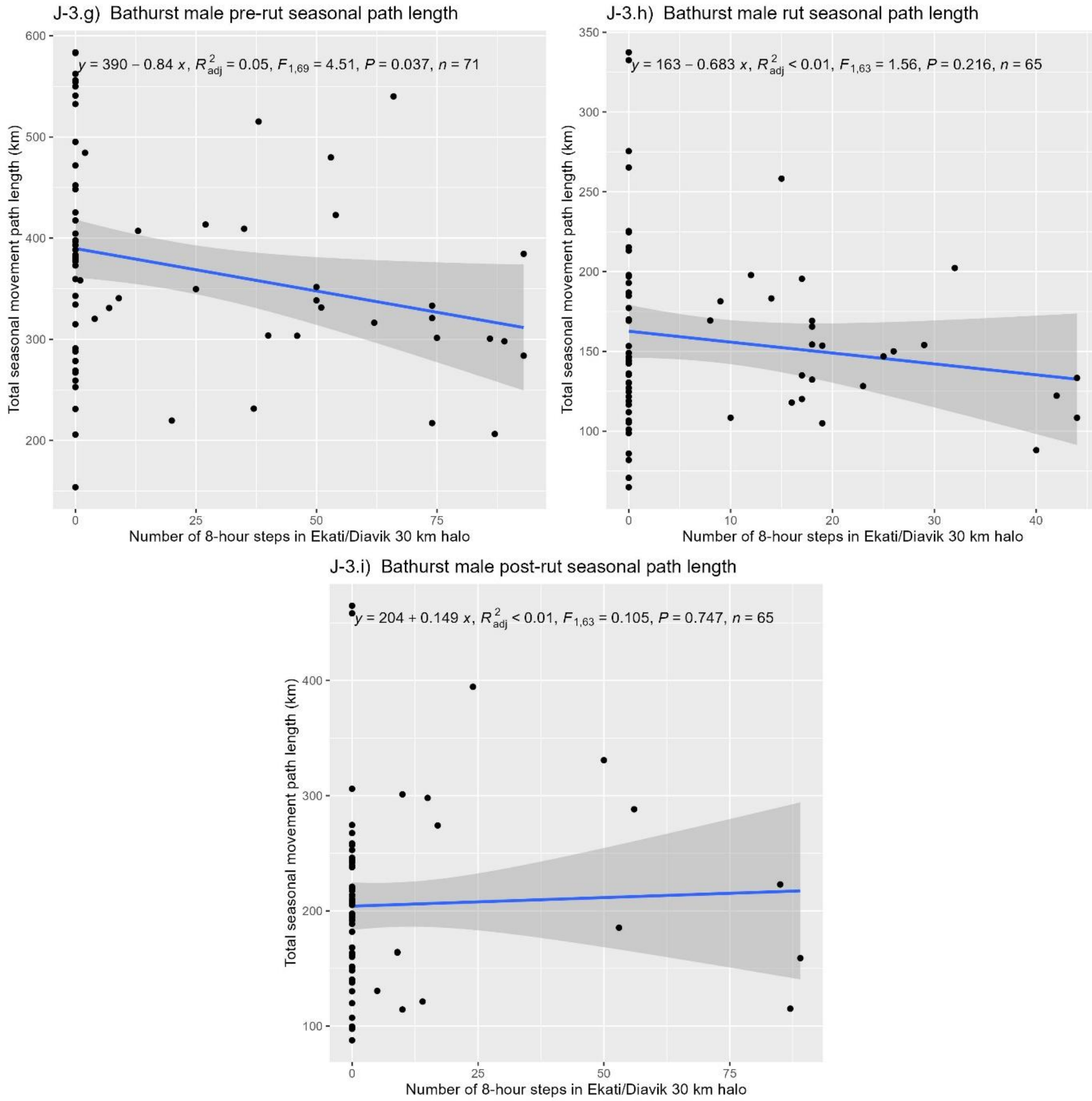
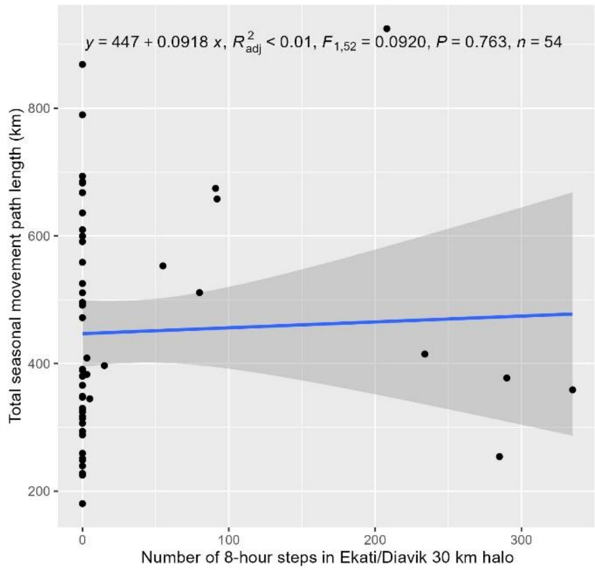
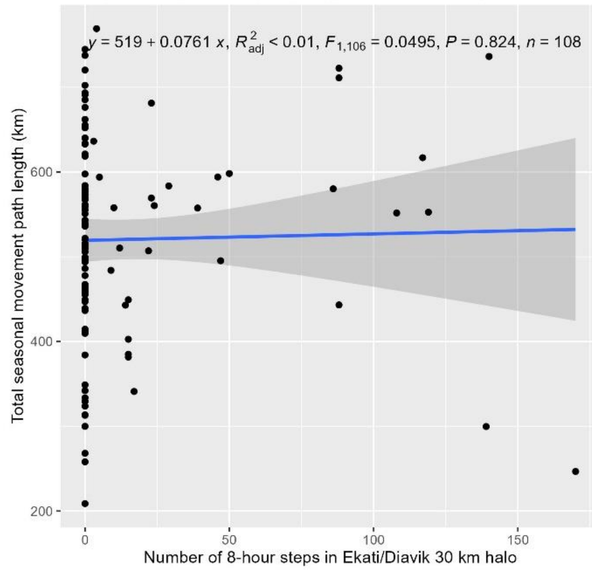


