



Caribou, grizzly bear, and moose activity along proposed routes to the Ambler Mining District, Alaska

Natural Resource Report NPS/GAAR/NRR—2016/1283



ON THE COVER

Caribou crossing the Kobuk River, September 2010 (top)

Paws of a Brooks Range grizzly bear, June 2015 (left)

Bull moose and frosted shrubs, November 2015 (right)

Photographs by: Kyle Joly

Caribou, grizzly bear, and moose activity along proposed routes to the Ambler Mining District, Alaska

Natural Resource Report NPS/GAAR/NRR—2016/1283

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Abstract

The Alaska National Interest Lands Conservation Act (ANILCA) provides for surface access across Gates of the Arctic National Preserve to mineral reserves in the Ambler Mining District. In 2015, the Alaska Industrial Development and Export Authority applied for a right-of-way to do just that. The filing triggers an environmental analysis which is also mandated by ANILCA. Using existing data, we analyzed the movements of caribou (*Rangifer tarandus*), grizzly bears (*Ursus arctos*), and moose (*Alces alces*) in relation to proposed road routes to the Ambler Mining District. Our analyses reveal that the differences between the routes are minor for the three study species, though the southern route would result in fewer and less severe impacts. Selection of a route hinges upon more than effects to these three species or wildlife in general; however these three species represent critical subsistence resources, sedentary as well as highly nomadic animals, and apex predators. As such, effects to these three species should be an important part of the decision of where to place a road if it is built, determine conditions for road usage, and to serve as baseline data to monitor the impacts of road development and activity.

Acknowledgments

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Introduction

The passage of the Alaska National Interest Lands Conservation (ANILCA), on December 2, 1980, added tens of millions of acres of lands to be managed by the National Park Service (NPS). The verbiage in ANILCA establishing Gates of the Arctic National Park and Preserve was more complex than for any other park unit. This complexity deals exclusively with providing access to the Ambler Mining District, in northwest Alaska. ANILCA states that access, via surface transportation, *shall* be provided through the “Kobuk River” unit of Gates of the Arctic Preserve. While the NPS cannot reject access to the Ambler Mining District, ANILCA does provide broad discretion for the placement of that right-of-way within the preserve. ANILCA also mandates an “environmental and economic analysis” of the “impact upon wildlife, fish, and their habitat” if a right-of-way proposal is submitted and that the selected route should “result in fewer or less severe adverse impacts upon the preserve”.

On November 24, 2015, the Alaska Industrial Development and Export Authority (AIDEA) submitted a proposal to the NPS, and other agencies, for a surface right-of-way to connect the Ambler Mining District to the James Dalton Highway. Two routes were identified in this proposal; both running along the southern edge of the Brooks Range and into the “Kobuk River” unit of Gates of the Arctic National Preserve (Figure 1). The northern route is 340.7 km long and the southern route 356.7 km.

The purpose of this report is to provide information to be utilized by the ANILCA-mandated “environmental and economic analysis”. The report summarizes and analyzes wildlife habitat data that the proposed routes crosses and the data from past and on-going monitoring efforts by the NPS of caribou (*Rangifer tarandus*), grizzly bears (*Ursus arctos*), and moose (*Alces alces*) along the proposed road corridors. We determined the interpolated crossing locations of individuals of all three species in order to quantify animal activity along the proposed corridors. For bears, we also determined the distance from known denning locations to the nearest proposed road. Our analyses provides a baseline understanding of habitat traits and timing of wildlife use of the area, which can inform future decisions on road routing, timing and conditions of use, and general planning if the proposed road proceeds into development. Wildlife is often affected by road development (see review by Forman *et al.* 2003). The collection and analysis of baseline data is critical to assess any effects road development may have on this heretofore roadless area.

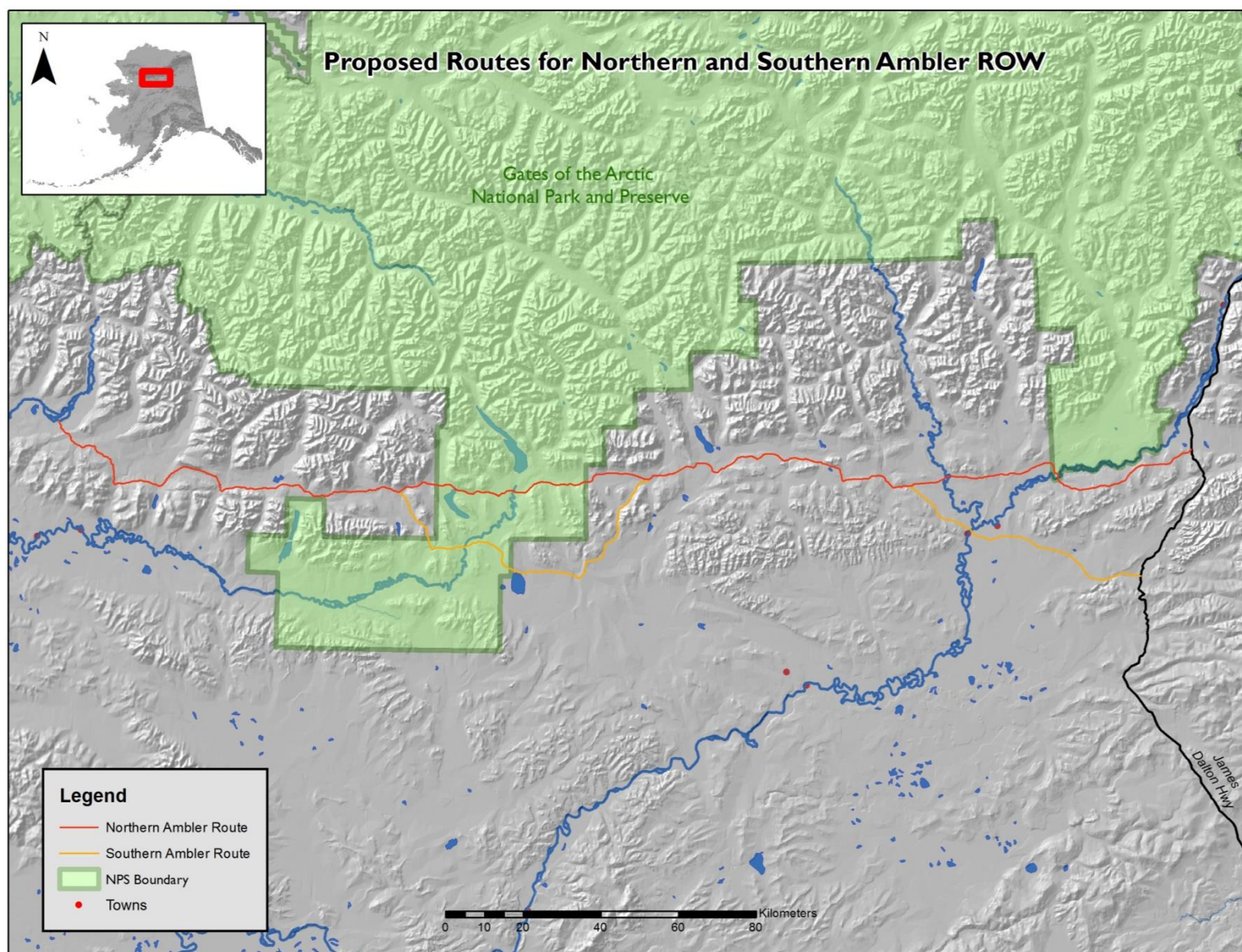


Figure 1. Proposed northern and southern routes of the right-of-way to the Ambler Mining District.

Study Area

The study area ranges from the James Dalton Highway in the east to the village of Ambler in west (Figure 1). The proposed routes run just to the south of the rugged Brooks Range mountains. The northern route passes through Gates of the National Park (only on private lands), then passes primarily through state lands before passing through the “Kobuk River” unit of Gates of the Arctic National Preserve. This route runs adjacent to the wilderness boundary of Gates of the Arctic National Park by Walker Lake (Figure 2). After exiting the preserve, the road continues steadily westward reaching the Ambler River. The southern route tracks the ice road to Bettles which runs along the right-of-way known as the “Hickel Highway”. This route was removed from consideration by AIDEA after access to private lands along this route became an issue. The southern route then converges with the northern route until just east of the “Kobuk River” unit of Gates of the Arctic National Preserve. Here the southern route veers away from the wilderness boundary of Gates of the Arctic National Park by Walker Lake and transverses the preserve in its narrowest point before swinging northward to again converge with the northern route. The routes generally stay on the side slopes of the foothills but do cross many rivers and creeks. Vegetation is dominated by black spruce (*Picea mariana*) but deciduous hardwoods including aspen (*Populus tremuloides*) and birch (*Betula papyrifera*) stands can be found, especially on southern slopes and areas that were burned relatively recently. Tundra, muskeg, riparian and fen habitats are also present in the study area.



Figure 2. Walker Lake and the Brooks Range mountains. The proposed northern route would run in the middle of this photograph from left (west) to right (east). Photo: K. Joly.

Methods

Ambler Routes and Habitat Characteristics

To derive biological and physical attributes of the proposed routes, we obtained habitat characteristics at 250m intervals along both routes (n=1364 for northern route, n = 1428 for southern route) using ArcMap 10.3 (Environmental Systems Research Institute, Redlands, CA). Elevation, aspect, and degree of slope were determined from existing National Elevation Datasets at 60 meter resolution (US Geological Survey (USGS)). We calculated terrain ruggedness using the vector ruggedness measure (VRM; Sappington *et al.* 2007) at two scales: 180 m (3x3 60m pixels) and 1 km (17x17 60m pixels). VRM values range from 0 – 1, indicating a spectrum of less rugged to more rugged terrain respectively. Land cover classifications were derived from the Alaska Land Cover Map (Alaska Natural Heritage Program 2012) and reclassified into nine classifications: bare ground, herbaceous, deciduous forest, spruce, ice/snow, tussock tundra, fire scar, water, and low shrub/lichen. While all satellite-based habitat maps never perfectly represent conditions on the ground, this coverage is the most accurate one available for the study area. Reconnaissance flights over the study were also performed.

Caribou Data

Caribou are considered a Vital Sign species for the NPS Arctic Inventory and Monitoring Network (ARCN) in part because their annual range encompasses Gates of the Arctic National Park and Preserve (Figure 3). Monitoring of the Western Arctic Caribou Herd (WAH) has been conducted by NPS and collaborating agencies since 2009 and detailed methodologies can be found in the ARCN Caribou Vital Sign Protocol (Joly *et al.* 2012). Caribou are outfitted with collars equipped with GPS technology that transmits position data via satellite at 8-hour intervals. Up to the most recent annual report, 95 collars have been deployed and nearly 250,000 GPS locations have been recorded from WAH caribou (Joly and Cameron 2015).

Grizzly Bear Data

As part of a 3-year collaborative study between the NPS, USGS, University of Alaska and other agencies, grizzly bears have been monitored since 2014 within Gates of the Arctic National Park and Preserve (Figure 4). GPS radio collars were deployed on adult bears (both male and female) and were programmed to obtain GPS locations every 1.5 hours from April 15 – Nov 15 and weekly outside of that window. Up to the writing of this report, roughly 51,000 GPS locations have been recorded from 41 individuals however, most locations collected occurred during 2014. Dens for bears during the winter of 2014-2015 were identified by clusters of GPS locations during the periods of entrance and emergence for denning. Field visits of a subset of dens in 2015 were used to confirm accuracy of this method. Only dens either confirmed by field visits or with clear GPS clustering are presented in this report. We identified a zone where the two routes diverged in and around the “Kobuk River” unit of Gates of the Arctic National Preserve. The zone was constrained by the longitude of the locations where the northern and southern route diverged and then rejoined. We calculated distance to the proposed routes in this zone of divergence to bear dens using ArcGIS.

