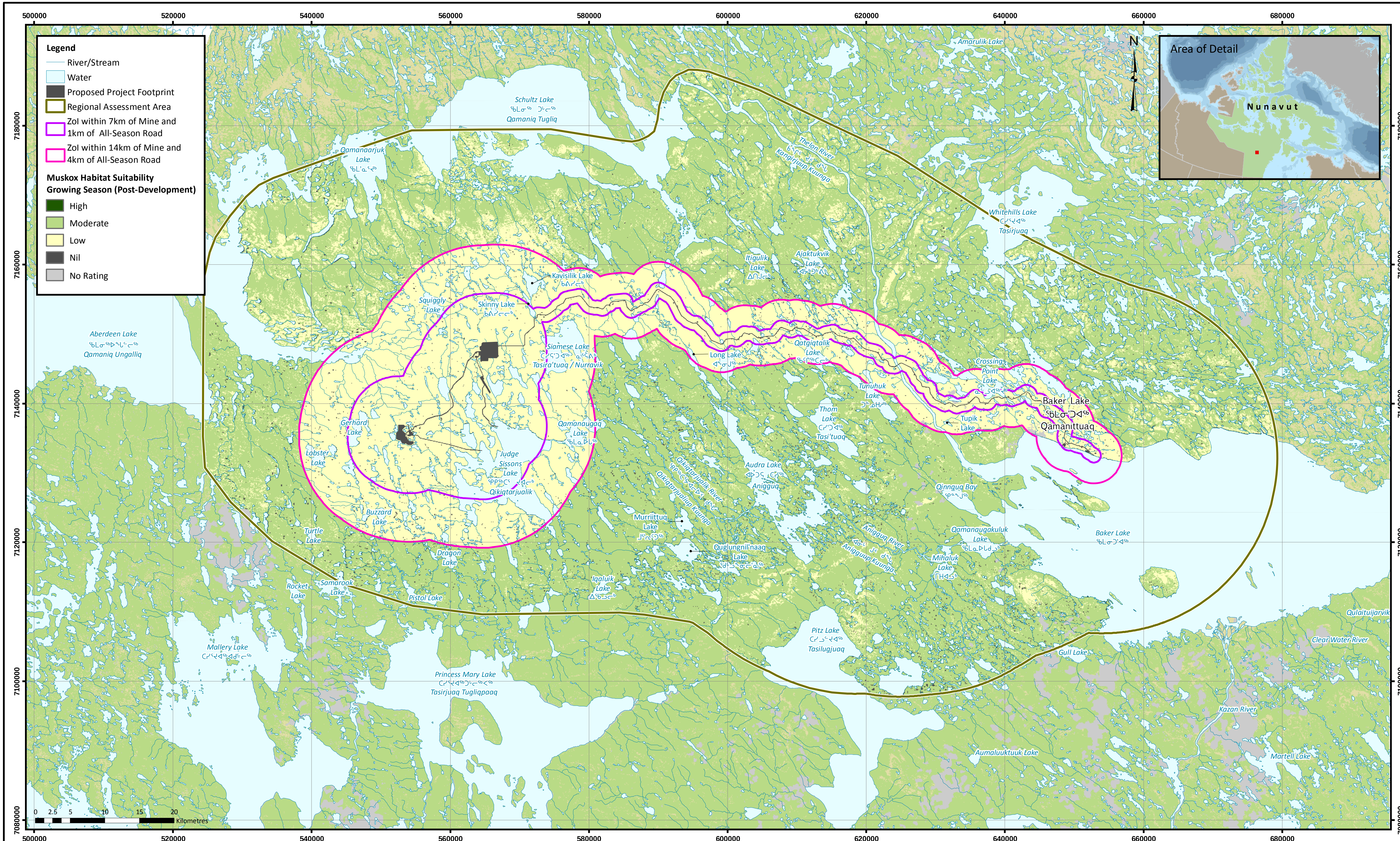

Projection: NAD 1983 UTM Zone 14N
Creator: CASLYS CONSULTING LTD.
Date: 06/02/2014 Scale: 1:500,000
File: 13.2-4_Habitat_Suitability_Growing_PD_Muskox.mxd
Data Sources: *Natural Resources Canada, GeoBase®, National Topographic Database, AREVA Resources Canada Inc., and Gebauer & Associates.*

FIGURE 13.2-4
POST-DEVELOPMENT MUSKOX HABITAT SUITABILITY - GROWING SEASON
MINE AND ALL-SEASON ROAD

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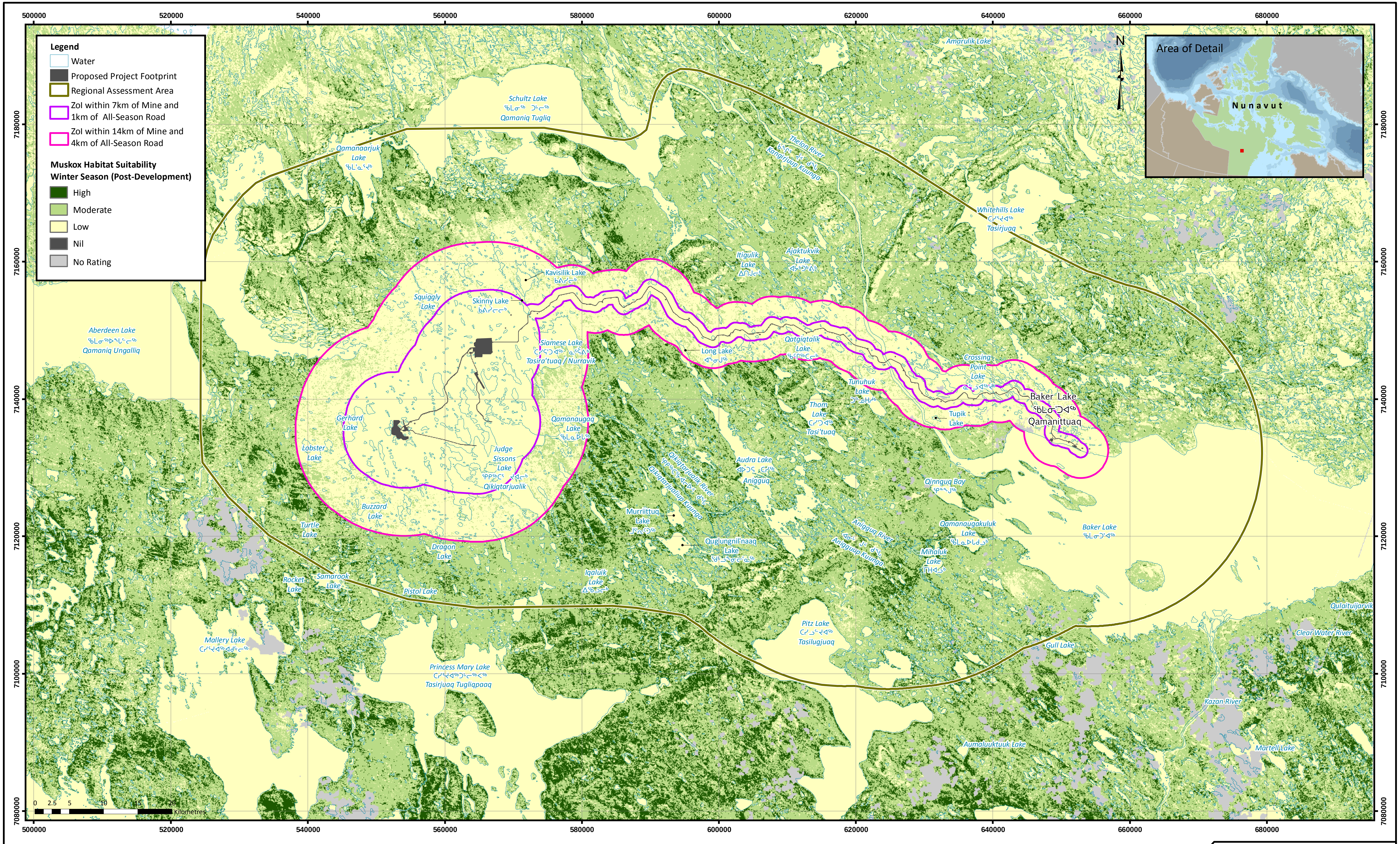

Projection: NAD 1983 UTM Zone 14N
Creator: CASLYS CONSULTING LTD.
Date: 06/02/2014 Scale: 1:500,000
File: 13.2-5_Habitat_Suitability_Winter_PD_Muskox_All-Season.mxd
Data Sources: *Natural Resources Canada, GeoBase®, National Topographic Database, AREVA Resources Canada Inc., and Gebauer & Associates.*

FIGURE 13.2-5
POST-DEVELOPMENT MUSKOX HABITAT SUITABILITY - WINTER SEASON
MINE AND ALL-SEASON ROAD

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Mine and Winter Road

The mine site causes a direct loss of caribou and muskox habitat during both the growing and winter seasons; however, the Winter Road only results in a direct loss of caribou or muskox habitat during the winter season because the road is decommissioned each year. The Project footprint results in a loss of 1,583 ha of winter season habitat. This corresponds to 0.16% of winter season habitat.

Caribou

Caribou winter habitat is directly lost to the footprint and habitat effectiveness is reduced within the mine and Winter Road ZOI. Habitat quality loss due to the footprint and ZOI is expressed as the combined effect of the direct loss and the downgrading of habitat due to the ZOI. During the winter season, the Project can cause a 23% loss of high quality habitat, 11% loss of moderate quality habitat, and a corresponding increase in low quality habitat within the RAA (Table 13.2-11, Figure 13.2-6). This equates to a change to 9.5% of the habitat units within the RAA (Table 13.2-11). The change in the RAA equates to reduced effectiveness in 0.2% of the Ahiak winter range (Table 13.2-11).

Table 13.2-11 Caribou Habitat Baseline and Predicted Effects for the Mine Site and Winter Road Option

Season	Habitat rating		Baseline ELC	Direct loss[2]	Indirect effect[3]	RAA effect	Seasonal range effect[4]
	Class	SI[1]	ha	ha	ha	%	%
Winter	High	3	288,771	-781	-65,891	-23.1%	**-0.2**
	Moderate	2	379,677	-633	-47,520	-12.7%	
	Low	1	311,696	-169	113,410	36.3%	
	Nil	0	0	0	0	0	
	No Rating		2,583	0	0	0.0%	
	Total area		982,728	1,583	226,820		
	Habitat units[5]		1,937,365	-3,779	-179,301	-9.5%	

Notes:

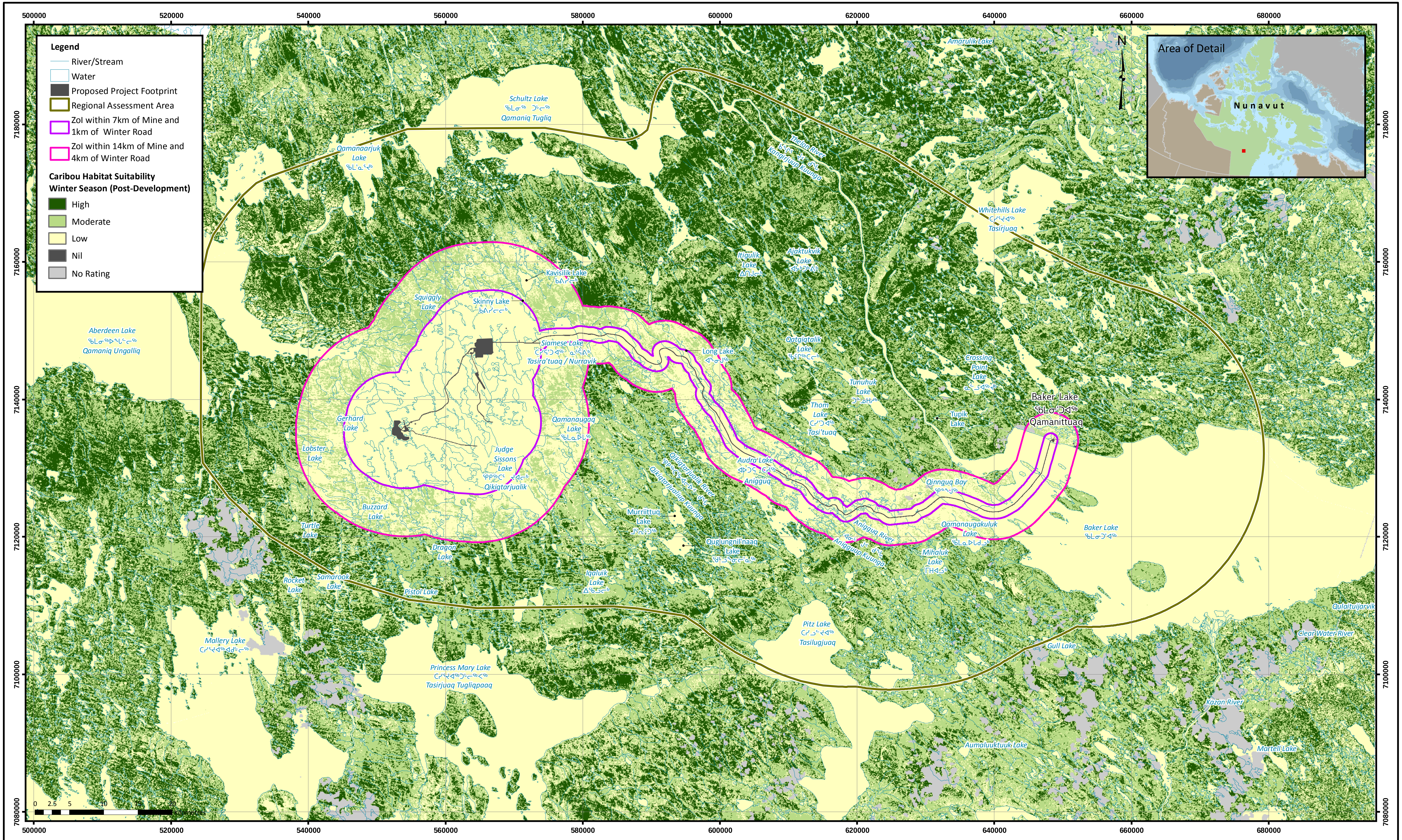
[1] SI = Suitability Index (used for weighted average calculation of Habitat Units)

[2] Direct loss is the change in habitat availability due to the footprint of the project.

[3] Indirect effect is the change in habitat availability due to the zone of influence (ZOI) of the project.

[4] % seasonal range effect = [Total % RAA Effect*RAA Total Area/Seasonal Range Area (*Section 13.2.2.1*))*100]

[5] Habitat units are the weighted sum of all available habitat (sum [ha * SI]).



Projection: NAD 1983 UTM Zone 14N
Creator: CASLYS CONSULTING LTD.
Date: 06/02/2014 Scale: 1:500,000
File: 13.2-6_Habitat_Suitability_Winter_PD_Caribou_Winter.mxd
Data Sources: *Natural Resources Canada, GeoBase®, National Topographic Database, AREVA Resources Canada Inc., and Gebauer & Associates.*

FIGURE 13.2-6
POST-DEVELOPMENT CARIBOU HABITAT SUITABILITY - WINTER SEASON
MINE AND WINTER ROAD

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Muskox

Muskox habitat is directly lost to the footprint and habitat effectiveness is reduced within the mine and Winter Road ZOI. Habitat quality loss due to the footprint and ZOI is expressed as the combined effect of the direct loss and the downgrading of habitat due to the ZOI. During the winter, the Project can cause a 25% loss of high quality habitat, 21% loss of moderate quality habitat, and a corresponding increase in low quality habitat within the RAA (Table 13.2-12, Figure 13.2-7). This equates to a change to 9.7% of the habitat units within the RAA (Table 13.2-12). The change in the RAA equates to reduced effectiveness in 3.0% of the winter habitat in Wildlife Management Unit MX/21 (Table 13.2-12).

Table 13.2-12 Muskox Habitat Baseline and Predicted Effects for the Mine Site and Winter Road Option

	Habitat Rating		Baseline ELC	Direct Loss[2]	Indirect Loss[3]	RAA Effect	MU effect[4]
Season	**Class**	**SI[1]**	**ha**	**ha**	**ha**	**%**	**%**
Winter	High	3	100,884	-191	-24,253	-24.2%	**-3.0**
	Moderate	2	546,848	-1,233	-115,606	-21.4%	
	Low	1	332,412	-159	139,859	42.0%	
	Nil	0	0	0	0	0	
	No Rating		2,583	0	0	0.0%	
	Total area		982,728	1,583	279,718		
	Habitat units[5]		1,728,762	-3,198	-164,112	-9.7%	

Notes:

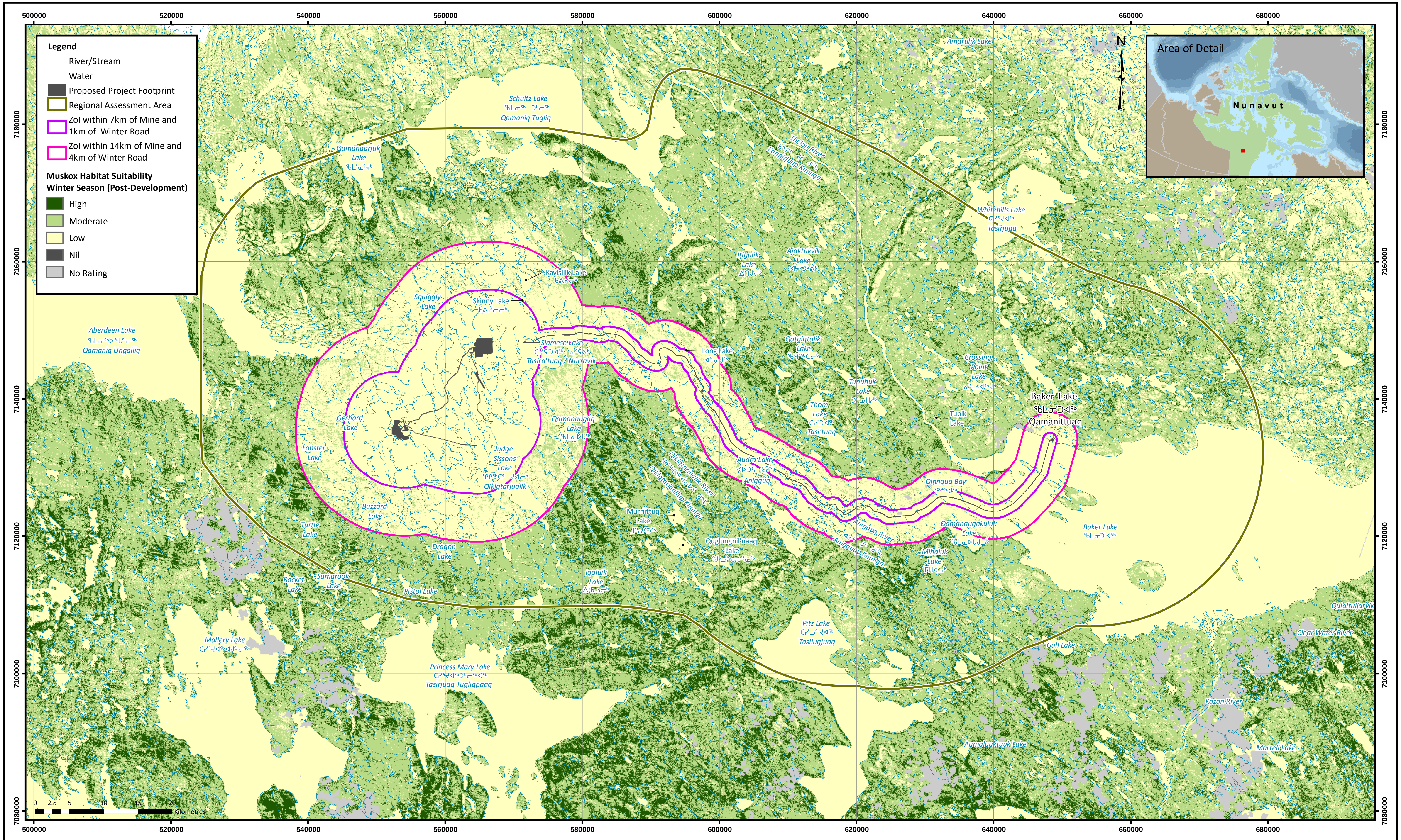
[1] SI = Suitability Index (used for weighted average calculation of Habitat Units)

[2] Direct loss is the change in habitat availability due to the footprint of the project.

[3] Indirect effect is the change in habitat availability due to the zone of influence (ZOI) of the project.

[4] %MU effect = [(Total % RAA Effect*RAA Total Area/MU Area (~*31,872km²*)*100]

[5] Habitat units are the weighted sum of all available habitat (sum [ha * SI]).



Projection: NAD 1983 UTM Zone 14N
Creator: CASLYS CONSULTING LTD.
Date: 06/02/2014 Scale: 1:500,000
File: 13.2-7_Habitat_Suitability_Winter_PD_Muskox_Winter.mxd
Data Sources: *Natural Resources Canada, GeoBase®, National Topographic Database, AREVA Resources Canada Inc., and Gebauer & Associates.*

FIGURE 13.2-7

POST-DEVELOPMENT MUSKOX HABITAT SUITABILITY - WINTER SEASON MINE AND WINTER ROAD

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13.2.2.6 Determination of Significance for Change in Habitat Availability

The Kiggavik Project will have a not significant effect on the availability of caribou and muskox growing and winter season habitat. Loss in habitat availability across the seasonal ranges of caribou or the Management Unit for muskox does not exceed the 5% significance threshold. For caribou, the Project footprint and ZOI will reduce habitat effectiveness in less than or equal to 0.3% within the seasonal ranges of the focal herds. For muskox, the Project footprint and ZOI will reduce habitat effectiveness in only 3% of muskox management unit MX/21.

13.2.2.7 Summary of Project Residual Environmental Effects for Change in Habitat Availability

Table 13.2-13 summarizes residual Project effects on caribou and muskox habitat. The magnitude is predicted to be moderate during construction, operation, and final closure phases. While the size of the Project footprint is small at the scale of the affected caribou and muskox herd/population's ranges, mine-associated activities will reduce the availability of habitat up to 14 km from the Project footprint resulting in a moderate reduction of habitat effectiveness. After final closure, the some of the Project footprint may remain unusable as foraging habitat, but the magnitude of the predicted effect remains low beyond the life of the Project. There is general consensus that human disturbance causes large wildlife to avoid areas at the scale of kilometres, diminishing with distance. The extent of avoidance can vary according to local environmental and topographic conditions. Consequently, the confidence in the predicted effect of the Kiggavik Project on caribou and muskox is moderate because there is inherent uncertainty in 1) the accuracy of the habitat models used; and 2) the ultimate behavioural response of caribou and muskox to the Kiggavik mine is yet to be determined.

The All-Season Road will have the largest footprint and disturbance between the two road options. This will cause the greatest reduction in growing season habitat compared to the Winter Road option because of the larger footprint and greater time (eight months) of disturbance. The Winter Road will be active roughly three winter months each year.

13.2.2.8 Compliance and Environmental Monitoring for Change in Habitat Availability

AREVA will monitor the Project footprint on an annual basis to assess the footprint area for changes in habitat availability, and develop a monitoring program to evaluate indirect habitat loss. Monitoring of caribou and muskox indirect habitat loss will involve documenting trends in caribou and muskox distribution in the ZOI through the collection of incidental observations and using information collected using aerial surveys or collaring. Continued contributions to a government-led caribou collaring program will provide future information on the response of caribou to habitat disturbance in the Kivalliq region.