Figure J-3: Relationship of total seasonal 8-hour movement path length of male Bathurst herd caribou to their exposure (number of 8-hour movement steps) to the Ekati/Diavik 30 km halo.

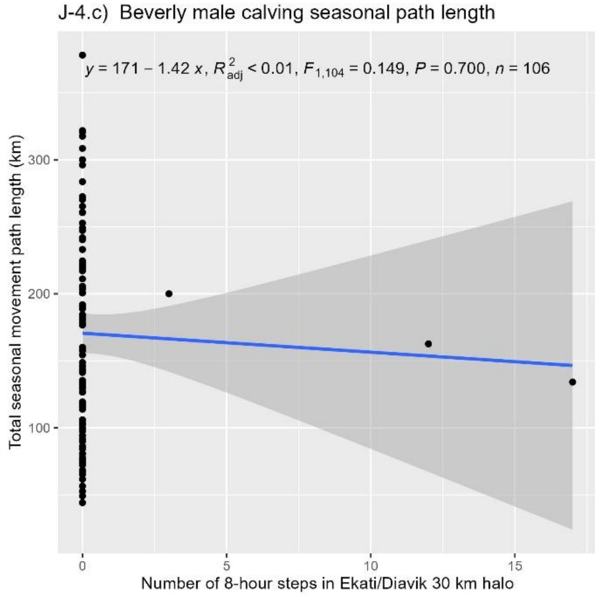
J-4.a) Beverly male winter seasonal path length