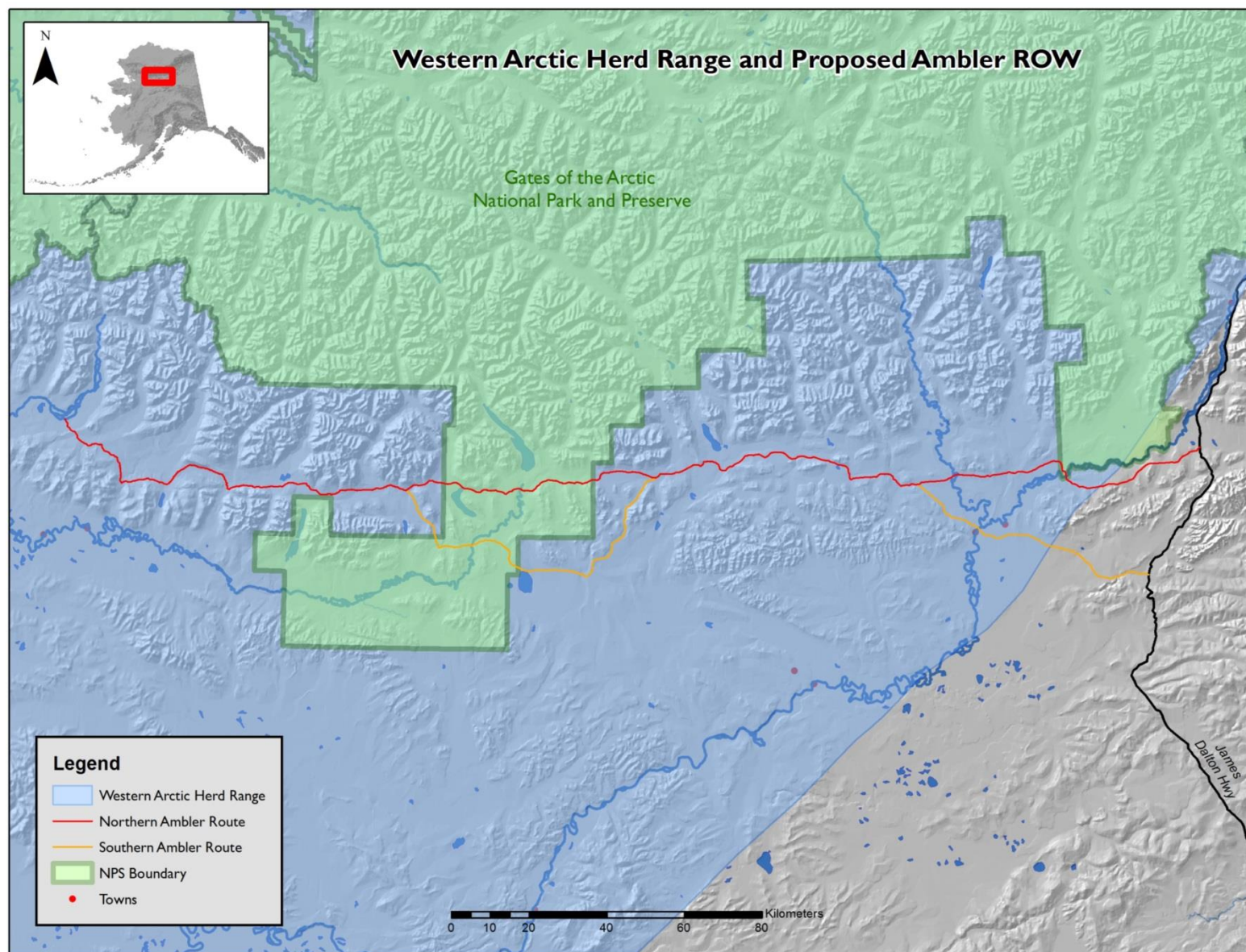


Figure 3. Annual range of the Western Arctic Caribou Herd in relation to the northern and southern proposed Ambler routes, Alaska.

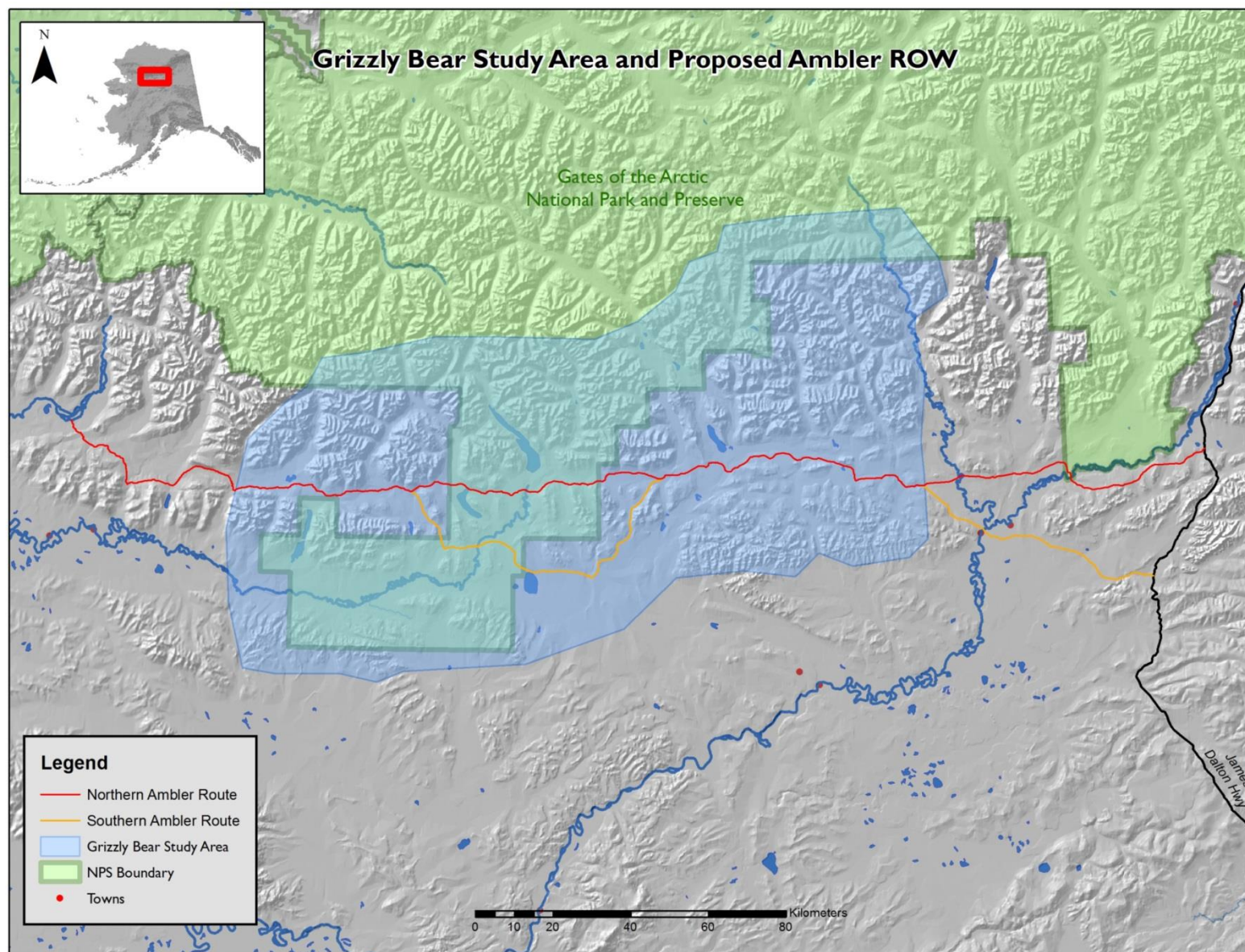


Figure 4. Grizzly bear study area in relation to the northern and southern proposed Ambler routes, Alaska.

Moose Data

Moose monitoring occurred from 2008-2013 in the upper Koyukuk River drainage as a collaborative study with the NPS, US Fish and Wildlife Service, Alaska Department of Fish and Game, and Bureau of Land Management (Figure 5). Moose were equipped with a GPS radio collar which transmitted position data once every 24 hours for collars equipped in March 2008 and at 8-hour intervals for all other deployments (see Joly *et al.* 2015a for further detail). Over the duration of the study, 37 moose were equipped with collars and approximately 74,000 GPS locations collected.

Crossing Analyses

Straight-line vectors were drawn between consecutive location points in ArcGIS for each species. Vectors intersecting the proposed routes were selected as they were the interpolated crossing location with the proposed road. Crossings with a duration greater than 24 hours (greater than 24 hours between the two subsequent GPS locations) were excluded from the analysis. Points were placed at each intersection location of the animal vector and the road route. If the animal vector crossed the road route at an acute angle and in a tortuous road section, it was possible for multiple intersection points to be placed for one vector. The time of the crossing was estimated to be half way between the time of the start location of the vector and the time at its terminus. Physical characteristics such as land cover classification, elevation, degree of slope, aspect, and VRM were extracted for each crossing point from the same physical attribute data sets as described above. Distance to river was calculated for crossing points using an Alaska-wide rivers dataset with 1:1,000,000 resolution (Alaska Department of Natural Resources, Land Records Information Section, 2009).

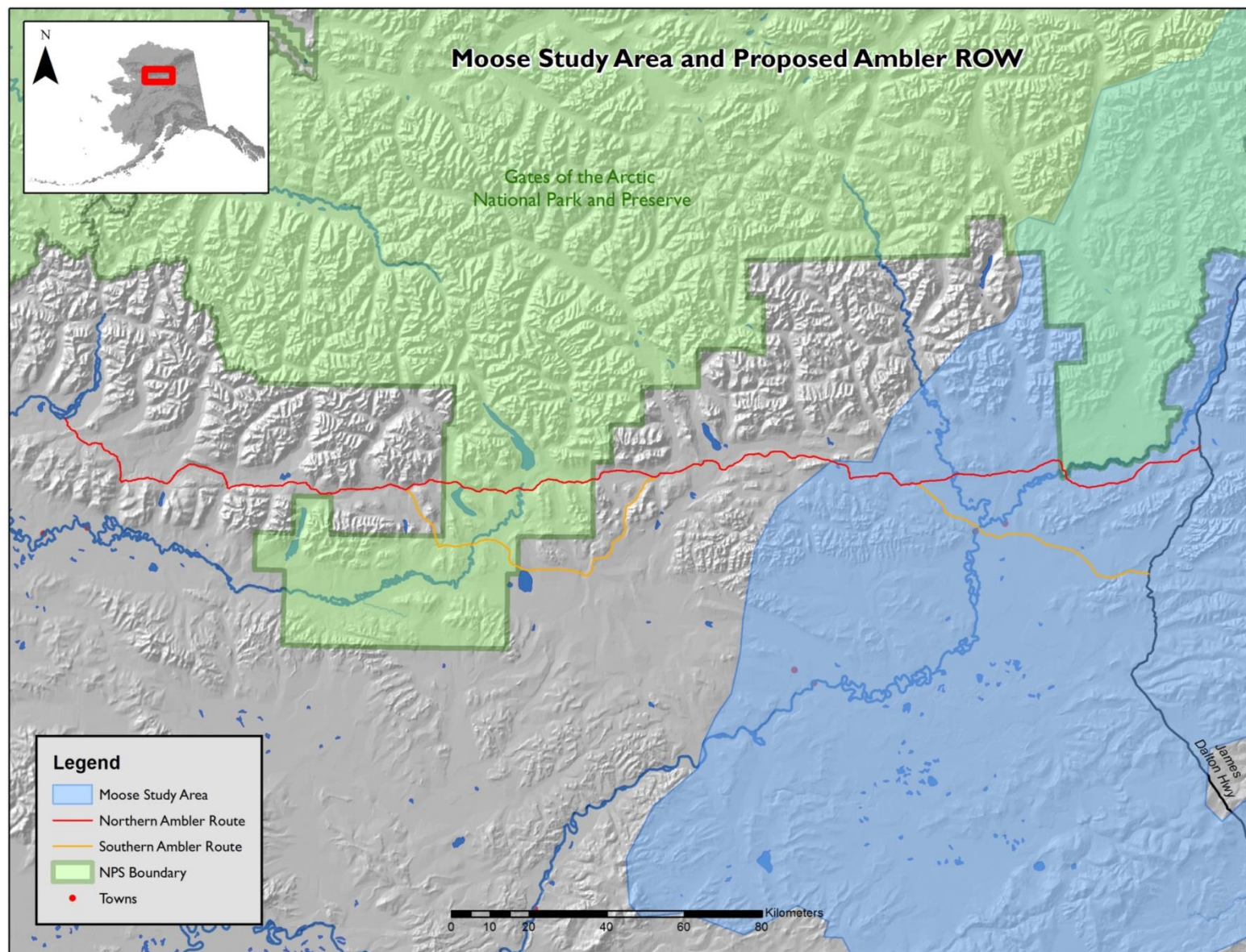


Figure 5. Moose study area in relation to proposed northern and southern Ambler routes, Alaska.