Table 13.2-13 Summary of Residual Environmental Effects for Change in Habitat Availability for Caribou and Muskox

Project Phase	Mitigation/ Compensation Measures	Direction	Residual Environmental Effects Characteristics						Significance	Likelihood	Prediction Confidence	Recommended Follow-up and Monitoring
			Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental Context				
Change in Caribou and Muskox Habitat — Mine with All-Season Road Option												
Construction	Dust management; Minimize Project footprint; Progressive reclamation	N	M	R	MT	C	R	U	N	N/A	M	Contribution to GN-led collaring program
Operation		N	M	R	MT	C	R	U	N	N/A	M	
Final Closure		N	M	R	MT	C	R	U	N	N/A	M	None required
Change in Caribou and Muskox Habitat — Mine with Winter Road Option												
Construction	Dust management; Minimize Project footprint; Progressive reclamation	N	M	R	MT	C	R	U	N	N/A	M	Collaring program
Operation		N	M	R	MT	C	R	U	N	N/A	M	Collaring program
Final Closure		N	M	R	MT	C	R	U	N	N/A	M	None required

KEY

Direction:
P Positive
N Negative

Magnitude:
N Negligible: No anticipated effect on wildlife species
L Low: Observable effect on wildlife species but not likely to affect the species' sustainability in the Project area
M Moderate: Observable effect on wildlife species but not likely to affect the species' sustainability in the region
H High: Measurable effect on wildlife species but that will likely affect the species' sustainability in the region

Geographic Extent:
S Site-specific
L Local: Effect confined to the LAA
R Regional - Effect extends beyond the LAA but within the RAA
T Territorial: Effect extends beyond the RAA but within Nunavut
N National: Effect extends beyond Nunavut but within Canada

Duration:
ST Short term: Less than one year
MT Medium term: More than one year, but not beyond the end of Project decommissioning
LT Long term: Beyond the life of the Project

Frequency:
O Once: Effect occurs once
S Sporadically: Effect occurs occasionally but not consistently throughout the life of the Project
R Regularly: Effect occurs at regular intervals throughout the life of the Project
C Continuous: Effect occurs continuously throughout the Project

Reversibility:
R Reversible: Will likely recover to baseline conditions after or before the end of Project decommissioning
I Irreversible: Unlikely to recover to baseline conditions after the end of Project decommissioning

Environmental Context:
U Undisturbed: Area relatively or not adversely affected by human activity
D Developed: Area has been substantially previously disturbed by human development or human development is still present

N/A Not Applicable

Significance:
S Significant
N Not significant

Prediction Confidence:
Based on scientific information and statistical analysis, professional judgment and effectiveness of mitigation
L Low level of confidence
M Moderate level of confidence
H High level of confidence

Likelihood of Significant Effects:
Based on professional judgment
L Low probability of occurrence
M Medium probability of occurrence
H High probability of occurrence

13.2.3 Assessment of Change in Caribou Movement

The focus of this assessment is on three components of caribou movement:

1. Directional movement between calving grounds and winter range during the spring and fall migration periods;
2. Directional movement across known water crossings within the RAA, and
3. Localized movements within the Project ZOIs

The long distance seasonal migrations performed by migratory caribou, and to a lesser degree by tundra wintering caribou between winter ranges and calving grounds are unique among arctic terrestrial mammals and are important for the continued existence of migratory herds. Reducing Project effects on caribou migration is an important component to address. Several areas within the RAA were identified as known caribou water crossings. Water crossings are important during the ice-free season for caribou because they are terrain bottlenecks where caribou movement is most restricted.

Localized movements were assessed qualitatively in this section, but the interaction between localized movements and the Project are also realized as potential effects to habitat. Section 13.2.2 describes how habitat availability within the ZOI will be reduced. Muskox move at relatively small scales (i.e., no long distance migration) between available habitats within their range and their movements are less directional and predictable than those of caribou. An assumption made during the assessment was mitigation measures implemented to reduce Project effects on caribou movement would also reduce potential effects to muskox.

13.2.3.1 Analytical Methods for Change in Caribou Movement

Information used to assess Project effects on caribou movement included:

- Campbell et al.'s (2012) *Kivalliq Ecological Land Classification Map Atlas: A Wildlife Perspective* (the Atlas);
- GNDoE and GNWT caribou collar data (migration routes, residency time, and encounter rate analysis);
- IQ and engagement data (migration routes and timing);
- Published reports and data from government and/or management agencies, and
- Baseline wildlife studies.

Collar data used for the assessment are summarized in**Error! Reference source not found.**. Technical limitations of the data used in this assessment are described in Section 13.1.4.

To assess Project effects on migratory movements and movement through water crossings, we focused on information restricted to the migratory seasons (spring and fall migration). For localized movements, we focused on the seasons with the greatest energetic costs of movement: early and late winter. All other non-migratory seasons (i.e., calving, post-calving, and summer) were also considered in the assessment. Caribou seasons in the Kivalliq region are defined by the BQCMB (1999) as follows:

Spring migration:	16 March–25 May
Calving:	26 May–25 June
Post-calving:	26 June–31 July
Summer dispersal:	1 August–15 September
Fall migration and rut:	16 September–31 October
Early and late winter:	1 November–15 March

During spring migration, female caribou migrate in large numbers to calving grounds to give birth. Their routes and calving grounds are relatively consistent among years, but long term studies of the caribou herds in Nunavut and Northwest Territories show that caribou calving grounds are somewhat dynamic (Nagy et al. 2011). This change over time concurs with IQ and engagement data: *caribou never stay in one ground because when they are delivering calves, they need clean grounds in order to keep themselves clean. They do not go to the same spot or ground for delivering calves every year* (EN-BL CLC Nov 2008). Similarly, *the elders say caribou have always changed their migration routes. They will eat lichen along one route and won't use it again until lichen is back* (EN-BL OH Oct 2012).

To identify areas of greatest caribou densities during spring and fall migration, available telemetry data and IQ were characterized across the full extent of the migratory and tundra-wintering herd ranges (Tier 3, Volume 6, Appendix 6C, Figures 5.7-12A to 5.7-12D). The Atlas identifies regional migration corridors according to relative levels of use (Tier 3, Volume 6, Appendix 6C, Figures 5.7-12A and 12C), while specific directional migration routes and important water crossings from IQ and IDS 1978 are identified within the RAA (Tier 3, Volume 6, Appendix 6C, Figures 5.7-12B and 12D). All water crossings within 10 km of each of the Project options were identified. Designated water crossing are identified in the DIAND Caribou Protection Measures, and from IQ and baseline studies. Crossings identified by any means were given the same weight in the effects assessment and mitigation planning as that given to the designated crossings.

Encounter Rates and Residency Time in ZOI

To better assess the potential effect of the Project as a semi-permeable barrier (filter) to caribou movement at a more localized scale, caribou residency times and encounter rates within the two Project Zones of Influence (ZOIs; mine site and All-Season Road ZOI and the mine site and Winter Road ZOI) were calculated. A GIS-based walk-line approach was developed to determine encounters with the Project ZOIs and estimate the time spent by collared female caribou in each ZOI. Telemetry data for the Lorillard, Wager Bay, and Qamanirjuaq herd was provided by the Government of Nunavut and the Government of Northwest Territories provided data for the Ahiak and Beverly herds.

Recognizing the technical limitations to using caribou collar data (Section 13.1.4), an assessment of likely encounter and residency rates was calculated based on collar data as a representation of herd interaction with the Project ZOI. This approach is similar to that used for a study of industrial effects on caribou completed on the Bathurst caribou herd for the Gahcho Kué Project in the NWT (De Beers Canada Inc. 2010a) the Kugluktuk HTO (Golder Associates Ltd. 2011), and the Back River Project (Rescan 2013).

The number of encounters with each ZOI was determined by summing the total number of entry and exit points into a ZOI, and dividing by two. The residency time analysis consisted of four main steps (illustrated in Figure 13.2-8):

1. Walk-lines (defined as a straight line connecting two telemetry point locations) were generated from telemetry point locations;
2. Walk-lines were overlaid with the ZOIs to determine the spatial relationship between the two;
3. Walk-lines were attributed with a duration of time (both within and outside a ZOI) using the proportion of line length in combination with day interval, and
4. All walk-line durations (hours) within an assessment area were summed and divided by the total duration of all walk-lines (within and outside of an assessment area) to estimate residency time as a proportion of total collar (i.e., herd) time.

All walk-line durations (hours) within a ZOI area were summed and divided by the total duration of all walk-lines (within and outside of a ZOI) to estimate residency time as a proportion of total collar duty cycle time (time between two consecutive locations).

Determination of encounter rates and residency time was based on the following assumptions:

1. The animals collared were accurately identified as members of a particular herd; i.e., they move and live with what is generally accepted as a particular herd.
2. The animals collared accurately represent a cross-section of a herd; i.e., as a subset, they sufficiently reflect the annual or seasonal home range (or extent) of an entire herd.
3. The encounter rates are based on the assumption that an animal is exposed to one disturbance event each time it enters a ZOI.
4. The residency values represent an estimate of the range/proportion of time that any one caribou herd spends in a ZOI.

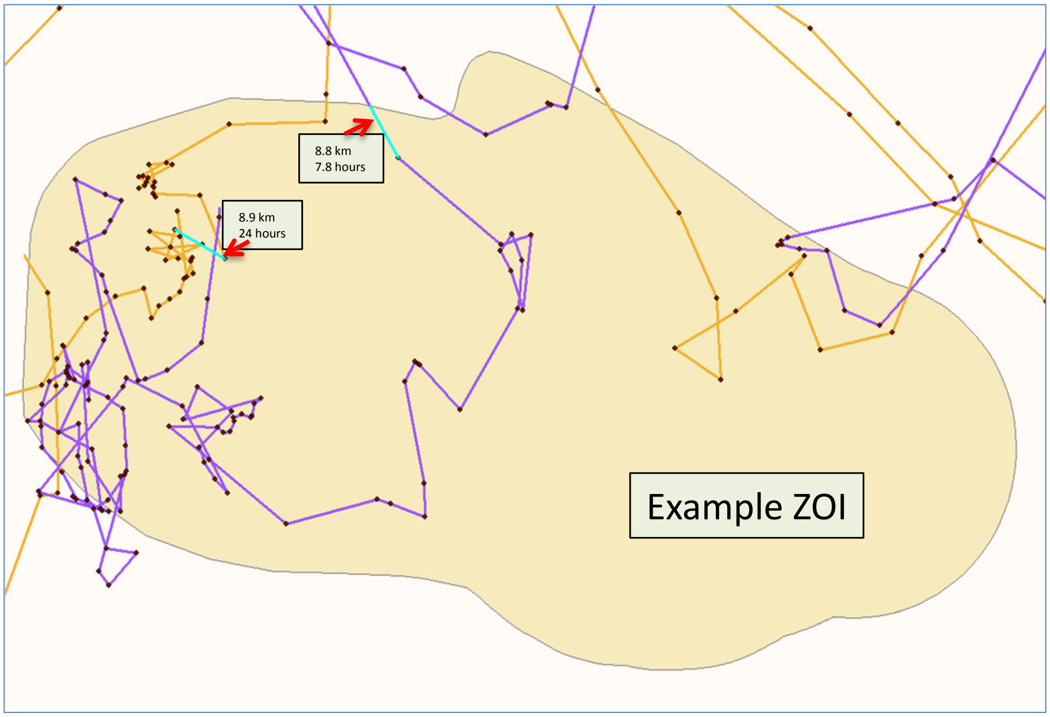

Figure 13.2-8 Example calculation of "walk-lines" in a hypothetical ZOI that were used to quantify encounter rates and residency times.