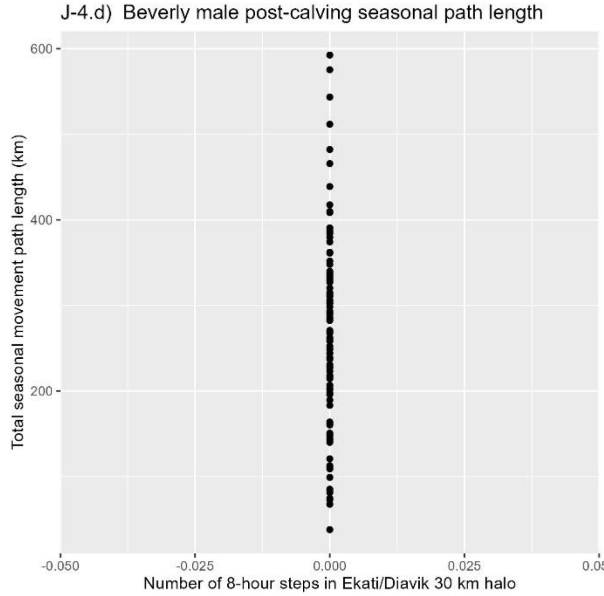
J-4.b) Beverly male spring migration seasonal path length



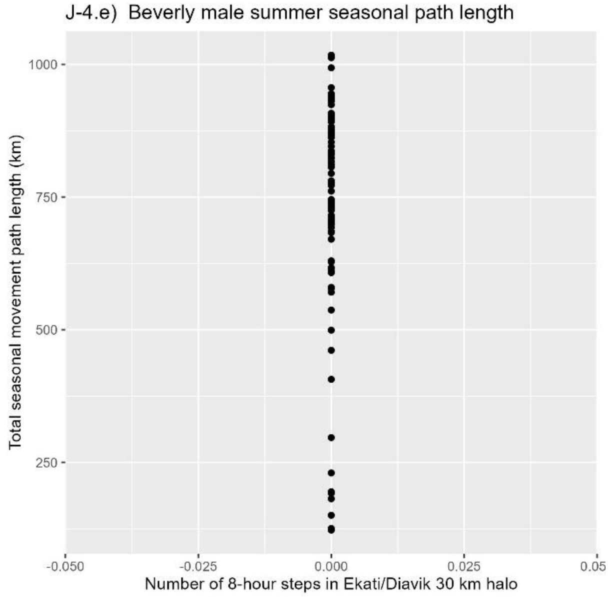
J-4.c) Beverly male calving seasonal path length



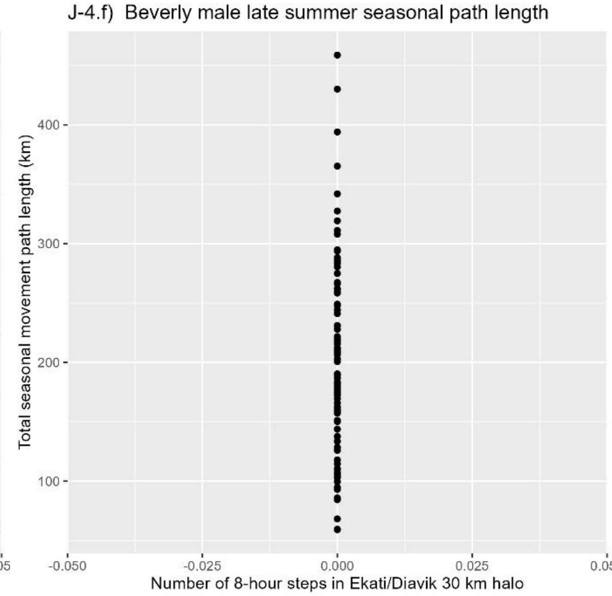
J-4.d) Beverly male post-calving seasonal path length