Results

Proposed northern and southern route characteristics

Both routes exhibited similar land cover composition with spruce forest being the dominant vegetation class followed by deciduous forest (Table 1). The percent of spruce forest was slightly higher for the southern route while the percentage of low shrub/lichen habitat was greater for the northern route.



Figure 6. Lichen habitat (yellow areas) found along the northern route. Photo: K. Joly.

Table 1. Percentage of land cover classes measured at 250m intervals along the proposed northern and southern routes.

Land Cover Class	Northern	Southern
Bare ground	0.1	0.4
Herbaceous	0.5	0.3
Deciduous forest	10.2	9.9
Spruce forest	72.9	74.0
Tussock tundra	7.8	7.5
Water	0.1	0.1
Low Shrub/Lichen	8.4	7.9

Both northern and southern routes had similar elevation profiles, with 75% of the northern and 78% of the southern route measured between 176–375 meters above sea level (Figure 7).

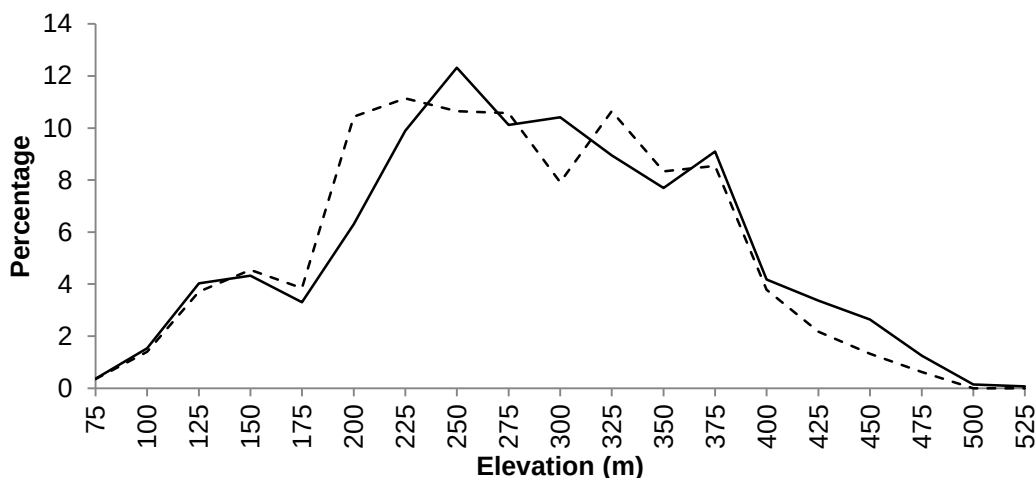


Figure 7. Histogram of elevation (m) percentage based on points in 250m intervals along the proposed northern (solid line) and southern (dashed) routes.

Slopes from 0 – 10° composed 94% of the northern route and 97% of the southern route, with slopes equal to or less than 5° comprising 75% of the northern route and 80° of the southern route (Figure 8).

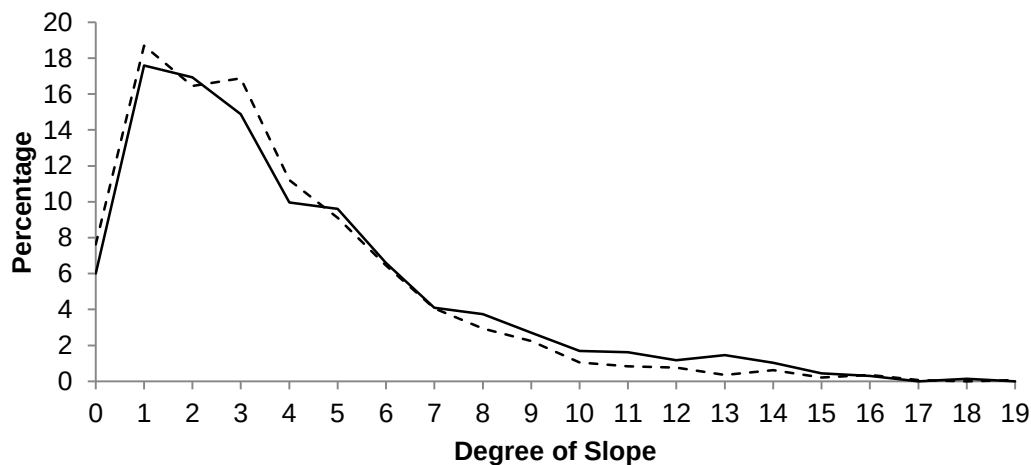


Figure 8. Histogram of slope (degrees) measured at 250m intervals along the proposed northern Ambler route (solid line) and southern route (dashed).

For both routes, northern aspects (311 - 40°) and southern aspects (141 - 220 °) were the most common, each making up 30% of the points on the northern route and 26% on the southern route (Figure 9). For the southern route, west aspects (221 - 310°) comprised 25% of the points, in contrast to 21% on the northern route.

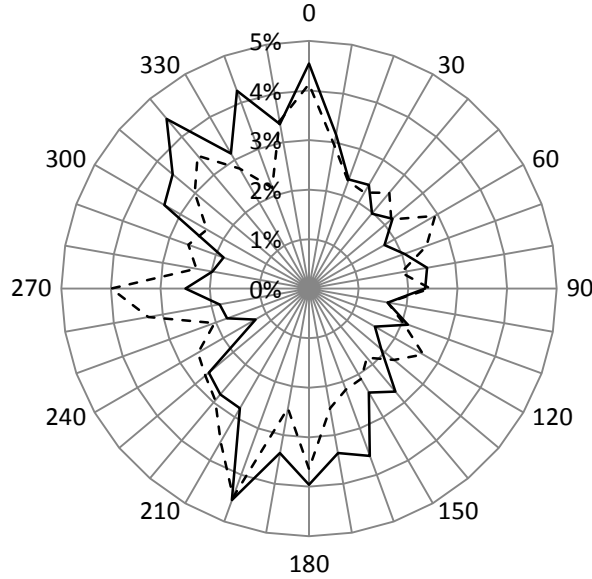


Figure 9. Histogram of aspect in 10° bins for percentage of points placed in 250m interval along the proposed northern (solid line) and southern (dashed) routes. Points identified as flat were 2.1% (northern) and 2.9% (southern).

Both routes exhibited similar average terrain ruggedness at both scales; however the southern route had more variability at both scales than the northern route (Table 2).

Table 2. Average vector ruggedness measures (VRM) at 180m and 1 km scale with standard deviations, measured at 250m intervals, for proposed northern and southern routes.

Distance	Northern Route	Southern Route
180m	0.002232 ± 0.003809	0.002304 ± 0.004556
1km	0.016633 ± 0.016097	0.017416 ± 0.018921

Caribou

From 2010 to 2015, 21 individual caribou crossed the proposed northern route for a total of 131 crossing events, compared with 19 individuals on the southern route for a total of 106 crossing events (Table 3, Figure 10, Figure 11). For both routes, only 1 crossing event was greater than 24 hours and was removed from the analysis. From the remaining vectors, 153 points were drawn at intersection locations with the northern route and 125 points were drawn at intersection locations with the southern route.

Table 3. Counts of caribou vectors crossing proposed routes.

Route	Number of Crossings	Number of Crossings under 24 hours	Number of Intersection Points
Northern Route	131	130	153
Southern Route	106	105	125

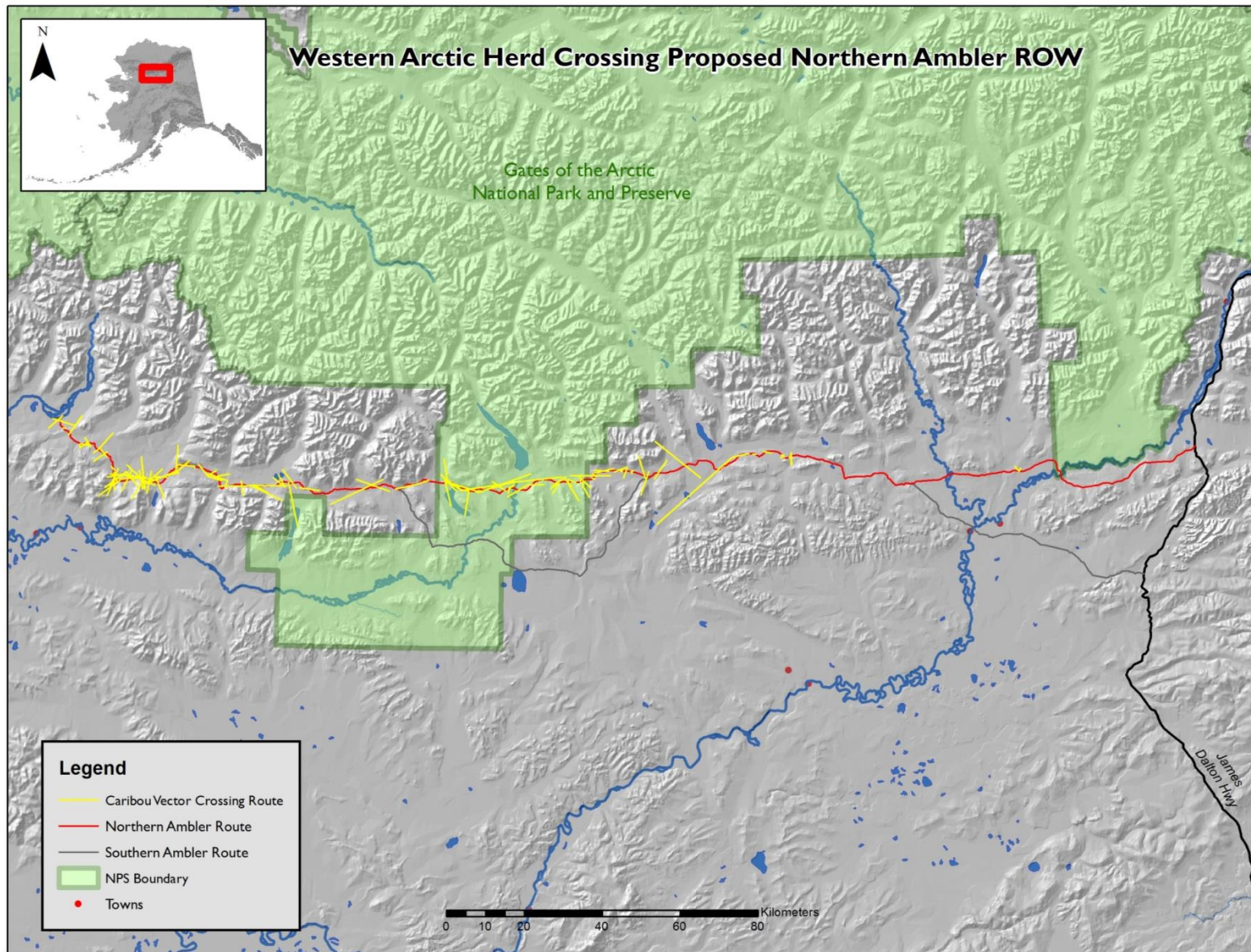


Figure 10. Vectors of Western Arctic Herd caribou crossing the proposing northern route to the Ambler Mining District, Alaska, 2010-2015.