13.2.3.2 Baseline Conditions for Change in Movement

This section serves as a summary of baseline conditions for caribou movement — a more detailed description is available in the Terrestrial Wildlife Baseline (Tier 3, Volume 6, Appendix 6C).The five caribou herds identified in Nunavut's mainland region are the Beverly, Ahiak, Wager Bay, Lorillard, and Qamanirjuaq herds. All of these herds are known to occur within the RAA, although at different frequencies and seasons depending on their herd ranges. The approximate annual distribution and calving grounds for these herds in Nunavut, based on recent analysis of satellite-tracking data over many years, are presented in Tier 3, Volume 6, Appendix 6C, Figure 5.7-1 (from Nagy et al. 2011). All caribou herds perform seasonal migrations between their calving areas and winter range, but the migratory caribou herds migrate much further to and from their wintering ranges in southern Nunavut and Northwest Territories, and northern Manitoba and Saskatchewan.

The Ahiak, Wager Bay, and Lorillard herds as part of a tundra-wintering barren-ground caribou herds (Nagy et al. 2011; Campbell et al 2012). Other available information from the BQCMB shows slightly different range boundaries for the Beverly herd (Tier 3, Volume 6, Appendix 6C, Figure 5.7-2), reflecting the inherent difficulty in accurately delineating herd ranges and why these herds continue to be studied and reassessed. Migratory tundra caribou are known to shift their distribution among years, often as a result of changes in herd abundance (Gunn et al. 2011). While caribou migrations and use of calving areas are relatively consistent among years, there is strong evidence that caribou herds are more dynamic than previously thought (Nagy et al. 2011; Boulet et al. 2007; Hinkes et al. 2005). Similarly, *elders say caribou have always changed their migration routes. They will eat lichen along one route and won't use it again until the lichen is back* (EN-BL OH Oct 2012).During migration, caribou follow natural geographic features, which cause them to concentrate at traditional water crossings (Williams and Gunn 1982). Some documented crossings that fall within the RAA are protected under the Territorial Land Use Regulations, where some land-use related activities within 5 km of designated water crossings are prohibited by the DIAND Caribou Protection Measures from May 15 to September 1. Additional water crossings (unprotected by DIAND but identified in GN DoE database) were also identified during baseline and IQ studies. All water crossings are included in the migration maps (Tier 3, Volume 6, Appendix 6C, Figures 5.7-12A to 5.7-12D) and were given equal weight in the assessment.

Understanding movement patterns of migratory and tundra-wintering caribou in and around the RAA is challenging given variability in movements between seasons, herds and individuals. Information from various sources, including IQ and engagement studies, baseline ground and aerial surveys, and telemetry data at local and regional scales in Nunavut and the NWT, has provided some evidence on how caribou move in and around the RAA annually. The RAA predominantly provides a transit corridor between calving grounds and wintering grounds for the Ahiak and Qamanirjuaq herds, and a wintering area for tundra-wintering herds such as the Lorillard and Wager Bay herds. As a result, caribou occur in the region year-round, which is supported by IQ and engagement data: *large herds of caribou (thousands) migrate near the proposed and through the proposed routes* (EN-BL NIRB Apr 2010). *When caribou are looking for food they migrate and travel far* (EN-BL CLC Oct 2012).

Also, according to IQ, collar data, and the Kivalliq Atlas (Campbell et al. 2012), few caribou, relative to the numbers existing in the Kivalliq region, are likely to encounter the mining activities or infrastructure. The likelihood of even a small number of animals in a herd encountering, then responding in the most negative way to disturbance (deflection or diversion) during movement to or from their calving or wintering areas is unlikely.

13.2.3.3 Effect Mechanism and Linkages for Change in Movement

IQ indicates several caribou movement areas in proximity to the Project (Tier 3, Volume 6, Appendix 6C, Figures 5.7-12A to 5.7-12D). Migratory caribou movement can be affected by human developments that block or restrict movement of caribou across Project infrastructure such as buildings, open pits, pipelines, and fencing (Klein 1971; Mahoney and Schaefer 2002). The Kiggavik Project could affect caribou migration to calving grounds in spring or winter range in fall through construction of infrastructure and human activities that change, filter, or block caribou movement across the landscape.

Migratory barren-ground caribou migrate as a strategy to access high quality seasonal habitats and avoid predation. Caribou migrations are timed so they reach their calving grounds in time to give birth with the onset of spring green-up and they move south so they are able to avoid harsh weather conditions and access suitable winter forage. Changes to migration could have implications on reproductive success and survival. Consequently, changes to caribou migration could affect regional caribou populations.

Water crossings play an important role in many periods of the annual cycle for caribou. Project infrastructure or activities that filter or block movement through these areas could result in Project effects on caribou. IQ and engagement data describe the importance of not disturbing these areas: *It is important that the caribou leaders are not disturbed during migrations; this is information we learned from our Elders* (EN-BL EL Oct 2012). *When there is a herd, the leader of the herd is followed quite closely by the rest of the herd, and nobody tries to disturb the herd to not disrupt the migratory route* (EN-BL HTO Mar 2009).

Large linear structures have the greatest potential to affect caribou movement, whereas caribou can more easily bypass non-linear features (e.g., camp or pit). The Project's proposed linear infrastructure that has the greatest potential to filter or block caribou movement is the two road options. Also, a component of habitat availability is the accessibility of habitat adjacent to Project infrastructure. Movement across infrastructure may not be blocked by a physical barrier; however, it can be filtered by a physical structure or sensory disturbances (i.e., caribou are able to cross a road but do not because of stress associated with unknown stimuli). Roads can also act as semi-permeable barriers to caribou movement across the landscape resulting from vehicle use, embankment characteristics, and snow clearing practices. At the Ekati diamond mine in Northwest Territories, snow track surveys found 57% of caribou tracks deflected from the mine road during spring migration (April and May), and found that snow bank heights >0.5 m were the most important deflection factor, while the road did not act as barrier during snow-free periods (BHP Billiton Canada Inc. 2012). Allowing caribou to easily travel between habitats on either side of the road will maintain their distribution and reduce the chance of caribou avoiding road crossings and adding to individual energetic costs.

Bergerud et al. (1984) studied behaviour in eight different caribou herds that were exposed to industrial development or transportation corridors and found that caribou are very resilient to human disturbance, and seasonal movements and range habitation are a function of population size as opposed to anthropogenic disturbance. The height of road embankments is a widely discussed aspect of caribou movement across transportation corridors due to the visual barrier they present to caribou. Barrier threshold heights of 1.2 m, 1.43 m, and 1.0–1.5 m have been reported for Arctic caribou herds, but it is generally believed that caribou move with their learned directional orientation (Miller 1985) and simply look for crossings with the least energetic cost (Bergerud et al. 1984), as opposed to responding to barriers of a certain threshold height. Deflection from transportation-related berms or embankments is believed to be a response to other sensory disturbances rather than the height of the barrier (Bergerud et al. 1984). Miller (1985) found caribou would cross 19 m high embankments in open terrain on the Dempster Highway. In the absence of traffic, caribou may be influenced by stimuli associated with roads, such as gas, oil, and rubber odours and the visual appearance of the plowed road (Miller 1985).

Fencing also has the potential to affect caribou movement. Snow fences are the only fencing structures proposed for the Kiggavik Project. The location of these snow fences can be found in the Tier 2, Volume 2, Project Description and Assessment Basis, Section 4.4.2, Figure 4.4-1 and Section 4.4.3, Figure 4.4-3. A standard mesh barrier heavy duty snow fence, likely made from high density polyethylene that will have a mesh opening small enough to prevent entanglement (i.e., likely a 1-1/4” x 1-1/4” mesh opening), will be constructed and maintained. Lessons learned from other mines in Nunavut and NWT suggest that fencing can entangle caribou, thus having a minimal amount of fencing will reduce the likelihood of injury or death from entanglement. The purpose of the snow fences is to limit snow accumulation on site and reduce water runoff from snow melt within the site. A further description of the snow fences is provided in Tier 2, Volume 2 (Project Description and Assessment Basis), Section 9.4. Lessons learned from operating uranium mines in northern Saskatchewan, which lay within both barren-ground and woodland caribou ranges, and AREVA’s knowledge of Project-related activities that may influence caribou occurrence within the Kiggavik Project footprint, have been considered in Project design and the development of management plans. Based on this experience, it is anticipated that caribou avoidance of the open pits and ore storage areas will likely occur due to noise generated during operation of heavy equipment/machinery/support vehicles and blasting activities, negating the need for fences to keep caribou out of the operational area.

The All-Season Road will be usable for eight months of the year, so activity along the road will overlap with caribou moving through the area during spring and fall migrations. The Winter Road option will be operational for less than 90 days per year, presumably from December to March, so the timing of seasonal construction and use of the Winter Road will overlap with spring migration in March but will not overlap with fall migration. Both road options will interact with localized movements during early and late winter.

13.2.3.4 Mitigation Measures and Project Design for Change in Movement

The Kiggavik Project will mitigate effects on caribou movement by:

- reducing road embankment height of the All-Season and Winter Road to prevent visual obstruction for migrating caribou, as well as to facilitate ease of crossing;
- practising snow management that avoids long continuous cuts or piles of snow that could restrict spring migration across roadways; there are no apparent movement areas across the road in the winter, but snowbank passageways can be created on an as-need basis;

- using fine-grained materials on the road surface and road slopes to create a good travel surface for caribou (or other wildlife) attempting to cross the road (i.e., road materials won't cause potential injury or difficulty for animals when crossing);
- avoiding construction activities within 10 km of designated water crossings during 15 May to 1 September, in accordance with the DIAND Caribou Protection Measures
- minimizing the use of physical barriers such as fencing and, where required, minimize the lengths of fencing unless required for safety, and
- implementing temporary road shutdowns if large numbers of caribou are observed migrating through the area.

The DIAND Caribou Protection Measures are intended to mitigate potential Project effects. The measures include protection for caribou during the calving and post-calving seasons, 15 May to 1 September. During this period, the caribou protection measures restrict construction of camps, fuel caching or blasting within 10 km of crossings (Protection Measure 4a); and diamond drilling within 5 km of crossings (Protection Measure 4b). Also, the protection measures state the Project cannot "*block or cause substantial diversion to migration*" (Protection Measure 3a) and will "*cease activities that may interfere with migration*" (Protection Measure 3b). This can include suspending flights of 300 m agl when caribou cows and calves are present between May 15 and July 15 (2bii).

13.2.3.5 Residual Effects for Change in Movement

During the migratory seasons the Kiggavik Project is expected to have some interaction with migratory and tundra wintering caribou herds. All migratory caribou cross many natural barriers during migrations (e.g., large river valleys, mountain ranges) and many herds cross human infrastructure. While caribou may spend less time near the infrastructure, the infrastructure is not a barrier to migration.

For spring migration (April to June), areas of high use by collared caribou are more contained (i.e., less spread out), and these corridors are quite clearly delineated on the way to and in proximity to calving grounds (note: all calving grounds are well outside the Kiggavik RSA; Tier 3, Volume 6, Appendix 6C, Figure 5.7-12A). Telemetry data indicate that most collared caribou are moving in a northerly direction in the spring, but generally outside the RAA (Tier 3, Volume 6, Appendix 6C, Figures 5.7-12A and 5.7-12C). IQ-derived spring migration arrows do not all concur with the patterns observed in the collar data, as some indicate spring movement into the RAA from north-to-south and south-to-north (Tier 3, Volume 6, Appendix 6C, Figure 5.7-12B). In most cases, historical IQ identified spring movement in a mostly northerly direction out of the RAA (IDS 1978), which is supported by recent collaring data. Taken together, spring movement through the RAA is known to occur, but to a much lesser extent than outside (e.g., west) of the RAA.