J-4.e) Beverly male summer seasonal path length



J-4.f) Beverly male late summer seasonal path length



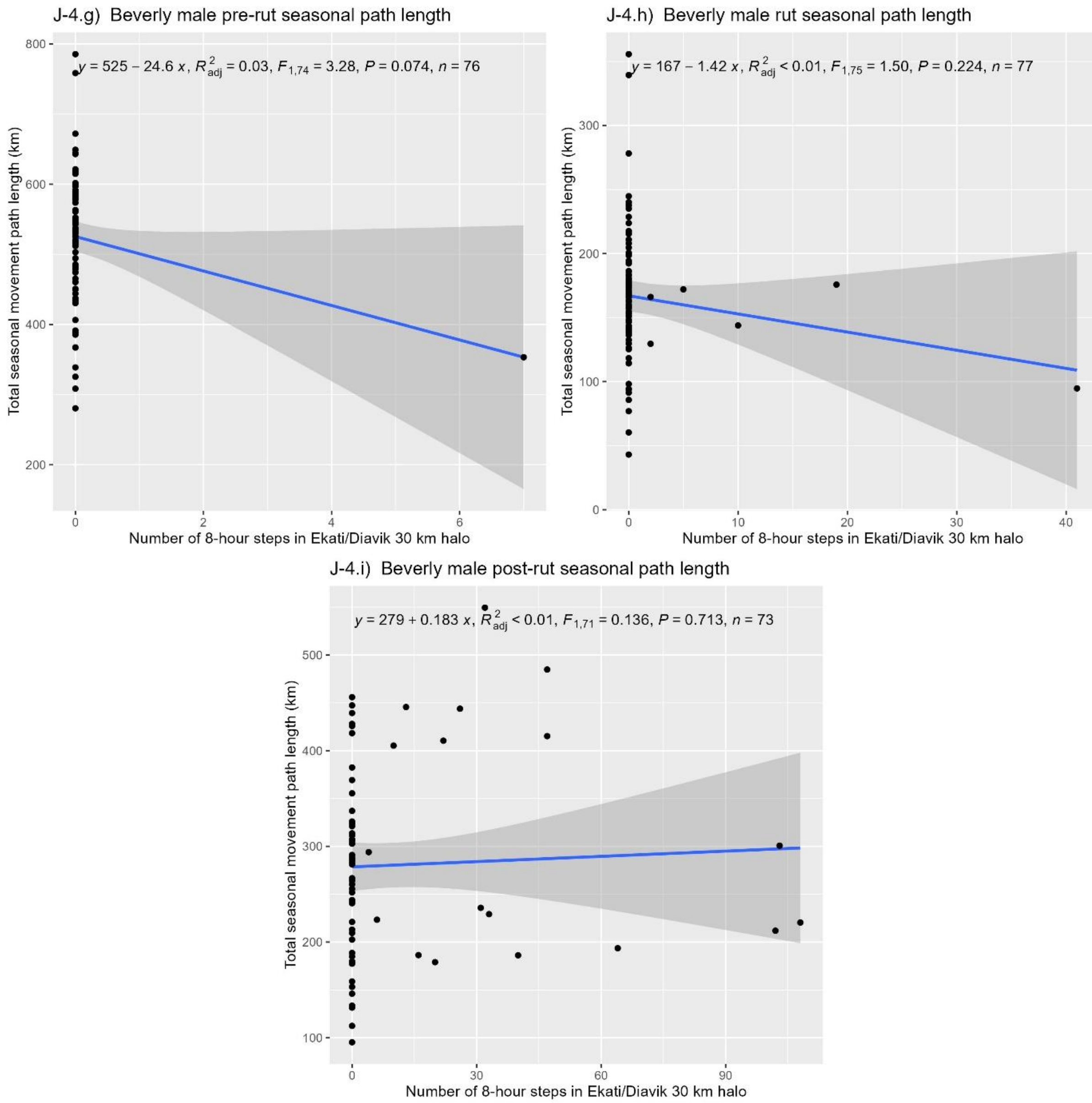


Figure J-4: Relationship of total seasonal 8-hour movement path length of male Beverly herd caribou to their exposure (number of 8-hour movement steps) to the Ekati/Diavik 30 km halo.