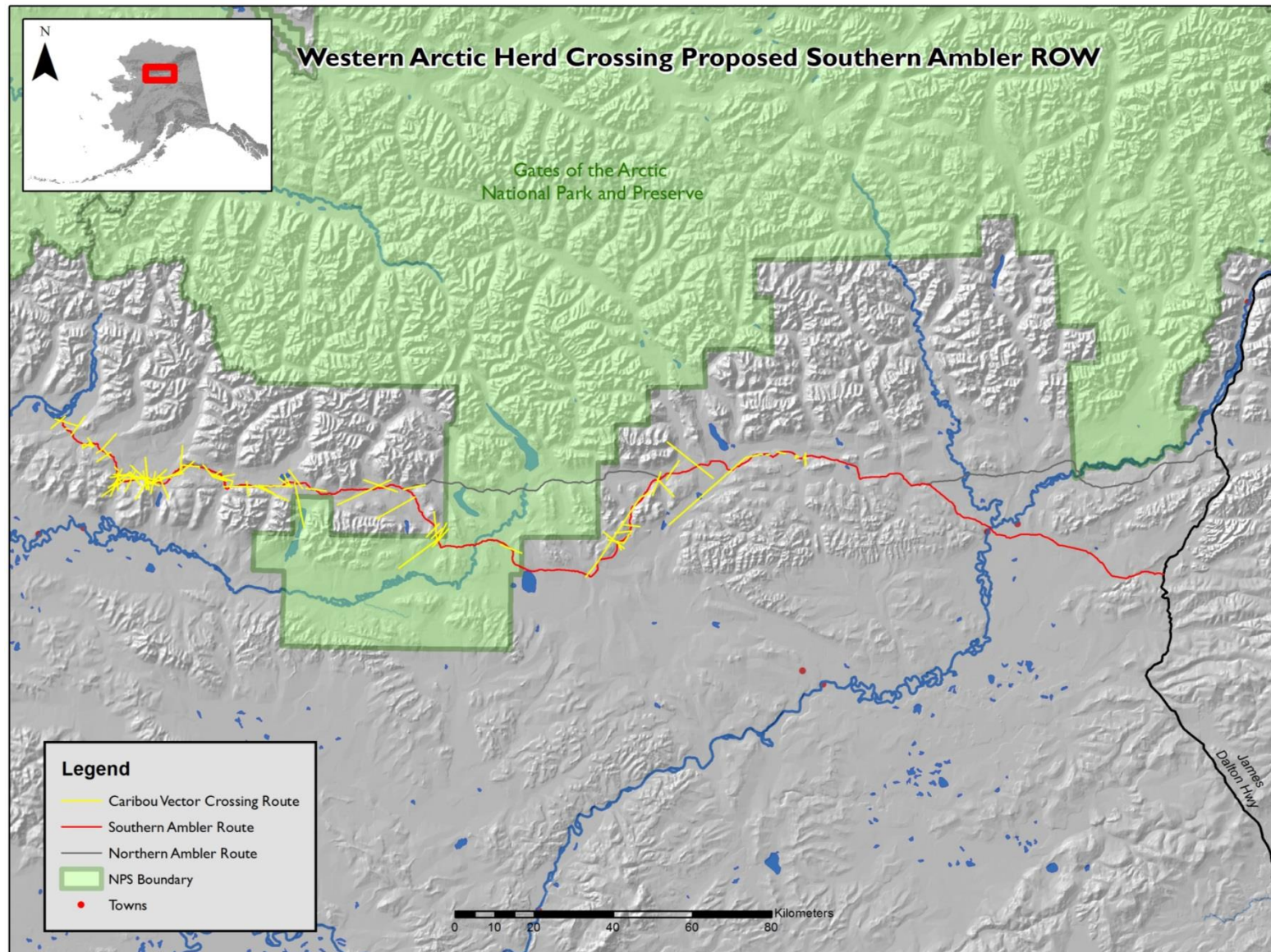


Figure 11. Vectors of Western Arctic Herd caribou crossing the proposing southern route to the Ambler Mining District, Alaska, 2010-2015.

Temporally, 2010 and 2011 were the years of highest activity along both routes. In 2010, 59 crossings occurred on the northern route and 61 on the southern route (Table 4). In 2011, there were 55 crossings on the northern route and 30 on the southern route. The majority of activity on both routes was recorded from October through January. The inclusion of the eastern portion of the southern route, which AIDEA abandoned in their November 2015 right-of-way application, had negligible impacts on this portion of the analysis.

Table 4. Counts of caribou crossings by year and month for the proposed northern and southern routes to the Ambler Mining District.

Year	Month	<i>Northern Route</i>	<i>Southern Route</i>
2010	Aug	2	2
	Oct	20	25
	Nov	15	19
	Dec	22	15
2011	Jan	21	5
	Feb	2	-
	May	3	2
	Oct	8	8
	Nov	3	4
	Dec	18	11
2012	Jan	4	4
	May	2	2
2013	Dec	2	-
2014	Sep	5	5
	Oct	2	2
2015	Oct	1	1

The plurality of estimated caribou crossing activity occurred during midday, but along both routes caribou were active during late night and early morning (Table 5).

Table 5. Proportion of caribou crossings that occurred at three times (Alaska Time Zone) along the proposed northern and southern routes. Times were adjusted for daylight savings time and two crossings were not included due to asynchronous fixes.

Time	Northern Route	Southern Route
4:00	27	24
12:00	40	42
20:00	34	34

The composition of land cover classification for caribou crossings was similar along both proposed routes, with spruce forest the dominant land cover type (Table 6).

Table 6. Percentage of land cover classes identified at caribou crossing locations along the proposed northern and southern Ambler routes.

Land Cover Class	Northern Route	Southern Route
Deciduous Forest	12	12
Spruce Forest	65	64
Tussock Tundra	13	13
Low Shrub/Lichen	10	11

A high number of caribou crossings occurred in the 101-125m elevation range (Figure 12). Seventy percent of the crossings on the northern route and 64% on the southern route occurred from 176–375 meters.

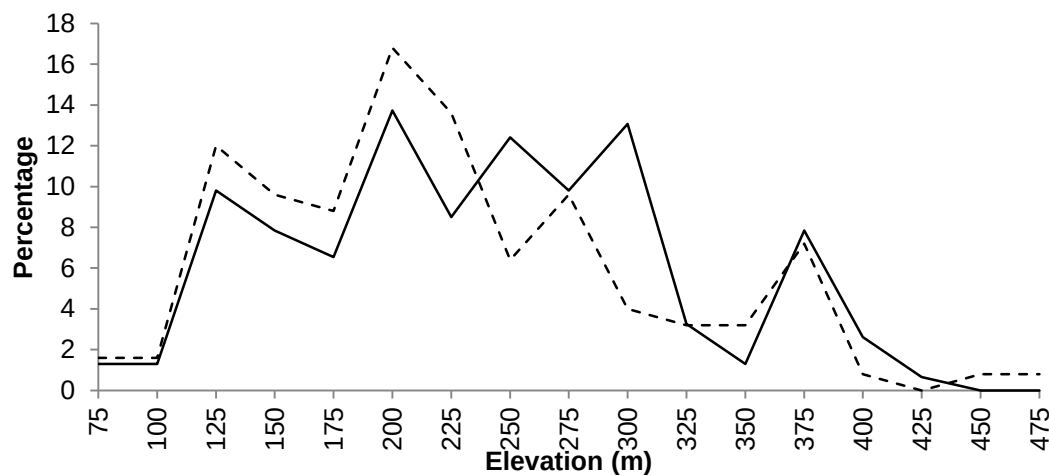


Figure 12. Histogram of elevation in meters, binned in 25m increments, for percentage of caribou crossing locations on the proposed northern (solid black) and southern (dashed) routes.

Slope profiles of crossing locations were similar along both routes (Figure 13). Slopes from 0-10° composed 92% of the northern route and 94% of the southern route crossings. Slopes from 0-5° comprised 79% of the northern and 78% of the southern route caribou crossings.

Northern aspects (311-40°) were the dominant aspect for both the northern route (44%) and the southern route crossings (46%, Figure 14).

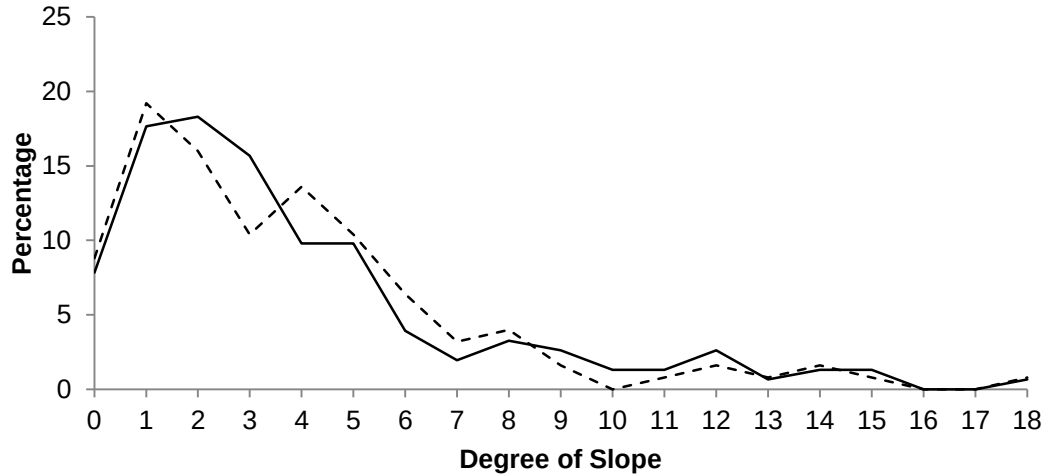


Figure 13. Histogram of degree of slope for percentage of caribou crossing locations on the proposed northern (solid line) and southern routes (dashed).

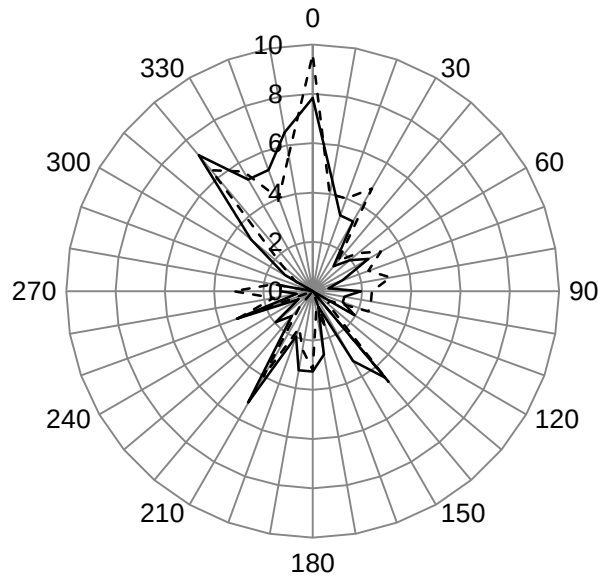


Figure 14. Histogram of aspect for percentage of caribou crossing locations along the proposed northern Ambler route (solid black) and the southern route (dashed). Aspect measurements were binned by 10 degree increments and percent ranges from 0 – 10 along the radius of the compass rose. Three percent of crossings on both routes were designated flat and not included.

At a fine scale (180m), the caribou crossings on the northern route were on average less rugged than crossings on the southern routes (Table 7). At a broader scale (1km), the average crossing location of the southern route was more rugged and had more variation than the northern route.

Table 7. Average vector ruggedness measures (VRM) for caribou crossings on both northern and southern routes at the 180m and 1km scales with standard deviations.

VRM Scale	Northern Route	Southern Route
180m	0.001983 ± 0.002658	0.002155 ± 0.002959
1km	0.018151 ± 0.017062	0.022269 ± 0.022725

The majority of caribou crossings along both routes occurred within 500m of a stream (Table 8).

Table 8. Percentage of distance to nearest stream for caribou crossing proposed northern and southern routes.