During fall migration (September to November), as animals are migrating to wintering grounds, areas of high use by collared caribou are more widely distributed (i.e., more spread out; Tier 3, Volume 6,

Appendix 6C, Figure 5.7-12C). Fall migration corridors are also located closer to the Kiggavik area than spring corridors, as herds generally move in a southerly direction from calving grounds. Similar to spring migration corridors, areas of greatest use in the fall are north of Aberdeen Lake (i.e., Beverly herd), east of the Thelon River (i.e., Ahiak herd), and south of Baker Lake (i.e., Qamanirjuaq herd). The two IQ-derived fall migration arrows located south of the Kiggavik RAA at Qamanaajuk Lake are supported by the available caribou collar data (Tier 3, Volume 6, Appendix 6C, Figure 5.7-12D). Historical IQ identified fall movement in a southerly and westerly direction out of the RAA (IDS 1978).

Many of the IQ-derived migration arrows were not differentiated by season; rather they reflected an important corridor of movement. The absence of a perfect correlation between the regional migration corridor density analyses, the individual collared caribou walk lines, and the IQ-derived migrations arrows provide further evidence of seasonal and year-round variations in movement patterns of caribou in the RAA as they move to calving grounds to the north and south. *When you look at the area, caribou do wander all over the place* (EN-BL HTO Mar 2009). This is consistent with movement paths of female collared caribou through the two Project potential ZOIs (Figure 13.2-9).

Based on the identification of movement corridors from IQ and data summarized in the Atlas, it is apparent that the Kiggavik RAA is not in a high use movement corridor during spring or fall migration. Collar data from the migratory caribou herds during the migratory period and the known locations of the current calving grounds suggests that few caribou will interact with the Project during the migration seasons. Nonetheless, it is well known that caribou are a dynamic species and migration routes often change over the years: *the Elders say caribou have always changed their migration routes. They will eat lichen along one route and will not use it again until lichen is back* (EN-BL OH Oct 2012). Some believe that *caribou naturally change their migration patterns every few years and an Elder explained that while herds used to start migrating towards the southeast and cross the Annigguq Lake and the mouth of Kazan River, they now start to migrate from the southeast towards the northwest. Another Elder simply stated that the herds don't take the same routes anymore* (IQ-BL01 2009; IQ-BL05 2008; IQ-BL02 2008; IQ-BLHT 2011; IQ-RBJ 2011). This introduces uncertainty into the assessment, which was considered when determining the significance of residual effects.

Projection: NAD 1983 UTM Zone 14N
Creator: CASLYS CONSULTING LTD.
Date: 09/18/2014 Scale: 1:500,000
File: 13.2-9_Caribou_Movement_in_ZoI.mxd
Data Sources: *Natural Resources Canada, GeoBase®, National Topographic Database, AREVA Resources Canada Inc., Gov't of Nunavut Gov't of NWT, Gebauer & Associates.*

FIGURE 13.2-9
COLLARED FEMALE CARIBOU MOVEMENT THROUGH THE PROJECT'S POTENTIAL ZONES OF INFLUENCE

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At a more localized scale, caribou movement within the ZOIs, as identified in the encounter residency analyses, appears to be limited to collared caribou from the Ahiak, Lorillard, Qamanirjuaq, and Wager Bay herds. During the migratory seasons, only collared caribou from the Ahiak herd were present in the Project ZOIs. During the early and late winter season, collared caribou from all herds (except the Beverly) encountered the Project ZOIs. Similar to the migratory seasons, mostly collared caribou from the Ahiak, Lorillard and Qamanirjuaq herds interacted with the ZOIs.

Beverly collared caribou have been predominately located west of the RAA during the migratory and winter seasons, and no collared Beverly caribou spent time in the RAA or either Project ZOIs during any season during collaring programs from 2001 to 2012. The RAA is located near the edge of traditional post-calving areas for the Beverly herd (to the north). In the Kiggavik area, hunters have noted that in the last three years have mainly been seeing male caribou in that area (tough meat); do not see as much females, young caribou or calves any more (EN-BL NIRB Apr 2010), suggesting that the area may not be used as much during post-calving as in previous years.

Mine and All-Season Road

With their main migratory route located just west of the RAA, Ahiak collared caribou appear to have the most interaction with the Project during early and late winter and spring migration, which is consistent with migratory corridor use identified in IQ and the Atlas. From 2005 to 2012, during the migratory seasons (spring and fall), the greatest proportion of collared animals in the ZOI was during spring in 2010; however, during non-migratory seasons, the greatest proportion of Ahiak caribou in the ZOI was during early winter in 2007 (50% of collared animals) and late winter in 2008 (50% of collared animals; Figure 13.2-10a). In terms of localized movements, the greatest average number of encounters (3.0 encounters) with the ZOI was during late winter in 2008 (Figure 13.2-10b). Of the collared caribou that encountered the ZOI from 2005 to 2012, the greatest average residency time (51.7%, n=1) was during fall and rut in 2012 (Figure 13.2-10c). This was a notably higher residency time than was observed in other years.

Qamanirjuaq caribou move through and within the Mine and All-Season ZOI primarily during post-calving and summer. From 1993 to 2012, during the migratory seasons (spring and fall), the greatest proportion of collared Qamanirjuaq caribou in the ZOI was during post-calving in 2010 and 2011 (27% of collared animals; Figure 13.2-11). Collared Qamanirjuaq caribou did not interact with the ZOI from 1993 to 2004, and it was not until 2005 that some collared animals began encountering the ZOI (Figure 13.2 11a). Although no collar locations were recorded in the ZOI from 1993 to 2004 does not suggest there was a change in distribution, rather, the number of collars in the herd increased from about 2004 onwards, likely capturing more of the variability in herd distribution. In terms of localized movements, the greatest average number of encounters (2.5 encounters) with the ZOI was during post-calving in 2010 (Figure 13.2 11b). Of the collared caribou that encountered the ZOI from 2005 to 2012, the greatest average residency time (13.4%, n=1) was during summer in 2011 (Figure 13.2-11c).

Of the tundra wintering caribou herds, Lorillard caribou have the greatest interaction with the Mine and All-Season ZOI. From 1998 to 2012 (excluding 2007–2010 when no Lorillard caribou were collared), the greatest proportion of collared Lorillard caribou in the ZOI was during early winter in 2012 (50% of collared animals; Figure 13.2-12a). In terms of localized movements, the greatest average number of encounters (3.0 encounters) with the ZOI was during early winter in 2012 (Figure 13.2-12c).

According to the collar data, Wager Bay caribou interact with the ZOI only during early winter. From 1999 to 2012 (excluding 2007–2008 when no Wager Bay caribou were collared), during the migratory seasons (spring and fall), no collared Wager Bay caribou were in the ZOI (Figure 13.2-13a). In terms of localized movements, the greatest average number of encounters (1.0 encounter) with the ZOI was during early winter in 2000 (Figure 13.2-13b). Of the collared caribou that encountered the ZOI from 1998 to 2012, the greatest average residency time (12.9%, n=1) was during early winter in 2000 (Figure 13.2-13c).

After mitigation, residual effects of the Project on caribou movement include reduced use of potential migratory routes because of mine site infrastructure and potential avoidance of some water crossings. Caribou will be unable to move through some areas that were previously available (e.g., open pits, airstrip). The routing of the All-Season Road is within 10 km of four non-designated water crossings, as outlined below. The caribou residency analysis reveals that some collared caribou from all herds (except the Beverly) interact with the Mine and All-Season Road ZOI at some point throughout a year; however, the greatest interaction with migratory movements is with the Ahiak herd during spring. Throughout the rest of the year, localized movement of the Ahiak and Qamanirjuaq herds may interact with the ZOI the most (i.e., highest number of encounters and residency time).

The footprint of the mine site and All-Season Road does not overlap with the water crossings, and no protected water crossings are within 10 km of the Project footprint. However, four unprotected water crossings are within 10 km of the All-Season Road (Table 13.2-14; Figure 13.2-18). Given the current distribution of all migratory caribou herds in the region, the magnitude of the effect of mine and road on causing changes to caribou migration is low.

Residual effects of the mine are not anticipated to cause a detectable change in baseline caribou migrations. The limited number of caribou that migrate through the area and the Project mitigations should essentially eliminate Project effects on caribou migration. However, the regional caribou herds' use of space is more dynamic than previously thought (Nagy et al. 2011), consequently, how caribou migration and calving areas might change in the future cannot be predicted. This is a technical limitation of the assessment. The worst-case scenario for the Kiggavik Project is a herd shifting its calving area so that the herd starts to migrate through the RAA. If this were to occur, caribou could experience some degree of restricted migration or localized movement from the Project structures and activities. The magnitude of this effect would still likely be small because of applied mitigations, but the increased interaction could result in some type of diversion as caribou move across the Project ZOI.

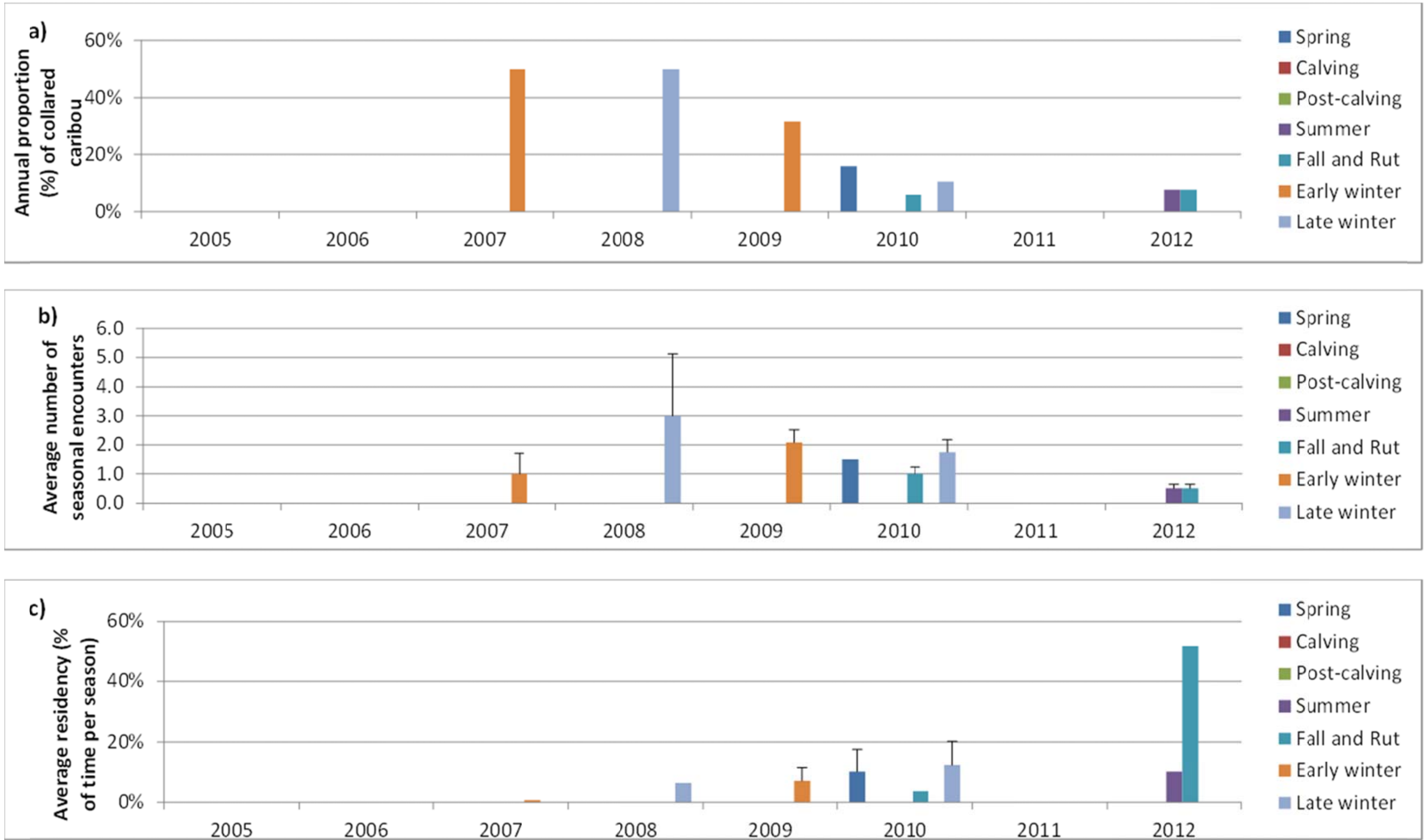

Figure 13.2-10 ***a)*** **Proportion of collared Ahiak caribou in the Mine and All-Season Road ZOI by season from 2005 to 2012,** ***b)*** **Average number of encounters of collared Ahiak caribou with the Mine and All-Season Road ZOI by season from 2005 to 2012, and** ***c)*** **Average residency time of collared Ahiak caribou in the Mine and All-Season Road ZOI by season from 2005 to 2012.**