Distance to stream (m)	Northern Route	Southern Route
≤ 500	23	30
501-1000	16	12
1001-1500	16	17
1501-2000	12	14
2001-2500	8	6
2501-3000	9	11
3001-3500	7	7
3501-4000	6	1
≥ 4000	4	2

Bears

From 2014 through 2015, 17 bears crossed the proposed northern route for a total of 209 crossing events, compared with 16 bears on the southern route for a total of 192 crossing events (Table 9, Figure 15, Figure 16). Thirty-two and 27 crossings along the northern and southern route, respectively, were removed from the analysis because they had durations greater than 24 hours. No single bear vector crossed either route more than once and subsequently 177 intersection points were used for the northern route and 165 for the southern.

Table 9. Counts of grizzly bears crossing the proposed northern and southern routes.

Route	Number of Crossings	Number of Crossings under 24 hours	Number of Intersection Points
Northern Route	209	177	177
Southern Route	192	165	165

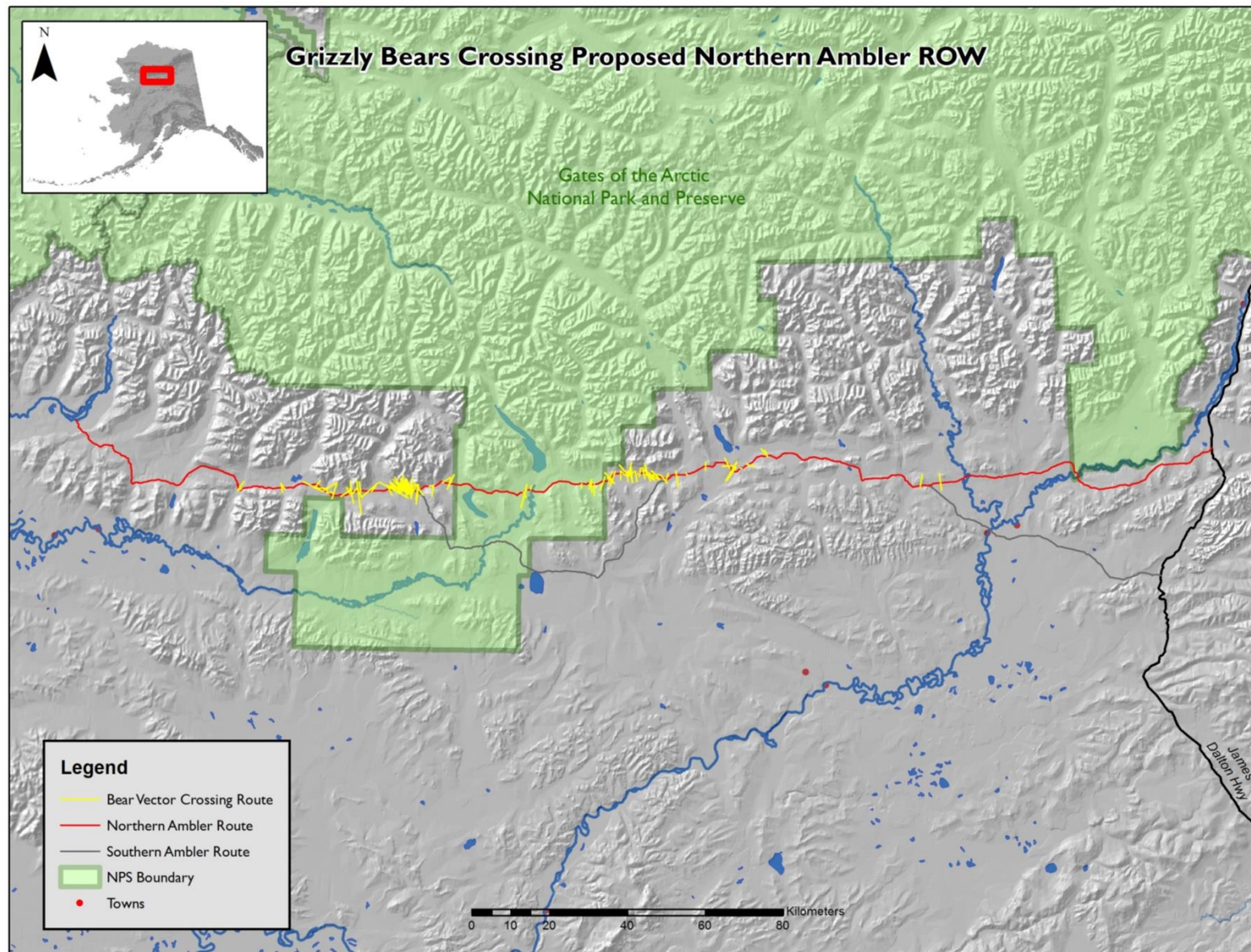


Figure 15. Grizzly bear vectors crossing proposed northern route from 2014-2015.

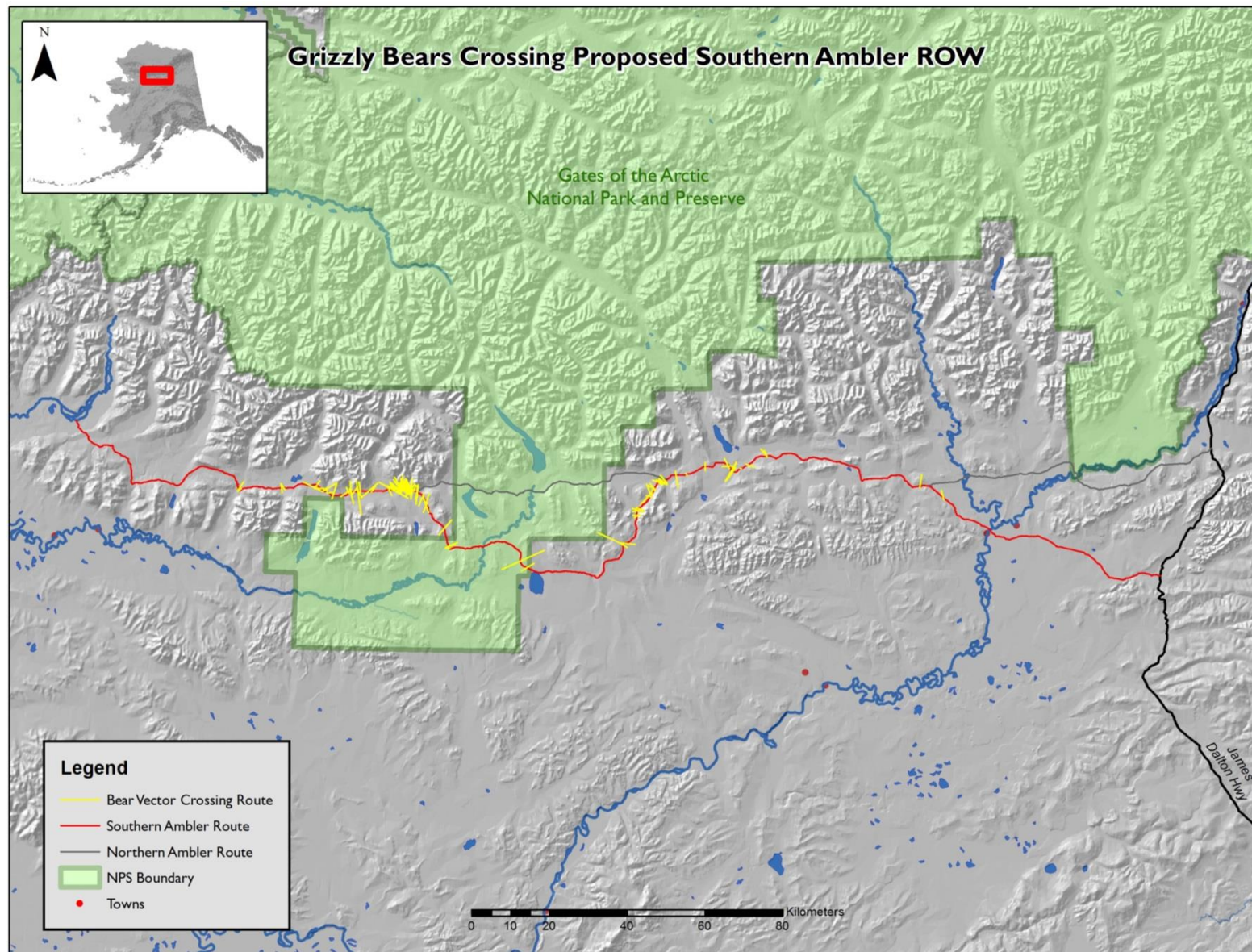


Figure 16. Grizzly bear vectors crossing proposed southern route from 2014-2015.

The majority of bear activity was in 2014 for both proposed routes (Table 10), when 141 and 136 crossings were recorded for the northern and southern route, respectively. For both routes, these crossings were comprised mostly by one individual crossing the route numerous times (52% northern; 55% southern). Crossing by bears were not evenly distributed across time, and crossings peaked in August along both routes (Table 10). The inclusion of the eastern portion of the southern route, which AIDEA abandoned in their November 2015 right-of-way application, had negligible impacts on this portion of the analysis.

Table 10. Counts of grizzly bear crossings by month and year for proposed northern and southern routes.

Year	Month	Northern Route	Southern Route
2014	May	15	13
	Jun	13	11
	Jul	20	20
	Aug	54	50
	Sep	27	29
	Oct	12	13

For the northern route, the earliest crossing in 2014 was May 4 and the latest crossing was October 24. For the southern route, the earliest crossing in 2014 was May 8 and the latest crossing was October 24. Estimated crossing time along both routes was distributed throughout the day, with the hours from 09:01 – 12:00 having the most activity and 03:01 - 06:00 the least activity (Table 11).

Table 11. Time of day for grizzly bears crossing the proposed northern and southern routes. Data presented as percentage of crossings for each route.

Time range	Northern	Southern
00:01 – 03:00	14	15
03:01 – 06:00	5	5
06:01 – 09:00	10	8
09:01 – 12:00	18	19
12:01 – 15:00	16	17
15:01 – 18:00	11	13
18:01 – 21:00	17	14
21:01 – 00:00	10	8

The composition of land cover types for bear crossings along both routes reflected the route characteristics, with spruce forest being the dominant type (Table 12). Bear crossings along the northern and southern route occurred in similar percentages of land cover types.

Table 12. Percentage of land cover classes identified at grizzly bear crossing locations along the proposed northern and southern routes.

Land Cover Class	Northern Route	Southern Route
Deciduous Forest	14	16
Spruce Forest	72	72
Tussock Tundra	3	3
Water	3	2
Low Shrub/Lichen	8	7

Sixty percent of crossings on the northern route and 62% of crossings on the southern occurred from 201 - 275m (Figure 17). Ninety percent of crossings on the northern route and 87% of crossings on the southern were between 176–375 m.

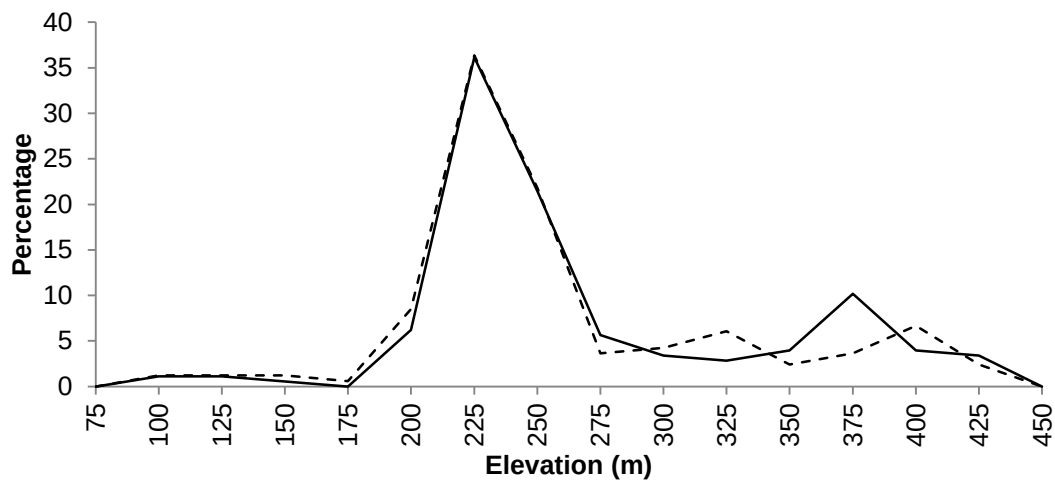


Figure 17. Histogram of elevation, binned in 25m increments, for percentage of grizzly bear crossing locations on the proposed northern (solid black) and southern routes (dashed).

Bear crossings along both routes exhibited a wide range of slopes (Figure 18). Slopes from 0-10° composed 96% of crossings on the northern and 97% on the southern route. Slopes from 0-5° comprised 62% of crossings on the northern and 56% of crossings on the southern route.

Southern aspects (131-220°) were the dominant aspect for bear crossings on both the northern (64%) and the southern route (59%, Figure 19).

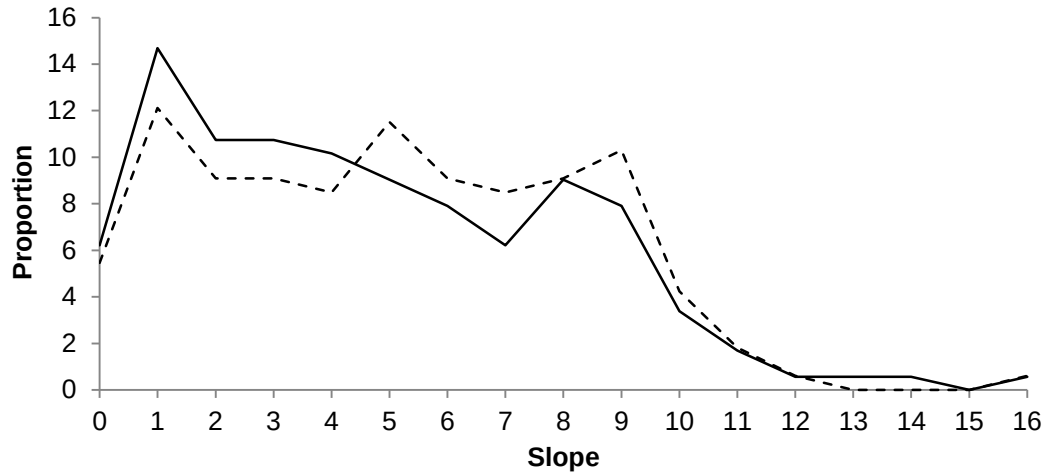


Figure 18. Histogram of slope (degrees) at grizzly bear crossings of proposed northern Ambler route (solid black) and southern Ambler route (dashed).

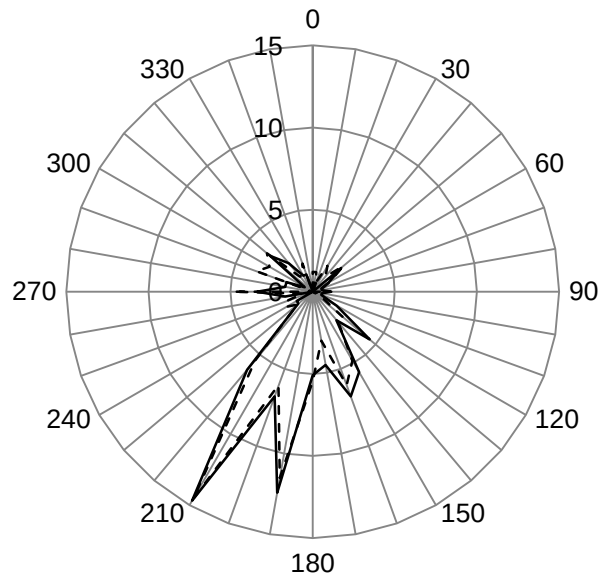


Figure 19. Histogram of aspect for percentage of moose crossing locations along the proposed northern Ambler route (solid black) and the southern route (dashed). Aspect measurements were binned by 10 degree increments and percent ranges from 0 – 10 along the radius of the compass rose. Three percent of northern crossings and two percent of southern crossings were designated flat and not included.

At a fine scale (180m), bear crossings on the southern route had higher average terrain ruggedness values than crossings on the northern route (Table 13). At the broader scale (1km), crossing locations on the northern route were more rugged than crossings on the southern route.

Table 13. Average vector ruggedness measures (VRM) for grizzly bear crossings on both northern and southern routes at 180m and 1km scales with standard deviations.

VRM Scale	Northern Route	Southern Route
180m	0.002274 ± 0.002853	0.003267 ± 0.005772
1km	0.014288 ± 0.011384	0.0017381 ± 0.012246

Grizzly bear crossings occurred in areas closer to streams for both routes. More than a third of crossings occurred within 500m of rivers along either route (Table 14).

Table 14. Proportion of grizzly bear crossings in relation to distance to nearest stream (m) along the proposed northern and southern Ambler routes.

Distance to stream (m)	Northern	Southern
≤ 500	35	36
501-1000	29	31
1001-1500	16	10
1501-2000	6	3
2001-2500	1	4
2501-3000	1	3
3001-3500	2	2
3501-4000	4	5
≥ 4000	6	6

Twenty grizzly bear dens were identified for the 2014-2015 denning period (Figure 20). Nineteen dens were located north of the northern route and one to the south. All 20 dens were north of the southern route. Five dens were located within the zone where the two routes diverge in the vicinity of the “Kobuk River” unit of Gates of the Arctic National Preserve. The average distance of those 5 dens to the northern route was 15.0 ± 4.1 km compared with 20.4 ± 9.3 km to the southern route.

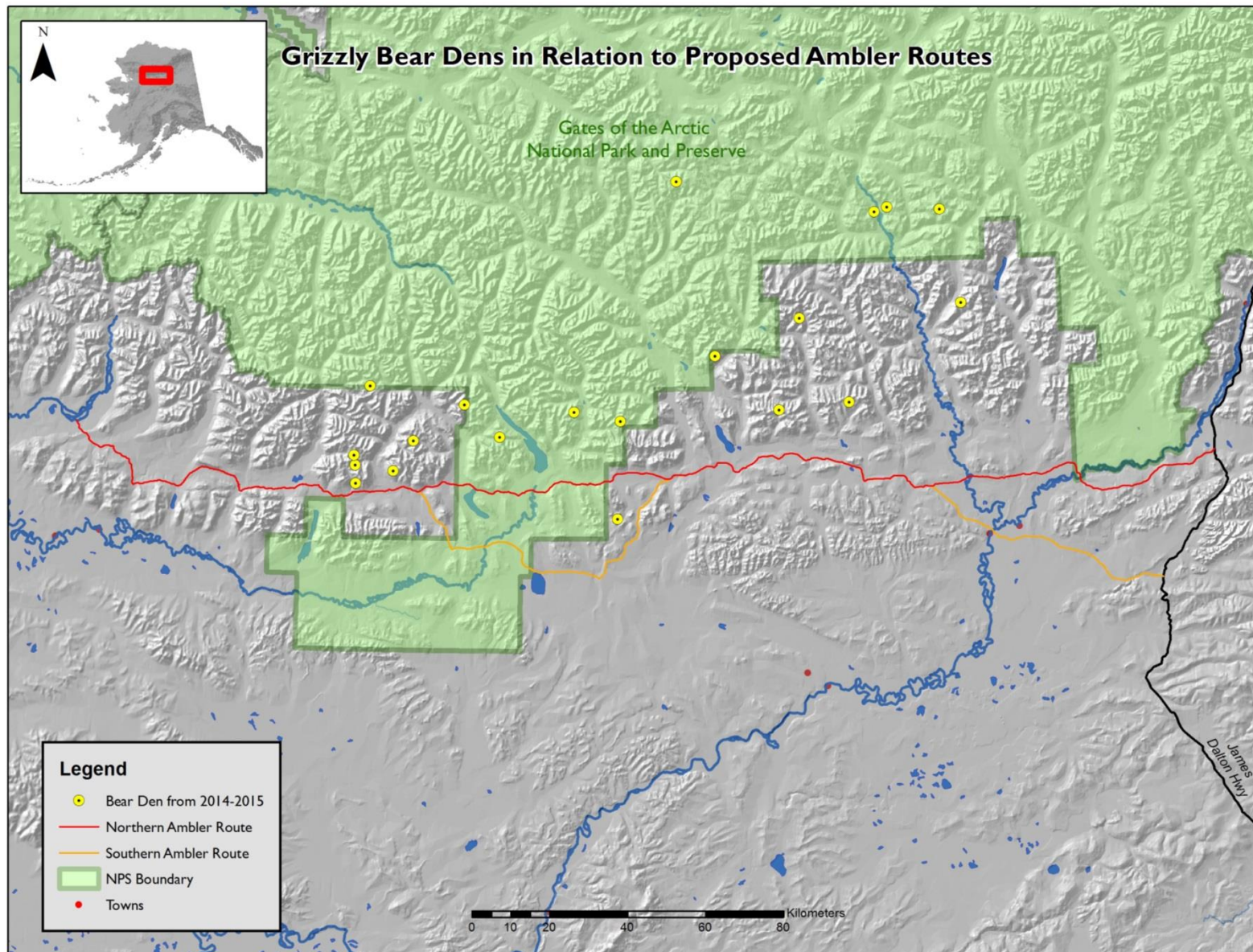


Figure 20. Grizzly bear dens in relation to proposed northern and southern routes.

Moose

From 2008-2013, 6 individual moose crossed the proposed northern route for a total of 156 crossing events, compared to 2 individuals that crossed the southern route for a total 29 crossing events (Table 15, Figure 21, Figure 22). Nine crossing events on the northern route and 12 events on the southern were longer than 24 hours in duration and not considered in the analysis. From the remaining vectors, 148 points were drawn at intersection locations with the northern route and 29 with the southern route.

Table 15. Counts of moose velocities crossing the proposed northern and southern routes.

Route	Number of Crossings	Number of Crossings under 24 hours	Number of Intersection Points
Northern Route	156	147	148
Southern Route	41	29	29

The majority of crossing activity along both routes occurred in 2011 and 2012 (Table 16). Most activity occurred during the fall season, and September was the month with the highest activity along both routes. The inclusion of the eastern portion of the southern route, which AIDEA abandoned in their November 2015 right-of-way application, constituted all of the differences between routes for this portion of the analysis. Moose data was not available for where the northern and southern routes diverge in and around the “Kobuk River” unit of Gates of the Arctic National Preserve.