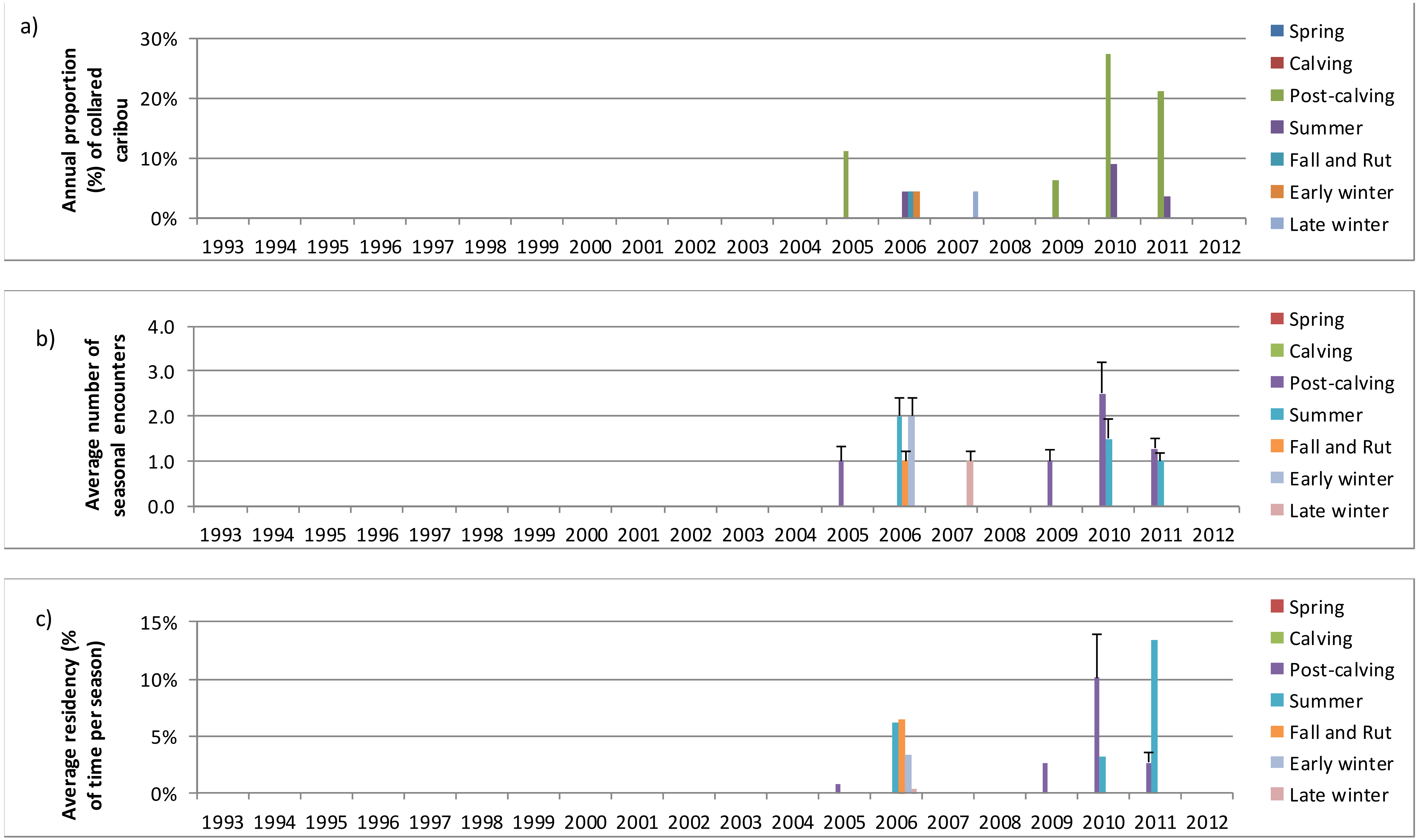

Figure 13.2-11 ***a)*** **Proportion of collared Qamanirjuaq caribou in the Mine and All-Season Road ZOI by season from 1993 to 2012,** ***b)*** **Average number of encounters of collared Qamanirjuaq caribou with the Mine and All-Season Road ZOI by season from 1993 to 2012, and** ***c)*** **Average residency time of collared Qamanirjuaq caribou in the Mine and All-Season Road ZOI by season from 1993 to 2012.**

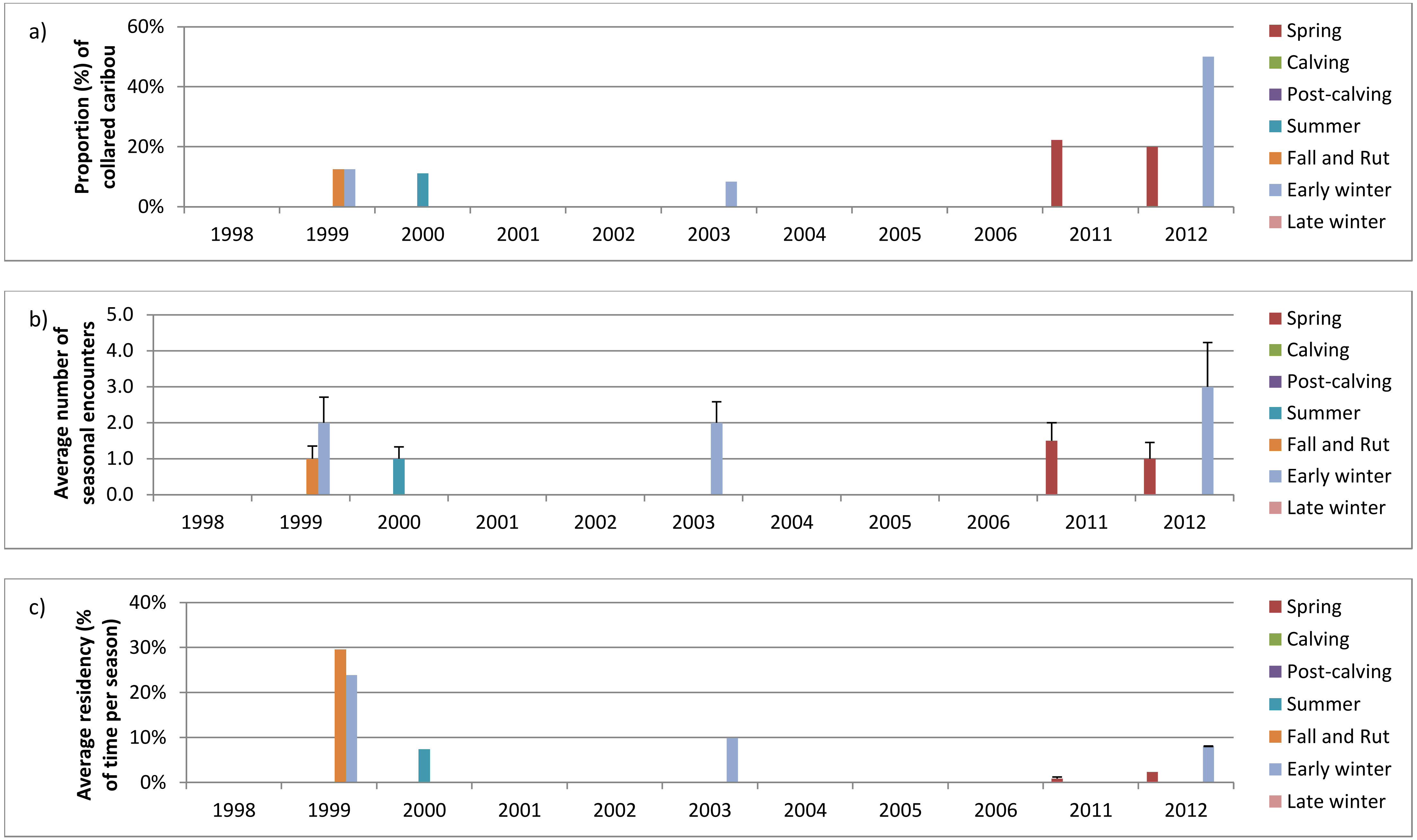

Figure 13.2-12 ***a)*** **Proportion of collared Lorillard caribou in the Mine and All-Season Road ZOI by season from 1998 to 2012 (excluding 2007–2010),** ***b)*** **Average number of encounters of collared Lorillard caribou with the Mine and All-Season Road ZOI by season from 1998 to 2012 (excluding 2007–2010), and** ***c)*** **Average residency time of collared Lorillard caribou in the Mine and All-Season Road ZOI by season from 1998 to 2012 (excluding 2007–2010).**

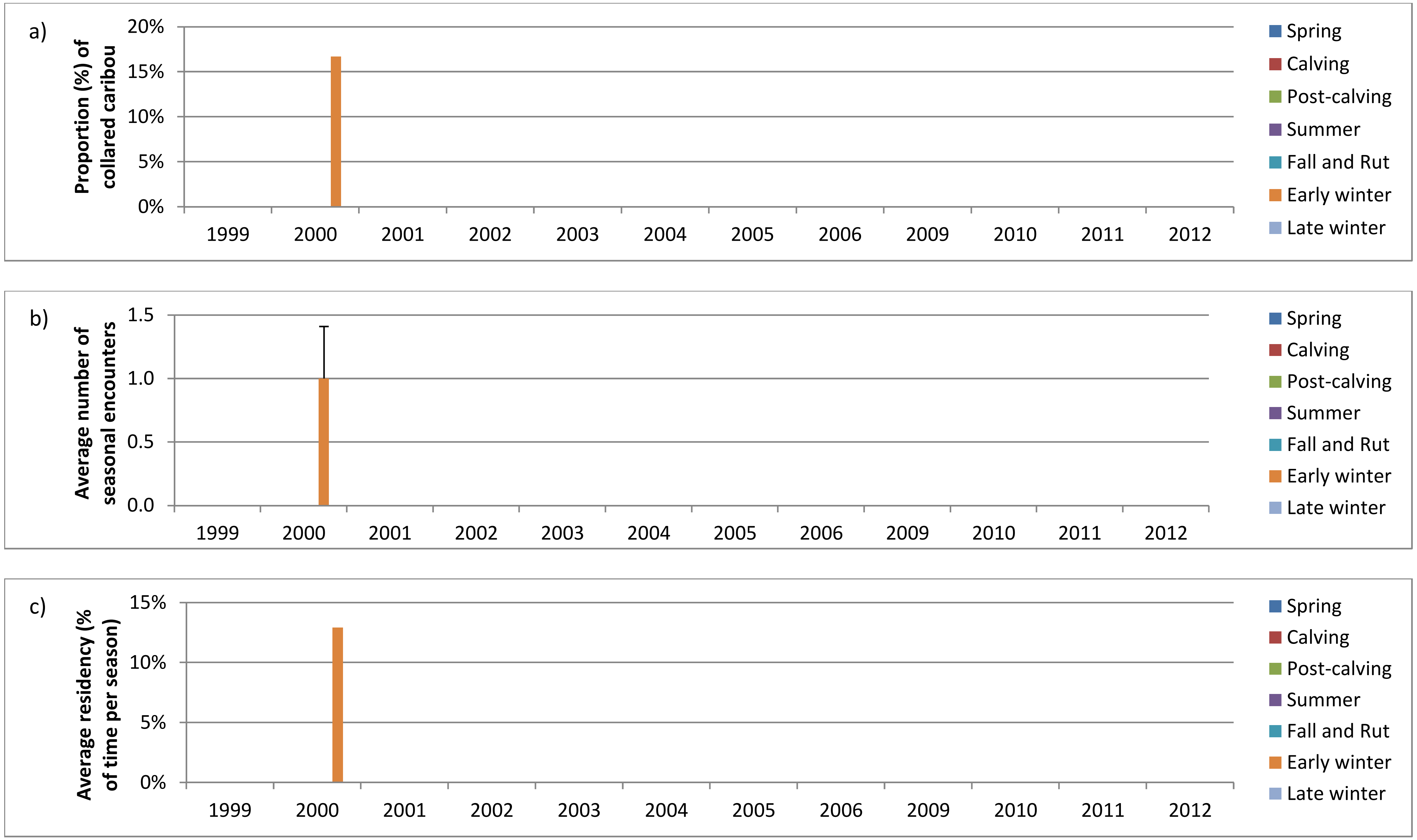

Figure 13.2-13 ***a)*** **Proportion of collared Wager Bay caribou in the Mine and All-Season Road ZOI by season from 1999 to 2012 (excluding 2007–2008),** ***b)*** **Average number of encounters of collared Wager Bay caribou with the Mine and All-Season Road ZOI by season from 1999 to 2012 (excluding 2007–2008), and** ***c)*** **Average residency time of collared Lorillard caribou in the Mine and All-Season Road ZOI by season from 1999 to 2012 (excluding 2007–2008).**