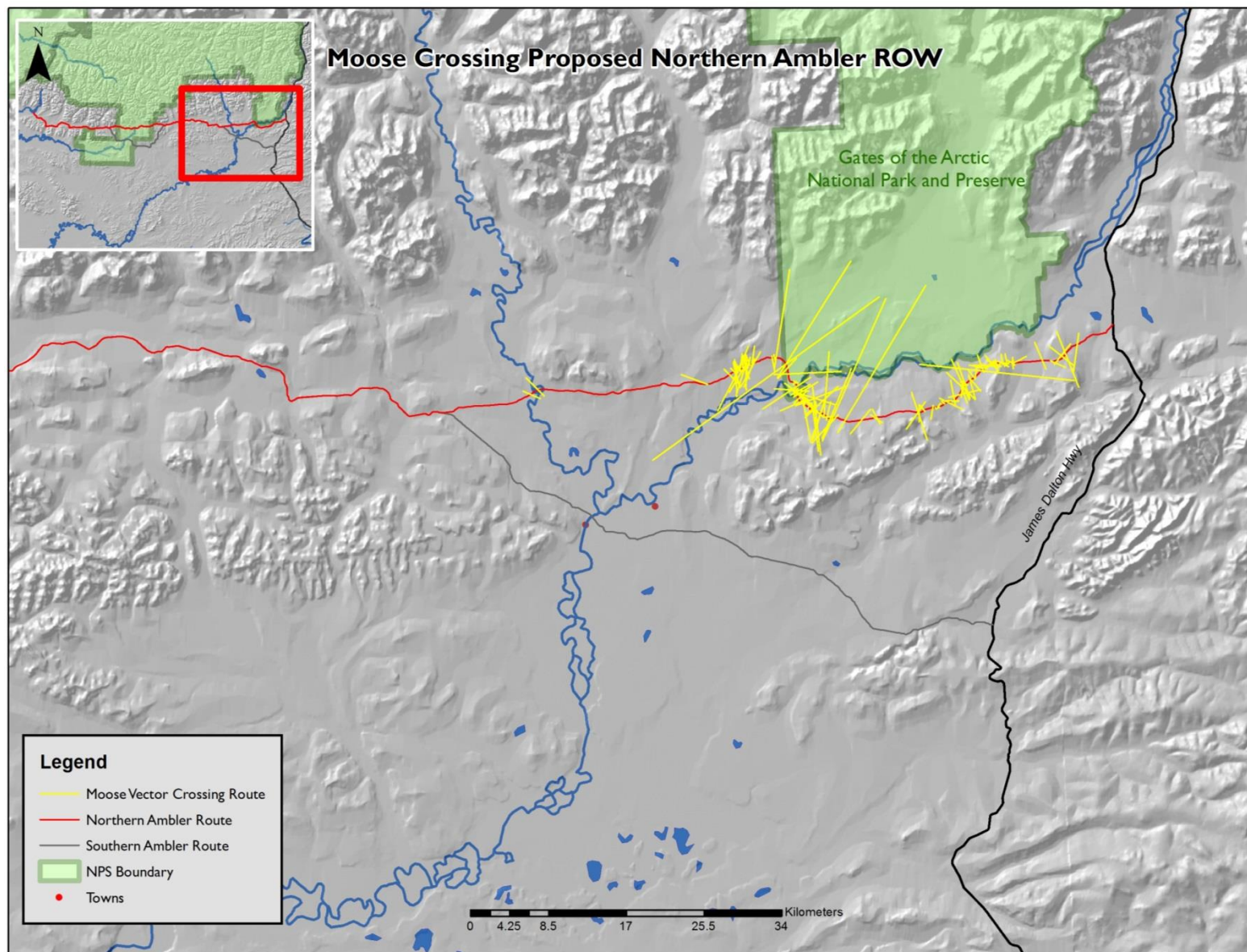


Figure 21. Moose vectors crossing proposed northern route from 2009-2013.

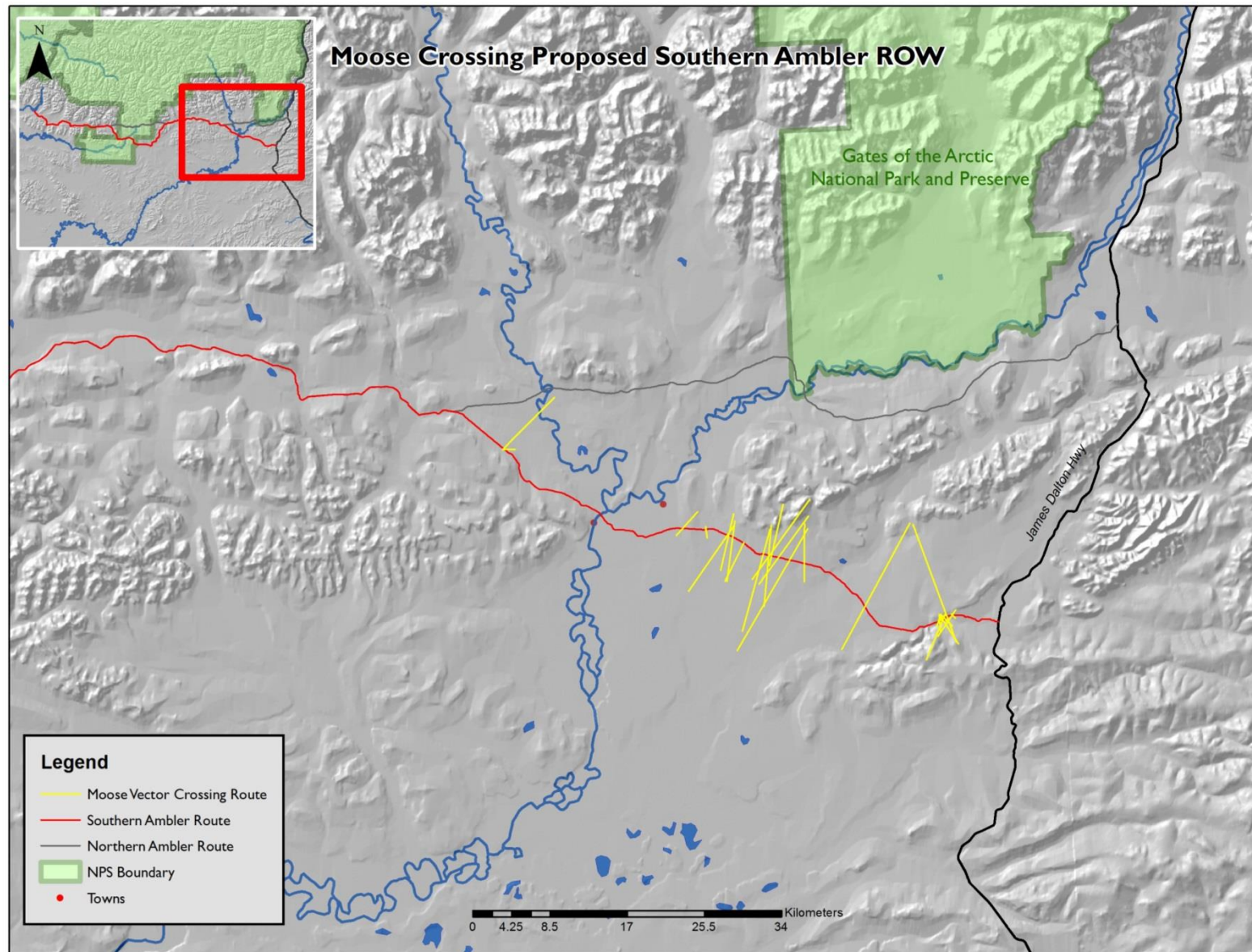


Figure 22. Moose vectors crossing proposed southern route from 2009-2013.

Table 16. Counts of moose crossings by month and year for proposed northern and southern routes.

Year	Date	Northern route	Southern route
2009	Sep	1	-
2011	Apr	3	-
	May	4	-
	Jun	6	2
	Jul	6	-
	Aug	9	-
	Sep	9	6
	Oct	9	4
	Nov	10	1
	Dec	3	1
2012	Jan	2	-
	Feb	4	-
	Mar	1	-
	Apr	3	-
	May	7	-
	Jun	2	-
	Jul	3	-
	Aug	11	-
	Sep	16	11
	Oct	12	2
	Nov	7	-
	Dec	13	1
2013	Jan	4	-
	Feb	1	1
	Mar	1	-

Estimated times for moose crossing were evenly distributed throughout the day (Table 17). The two routes differed substantively only in early morning crossings, in which the southern route had more activity around 4 a.m.

The composition of land cover types for moose crossing locations on both routes was predominantly spruce forest (Table 18). Crossings on the southern route occurred in more tussock tundra and low shrub habitat than the northern route.

A disproportionate percentage of crossings on the southern route occurred from 251-275m (Figure 23), but this is attributed to one individual having numerous crossings in one consolidated area. Seventy-three percent of crossings on the northern route and 100% of crossings on the southern route occurred from 176-375m.

Table 17. Proportion of moose crossings that occurred at six times (Alaska Time Zone) along the proposed northern and southern routes. Times were adjusted for daylight savings time.

Time	North	South
0:00	5	3
4:00	10	31
8:00	20	14
12:00	29	21
16:00	3	0
20:00	34	31

Table 18. Proportion of land cover classes identified at moose crossing locations along the proposed northern and southern routes.

Land Cover Class	Northern Route	Southern Route
Herbaceous	1	0
Deciduous Forest	4	7
Spruce Forest	89	76
Tussock Tundra	2	10
Water	1	0
Low Shrub/Lichen	3	7

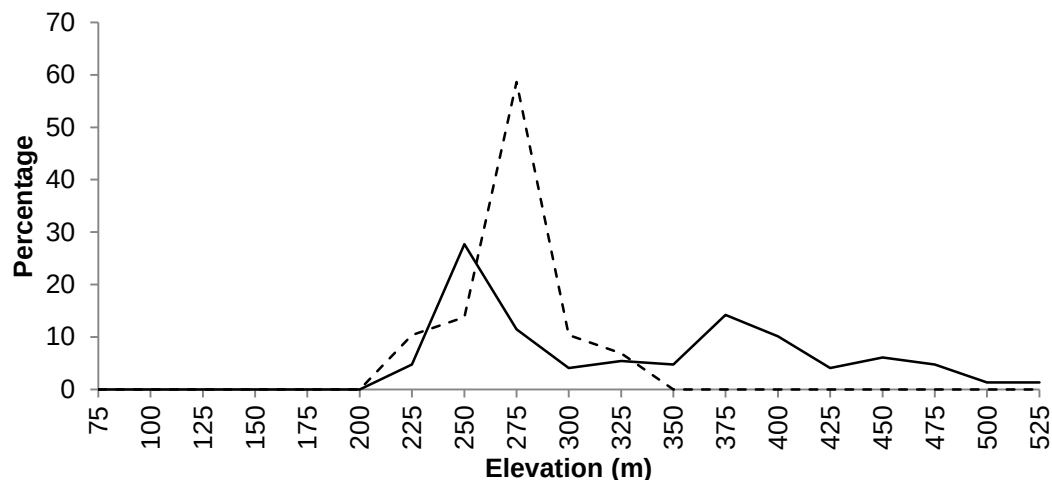


Figure 23. Histogram of elevation, binned in 25m increments, for percentage of moose crossing locations on the proposed northern (solid black) and southern routes (dashed).

Crossings on the southern route occurred at a higher percentage of low slopes than the northern route (Figure 24), but this is again attributed to the concentrated activity of one individual. Slopes from 0-10° accounted for 83% of crossings on the northern route and 97% of crossings on the southern route. Slopes from 0-5° composed 83% of crossings on the northern route and 83% on the southern route.

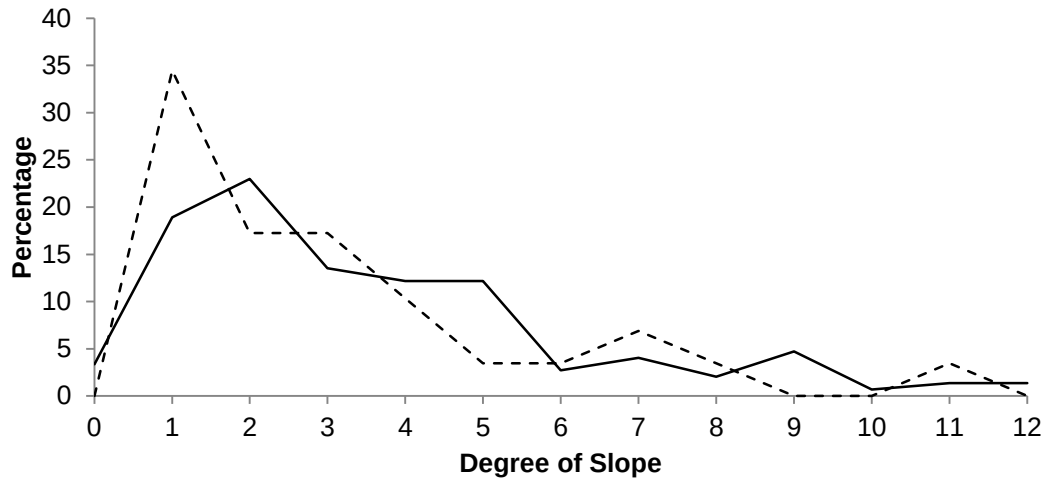


Figure 24. Histogram of degree of slope for moose crossings of proposed northern (solid black) and southern routes (dashed).

The majority of crossings along the northern route occurred on western aspects (221-310°) and on southern aspects (131-220°) along the southern route (Figure 25).

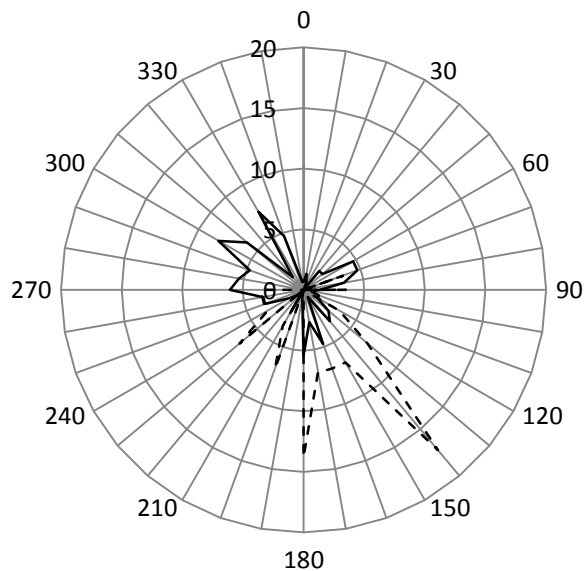


Figure 25. Histogram of aspect for percentage of moose crossing locations along the proposed northern (solid black) and southern routes (dashed). Aspect measurements were binned by 10 degree increments and percent ranges from 0 – 10 along the radius of the compass rose. No crossings were designated flat.

At a fine scale (180m), moose crossings were similar between the northern and summer routes for terrain ruggedness. At a broader scale (1km), crossings occurred on more rugged terrain on the southern route compared to the northern route (Table 19).

Table 19. Average vector ruggedness measures (VRM) for moose crossings on both northern and southern routes at 180m and 1km scales with standard deviations.

VRM Scale	Northern Route	Southern Route
180m	0.003098 ± 0.005988	0.003175 ± 0.005347
1km	0.013607 ± 0.015079	0.022037 ± 0.023827

The majority of crossings on the southern route occurred within 500m of a stream (Table 20), in contrast to the northern route. Fifty-one percent of crossings on the northern route and 31% of crossings on the southern route occurred from 1501-3000 meters of a stream.

Table 20. Percentage of distance to nearest stream in meters for moose crossing proposed northern and southern routes.

Distance to stream (m)	Northern Route	Southern Route
≤ 500	12	48
501-1000	3	10
1001-1500	9	0
1501-2000	16	10
2001-2500	18	17
2501-3000	16	3
3001-3500	6	0
3501-4000	9	7
≥ 4000	9	9

Discussion

Roads can have dramatic impacts on wildlife (Forman *et al.* 2003). The purpose of this report was to provide baseline information on the movements and activities of three important, harvested species (caribou, grizzly bears, and moose) prior to the development of an industrial access road leading to the Ambler Mining District from the James Dalton Highway. The NPS has been delegated the authority to recommend the route through the “Kobuk River” unit of Gates of the Arctic National Preserve. The results of this report may provide insight for the NPS to make this decision as well as determine conditions of use for the right-of-way within the preserve.

In general, differences in habitat, physiography, and animal use between the proposed routes were muted. Here, we focus on the differences that were identified. We found lichen habitats were more prevalent along the northern route. Lichens constitute the majority of the diet of Western Arctic Herd caribou and are an important forage for this critical subsistence species (Joly *et al.* 2015b). Besides the direct destruction of this habitat type by road construction and its degrading by fugitive dust, the presence of a road near lichen-rich habitats could displace caribou from this resource (Wilson *et al.* 2014). Wilson *et al.* (2014) also reported that more high-quality caribou habitat within Gates of the Arctic Preserve would be affected by the selection of the northern than the southern route.

The timing of caribou use where they crossed the proposed routes was dominated by early- to mid-winter months (October to January). The northern route had 22.4% more crossing locations than the southern route. Crossing locations occurred more in open habitats than those habitats were available over the course of the routes. While the differences between routes were not dramatic, our results suggest the southern route would result in fewer and less severe impacts to caribou.

Use of the proposed routes by grizzly bears varied through time, and was greatest during August while salmon were spawning. Salmon are an important food item for grizzly bears across Alaska (Ben-David *et al.* 2004, Gende and Quinn 2004, Sorum 2013, Deacy *et al.* 2016). Populations with access to abundant salmon resources have 1) larger bears, 2) higher reproductive success, and 3) greater population densities (Hilderbrand *et al.* 1999a, Hilderbrand *et al.* 1999b). The availability of high-quality food resources, such as salmon, are particularly important during late summer and fall when accumulation of fat by bears is necessary for sustenance through winter dormancy (Farley and Robbins 1995; Barboza *et al.* 1997). Thus, grizzly bears will likely use areas closer to salmon-bearing streams.

All but one bear den site were north of and closer to the northern route, highlighting the importance of the Brooks Range as denning habitat. Bears can be susceptible to disturbance during denning, which can reduce reproductive output (Linnell *et al.* 2000), and ultimately individual fitness (Swenson *et al.* 1997). Many studies have found that grizzly bears avoid denning in areas near roads (Elfström *et al.* 2008, Goldstein *et al.* 2010, Pigeon *et al.* 2014). Our results suggest the southern route would result in fewer and less severe impacts to grizzly bears.

Moose data was limited to the eastern portion of the proposed road, within and around the southeast portion of Gates of the Arctic National Park: none was available near the “Kobuk River” unit of Gates of the Arctic National Preserve. Further, the southern route on the east side of the study area has been withdrawn from consideration by AIDEA. Therefore, our results only indirectly impact the choice of route within the preserve. Moose were located along the proposed routes every month of the year but high use was clustered in the fall, with September having the most occurrences. Fall, and especially September, is moose hunting season within this region. Moose densities tend to be lower further north, closer to the mountains (Sorum *et al.* 2015). Thus access to very low moose density populations during hunting season could be afforded by the proposed road and the further north the road was, the lower the density of moose there would likely be. Similar levels of hunting would have greater impact on lower density populations. Moose crossed the proposed northern route five times as much as the southern route, though that was likely affected by low sample size and the distribution of collared moose – there were more GPS-collared moose in the north than in the south (Joly *et al.* 2015a). There were fewer crossings of the proposed routes in open terrain than expected. There have been some relatively recent fires along the northern route within the preserve, which may be good moose habitat (Wilson *et al.* 2014). Our results suggest that perhaps the southern route would result in slightly fewer and less severe impacts to moose in the preserve but certainly would have less impact on moose in the southeast portion of the park.

While Gates of the Arctic National Preserve is open to sport hunting, Gates of the Arctic National Park is not. The closer a road is to the park (*i.e.*, the further north it is within the preserve), the greater the likelihood that poaching could occur within the park. This could not only potentially affect the species investigated here but Dall’s sheep (*Ovis dalli*), wolves (*Canis lupus*) and other species. The northern route is also straighter than the southern route which may facilitate higher rates of travel and potentially more vehicle-induced wildlife mortalities. For these reasons, and those discussed above, we find that the southern route would result in fewer and less severe impacts to caribou, grizzly bears, moose and perhaps other wildlife species.

Literature Cited

- Barboza, P.S., Farley, S.D., and Robbins, C.T., 1997. Whole-body urea cycling and protein turnover during hyperphagia and dormancy in growing bears (*Ursus americanus* and *U. arctos*). *Canadian Journal of Zoology* 75: 2129-2136.
- Ben-David, M., Titus, K., and Beier, L.R. 2004. Consumption of salmon by Alaskan brown bears: a trade-off between nutritional requirements and the risk of infanticide? *Oecologia* 138: 465–474
- Deacy, W., Leacock, W., Armstrong, J. B., and Stanford, J. A. 2016. Kodiak brown bears surf the salmon red wave: direct evidence from GPS collared individuals. *Ecology*. In press (doi: 10.1890/15-1060.1).
- Elfström, M., Swenson, J.E., and Ball, J.P., 2008. Selection of denning habitats by Scandinavian brown bears *Ursus arctos*. *Wildlife Biology* 14: 176-187.
- Farley, S.D., and Robbins, C.T., 1995. Lactation, hibernation, and mass dynamics of American black bears and grizzly bears. *Canadian Journal of Zoology* 73: 2216-2222.
- Forman, R.T., Sperling, D., Bissonette, J.A., Clevenger, A.P., Cutshall, C.D., Dale, V.H., Fahrig, L., France, R.L., Goldman, C.R., Heanue, K., Jones, J., Swanson, F., Turrentine, T., and Winter, T.C. 2003. Road ecology: science and solutions. 2nd edition. Island Press, Washington, DC, USA.
- Gende, S.M., and Quinn, T.P. 2004. The relative importance of prey density and social dominance in determining energy intake by bears feeding on Pacific salmon. *Canadian Journal of Zoology* 82: 75-85.
- Goldstein, M.I., Poe, A.J., Suring, L.H., Nielson, R.M., and McDonald, T.L. 2010. Brown bear den habitat and winter recreation in south-central Alaska. *Journal of Wildlife Management* 74: 35-42.
- Hilderbrand, G.V., Jenkins, G., Schwartz, C.C., Hanley, T.A., and Robbins, C.T. 1999a. Effect of seasonal differences in dietary meat intake on changes in body mass and composition in wild and captive brown bears. *Canadian Journal of Zoology* 77: 1623-1630.
- Hilderbrand, G.V., Schwartz, C.C., Robbins, C.T., Jacoby, M.E., Hanley, T.A., Arthur, S.M., and Servheen, C. 1999b. The importance of meat, particularly salmon, to body size, population productivity, and conservation of North American brown bears. *Canadian Journal of Zoology* 77: 132–138.
- Joly, K., and Cameron, M. D. 2015. Caribou vital sign annual report for the Arctic Network Inventory and Monitoring Program: September 2014-August 2015. Natural Resource Report NPS/ARC/NRR—2015/1090. National Park Service, Fort Collins, Colorado.
- Joly, K., Craig, T., Sorum, M. S., McMillan, J. S., and Spindler, M. A. 2015a. Moose (*Alces alces*) movement patterns in the upper Koyukuk river drainage, northcentral Alaska. *Alces* 51: 87-96.

- Joly, K., Miller, S. D., and Shults, B. S. 2012. Caribou monitoring protocol for the Arctic Network Inventory and Monitoring Program. Natural Resource Report NPS/ARC/NRR—2012/564. National Park Service, Fort Collins, Colorado. 99pp
- Joly, K., Wasser, S. K., and Booth, R. 2015. Non-invasive assessment of the interrelationships of diet, pregnancy rate, group composition, and physiological and nutritional stress of barren-ground caribou in late winter. PLoS One 10 (6): e0127586. doi:10.1371/journal.pone.0127586.
- Linnell, J.D., Swenson, J.E., Andersen, R., and Barnes, B., 2000. How vulnerable are denning bears to disturbance? Wildlife Society Bulletin 28: 400-413.
- Pigeon, K.E., Nielsen, S.E., Stenhouse, G.B., and Côté, S.D., 2014. Den selection by grizzly bears on a managed landscape. Journal of Mammalogy 95: 559-571.
- Sappington J.M., Longshore, K.M., and Thompson, D.B. 2007. Quantifying landscape ruggedness for animal habitat analysis: a case study using bighorn sheep in the Mojave Desert. Journal of Wildlife Management 71:1419–1426.
- Sorum, M. 2013. Behavior-specific resource selection by Kodiak brown bears. MSc Thesis, University of Idaho, Moscow.
- Sorum, M. S., Joly, K., and Cameron, M. D. 2015. Aerial moose survey within and around Gates of the Arctic National Park and Preserve, March 2015. Natural Resource Report NPS/GAAR/NRR—2015/967. National Park Service, Fort Collins, Colorado.
- Swenson, J.E., Sandegren, F., Brunberg, S., and Wabakken, P. 1997. Winter den abandonment by brown bears *Ursus arctos*: causes and consequences. Wildlife Biology 3: 35-38.
- Wilson, R. R., Gustine, D. D., and Joly, K. 2014. Evaluating potential effects of an industrial road on winter habitat of caribou in north-central Alaska. Arctic 67: 472-482.

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