Table 13.2-14 Summary of Non-designated Caribou Water Crossings Known to Occur within 10 km of the Mine and All-Season Road Footprint

Water Crossing	Source	Protection	Distance to Project Footprint (km)
Long Lake (south end)	IQ study	None	7.8
Northwest of Baker Lake	IQ study	None	1.8
Thelon River	Baseline study	None	1.5
Thelon River west of Baker Lake	Baseline study	None	4.3
Source: Government of Nunavut and Government of Northwest Territories caribou collar data.			

Mine and Winter Road

The Winter Road option will be operational for less than 90 days per year, presumably from December to March, so the timing of seasonal construction and use of the Winter Road will overlap with spring migration in March but will not overlap with fall migration. After mitigation, residual effects of the Project on caribou movement across the mine and along the Winter Road include loss of potential spring migratory routes because of mine site infrastructure and potential avoidance of some water crossings. Caribou will be unable to move through some areas that were previously available (e.g., open pits, airstrip). The routing of the Winter Road option is within 10 km of non-designated water crossings.

Ahiak collared caribou appear to have the most interaction with the Winter Road ZOI during early winter. From 2005 to 2012, during the spring migration, the greatest proportion of collared animals in the Mine and Winter ZOI was in 2010 (15.8% of collared animals, Figure 13.2-14a). In terms of localized movements, the greatest average number of encounters (3.0 encounters) with the ZOI was during early winter in 2009 (Figure 13.2-14b). Of the collared caribou that encountered the ZOI from 2005 to 2012, the greatest average residency time (51.7%, n=1) was spent during fall and rut in 2012 (Figure 13.2-14c). It is expected that little interaction will occur during this time because the Winter Road will not be operational during fall and rut.

Qamanirjuaq caribou move through and within the Mine and Winter Road ZOI primarily during post-calving when the Winter Road is not operational. From 1993 to 2012, during the spring migration, the greatest proportion of collared Qamanirjuaq caribou in the ZOI was during post-calving in 2010 (36.4% of collared animals; Figure 13.2-15a). Collared Qamanirjuaq caribou did not interact with the ZOI from 1993 to 2004, and it was not until 2005 that some collared animals began encountering the ZOI (Figure 13.2-15a). Although no collar locations were recorded in the ZOI from 1993 to 2004, this does not necessarily suggest there was a change in distribution, rather, the number of collars in the herd increased from about 2004 onwards, likely capturing more of the variability in herd distribution. In terms of localized movements, the greatest average number of encounters (4.0 encounters) with the ZOI was during early winter in 2006 (Figure 13.2-15b). Of the collared caribou that encountered the ZOI from 2005 to 2012, the greatest average residency time (13.4%, n=1) was spent during summer in 2011 (Figure 13.2-15c). It is expected that little interaction will occur during this time, as the Winter Road will not be operational during the summer.

Of the tundra wintering caribou herds, Lorillard caribou have the greatest interaction with the Mine and Winter Road ZOI. From 1998 to 2012 (excluding 2007–2010 when no Lorillard caribou were collared), the greatest proportion of collared Lorillard caribou in the ZOI was during spring in 2011 and 2012 (22.2% and 20.0% of collared animals, respectively; Figure 13.2-16a). In terms of localized movements, the greatest average number of encounters (3.0 encounters) with the ZOI was during early winter in 2003 (Figure 13.2-16b). Of the collared caribou that encountered the ZOI from 1998 to 2012, the greatest average residency time (29.6%, n=1) was spent during fall and rut in 1999 (Figure 13.2-16c).

According to collar data, Wager Bay caribou interact with the Winter Road ZOI only during early winter. From 1999 to 2012 (excluding 2007–2008 when no Wager Bay caribou were collared), the greatest proportion of collared Wager Bay caribou in the ZOI was during early winter in 2000 (16.7% of collared animals; Figure 13.2-17a). In terms of localized movements, the greatest average number of encounters (1.0 encounter) with the ZOI was during early winter in 2000 (Figure 13.2-17b). This collared caribou had an average residency time of 9.4% (n=1) during early winter in 2000 (Figure 13.2-17c).

Five unprotected water crossings are within 10 km of the Winter Road footprint, but no protected water crossings are within 10 km of the Project footprint (Table 13.2-15; Figure 13.2-18). The footprint of the Winter Road overlaps with one unprotected water crossing. The Winter Road will only be used from December to March, so use of the road will only overlap temporally with caribou migration during March, and this will likely not be in open water season when water crossings are used. Temporary traffic shutdowns when caribou are moving through the area will mitigate effects on caribou movement during migration.

Residual effects of the mine are not anticipated to cause a detectable change in baseline caribou migrations or localized movements. The limited number of caribou that migrate through the area are animals from the Ahiak herd, likely on the edge of their migratory route, and the Project mitigations should miinimize Project effects on caribou migration. The Project will interact with more localized movements of the Qamanirjuaq, Lorillard, and Wager Bay herds. However, while caribou herds are known to be dynamic (Nagy et al. 2011), how caribou migration and calving areas might change in the future cannot be predicted. This is a technical limitation of the assessment. The worst-case scenario for the Kiggavik Project is a herd shifting its calving area so that the herd starts to migrate through the RAA. If this were to occur, caribou could experience some restricted migration from the Project structures and activities. The magnitude of this effect would still likely be small because of applied mitigations, but the increased interaction could result in some type of diversion as caribou move across the ZOI.

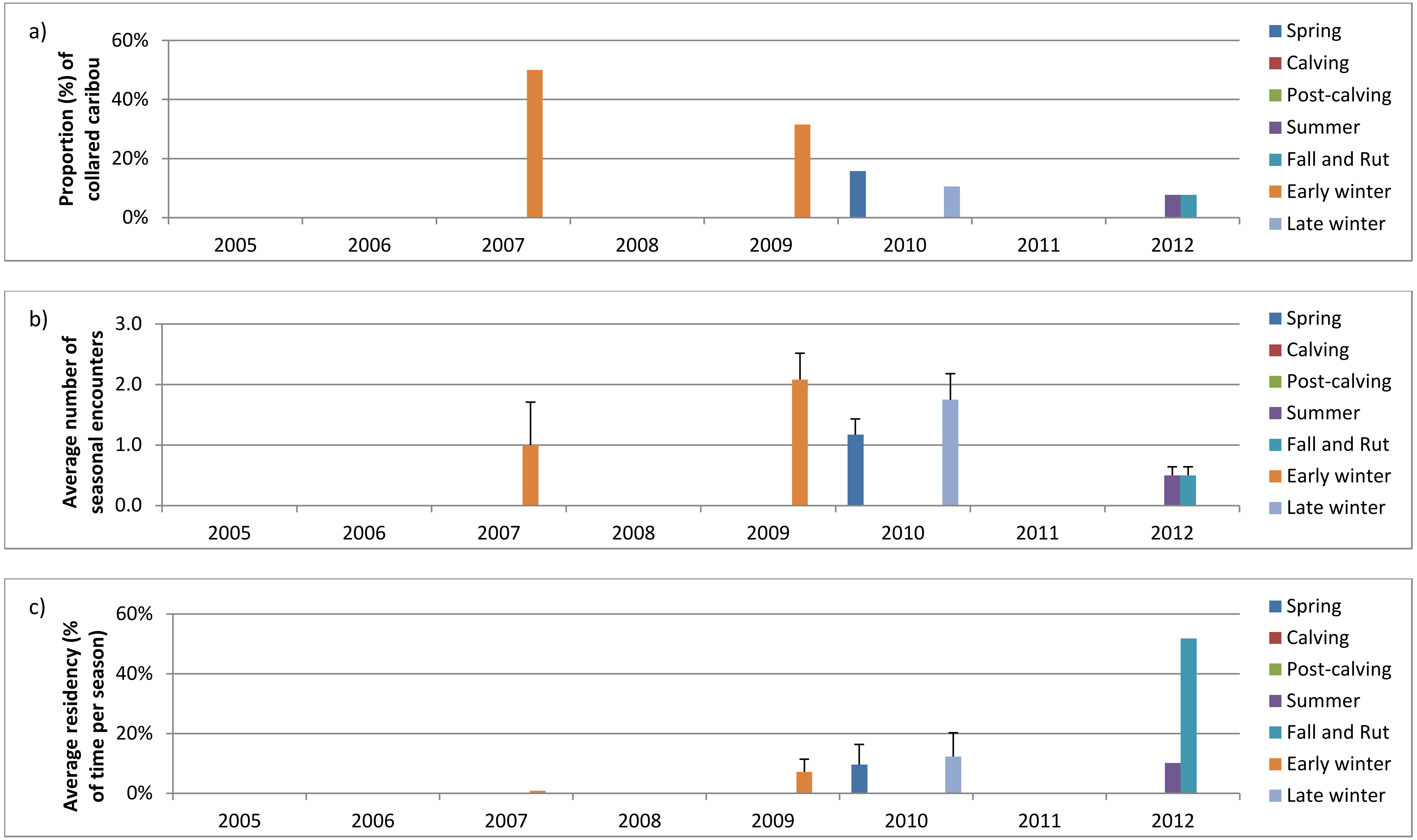

Figure 13.2-14 ***a)*** **Proportion of collared Ahiak caribou in the Mine and Winter Road ZOI by season from 2005 to 2012,** ***b)*** **Average number of encounters of collared Ahiak caribou with the Mine and Winter Road ZOI by season from 2005 to 2012, and** ***c)*** **Average residency time of collared Ahiak caribou in the Mine and Winter Road ZOI by season from 2005 to 2012.**

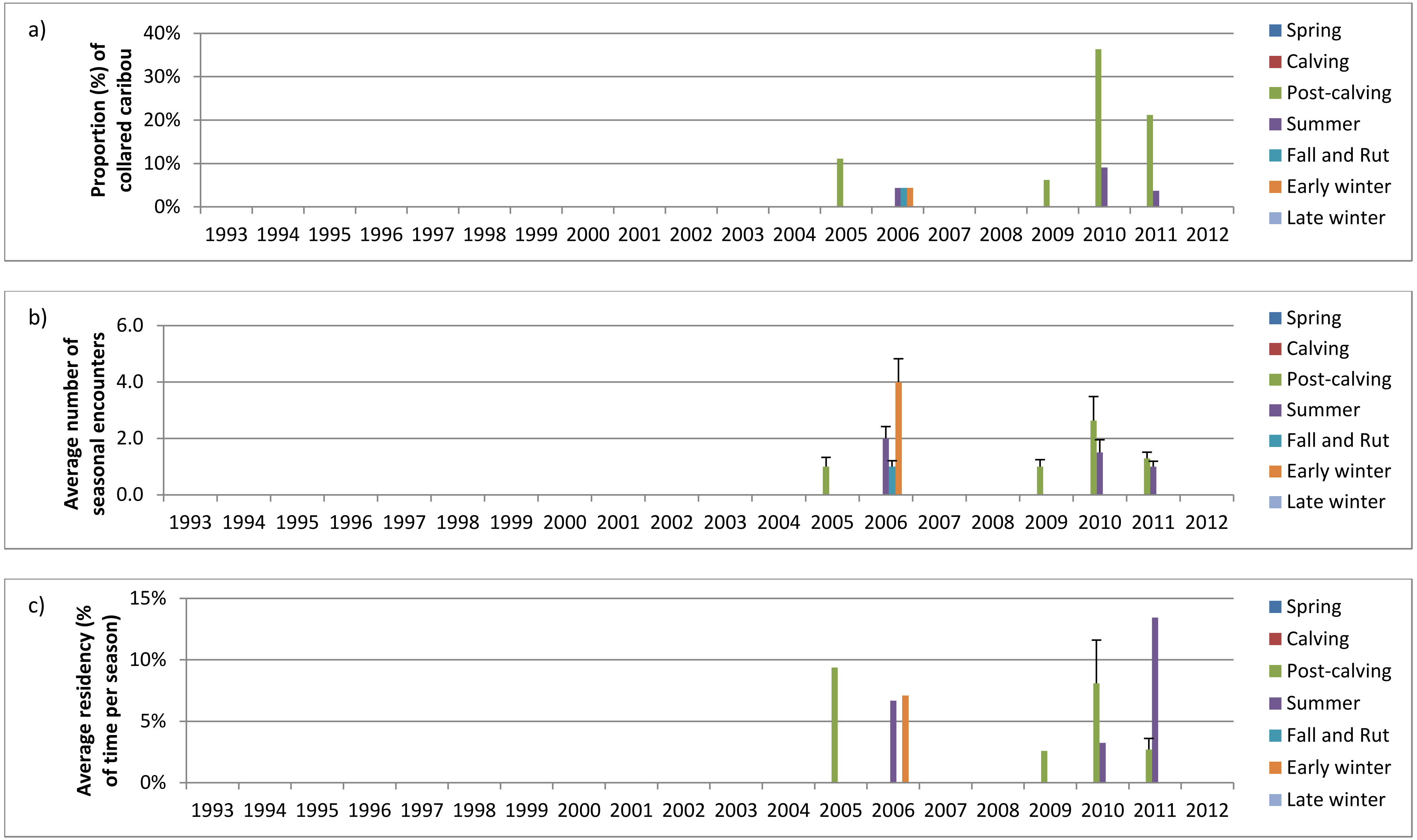

Figure 13.2-15 ***a)*** **Proportion of collared Qamanirjuaq caribou in the Mine and Winter Road ZOI by season from 1993 to 2012,** ***b)*** **Average number of encounters of collared Qamanirjuaq caribou with the Mine and Winter Road ZOI by season from 1993 to 2012, and** ***c)*** **Average residency time of collared Qamanirjuaq caribou in the Mine and Winter Road ZOI by season from 1993 to 2012.**

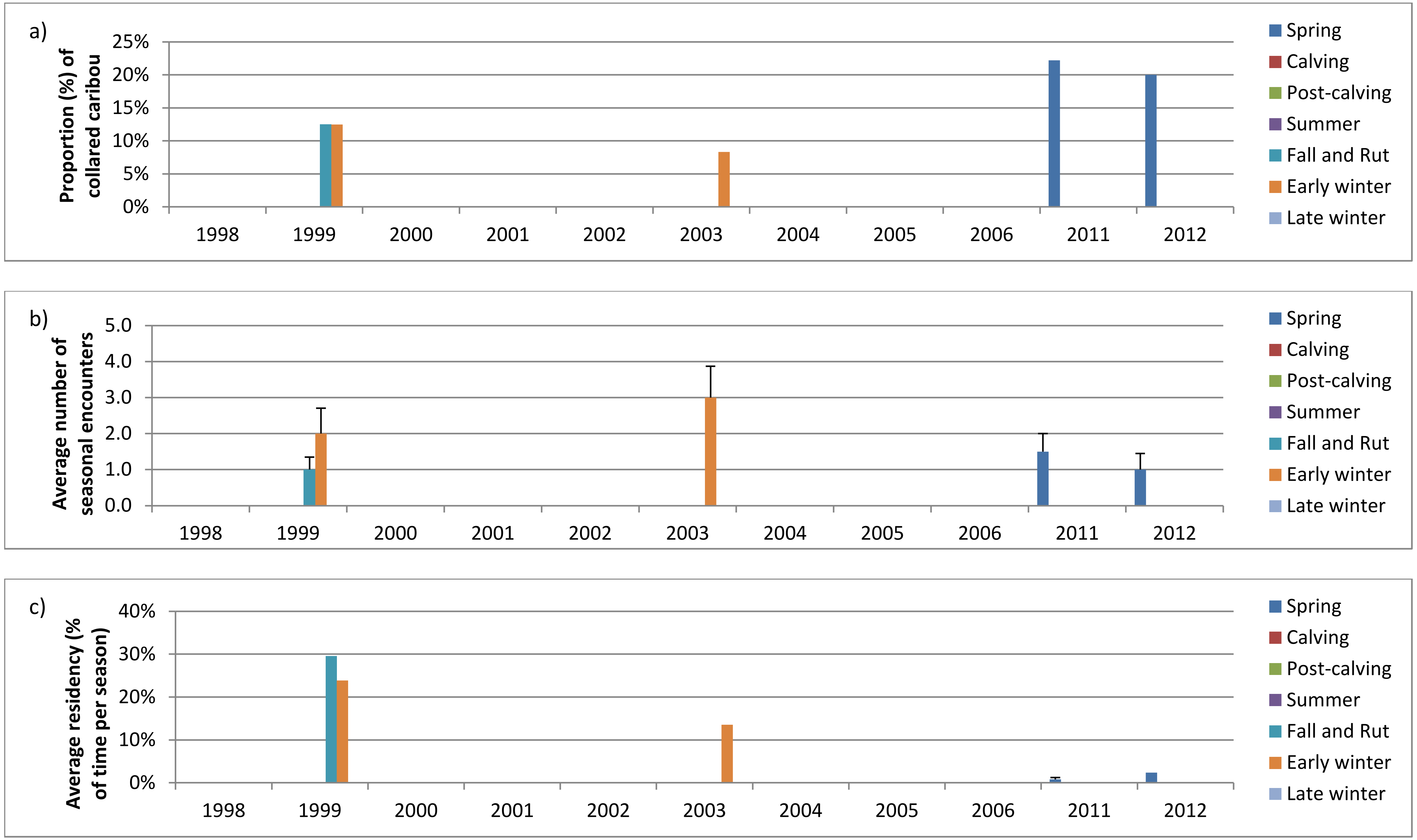

Figure 13.2-16 ***a)*** **Proportion of collared Lorillard caribou in the Mine and Winter Road ZOI by season from 1998 to 2012 (excluding 2007–2010),** ***b)*** **Average number of encounters of collared Lorillard caribou with the Mine and Winter Road ZOI by season from 1998 to 2012 (excluding 2007–2010), and** ***c)*** **Average residency time of collared Lorillard caribou in the Mine and Winter Road ZOI by season from 1998 to 2012 (excluding 2007–2010).**

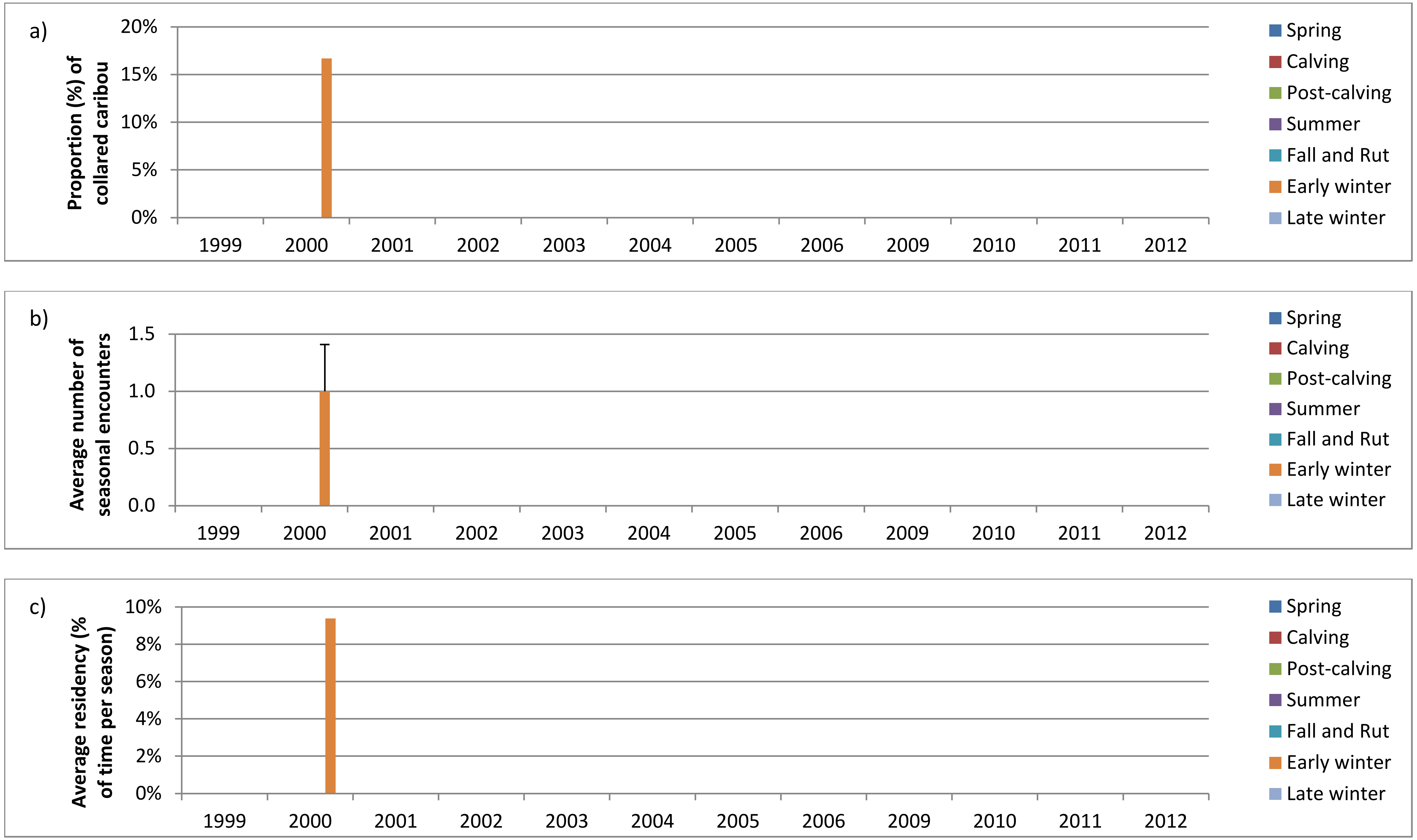

Figure 13.2-17 a) Proportion of collared Wager Bay caribou in the Mine and Winter Road ZOI by season from 1999 to 2012 (excluding 2007–2008), b) Average number of encounters of collared Wager Bay caribou with the Mine and Winter Road ZOI by season from 1999 to 2012 (excluding 2007–2008), and c) Average residency time of collared Lorillard caribou in the Mine and Winter Road ZOI by season from 1999 to 2012 (excluding 2007–2008).