TERRESTRIAL WILDLIFE
Mountain Goat Studies: 2015-2018
Constantine Mining: Palmer Project Site

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Prepared for:

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Project No. 989239-02

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May 23, 2018
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Constantine Metal Resources Ltd.
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Attention: Darwin Green, VP of Exploration

Dear Darwin:

Re: Palmer Project Wildlife Monitoring Program

Constantine Metal Resources (Constantine) engaged Hemmera to conduct mountain goat surveys between June 2015 and February 2018 to better understand distribution, abundance, and movement of mountain goat populations near the Palmer Exploration Project (the Project) near Haines, Alaska.

The information presented in this report summarizes results from seven mountain goat surveys including: two summer surveys (completed June 2015 and 2017), three fall surveys (completed September 2015, 2016, and 2017), and two winter surveys (completed February 2017 and 2018). Survey results are collated herein.

Regards,

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EXECUTIVE SUMMARY

Mountain goat (*Oreamnos americanus*) was identified as a Species of Interest (SOI) during preliminary wildlife studies completed in 2014 for the Palmer Exploration Project (the Project). Beginning June 2015, Constantine engaged Hemmera to conduct mountain goat surveys within a defined geographic area surrounding the Project referred to as the Tsirku-Klehini mountain goat survey block (Tsirku-Klehini Block). Prior to study commencement in 2015, input was solicited from key personnel within the Alaska Department of Fish and Game (ADFG) to delineate the study area and to guide mountain goat field surveys conducted by Hemmera between 2015 and 2018. Methods used for the surveys and for delineation of the Tsirku-Klehini Block were consistent with recommendations provided by ADFG.

Information regarding mountain goat abundance, distribution, productivity, and juvenile survivorship was collected over four years: 2015 (June and September), 2016 (September), 2017 (February, June, and September), and 2018 (February). Data from all surveys and all years is collated, analyzed, and reported herein. This information has been obtained to inform and support future Project plans, including the regulatory review and approval of any such plans, as well as to support longer-term goat management and conservation as the Project advances. Goat distribution and survey data to inform estimates of abundance, productivity, and survivorship collected by Hemmera were similar to numbers reported in previous annual counts conducted by ADFG in the area. This suggests that the mountain goat population within the Tsirku-Klehini Block is likely stable. Compared with other areas in the surrounding Haines mountain goat census area, densities of mountain goats in the Tsirku-Klehini Block were in the mid-range of densities previously observed by ADFG.

Additional information pertinent to goat management for the Project is also summarized herein, including analysis of goat habitat use and distribution. To depict areas of high summer use, results from two summer surveys (June 2015 and 2017) were analyzed. To depict fall and winter habitat use, results from three fall surveys (September 2015, 2016, and 2017) were analyzed. Fall distribution was also analyzed to predict winter distribution. Accordingly, data from fall surveys was assessed relative to context provided by a Resource Selection Function (RSF) winter habitat model provided by ADFG; (White et al. 2016). Prior to the 2017 and 2018 winter surveys led by Hemmera (this report) no formal model validation exercise had been documented within the Tsirku-Klehini Block

Finally, winter surveys were conducted in February 2017 and 2018 to assess winter use of a small (focused) portion of the Tsirku-Klehini Block. These surveys were conducted to better understand winter habitat use within the relatively smaller Project area.

In general, very few goats were observed in the Saksaia Glacier and Flower Mountain areas (all years), which includes the Palmer Project area and Tsirku-Klehini Block study area. The pattern of mountain goat distribution in the Tsirku-Klehini Block surveys, including the low number of mountain goats recorded in the Project area, is regarded as typical for this area and is consistent with observations from ADFG surveys conducted in the smaller Porcupine Creek Block[1].

[1] The Porcupine Creek Block is a mountain goat census area that was previously defined and surveyed by ADFG prior to commencement of surveys conducted by Hemmera for Constantine. The Tsirku-Klehini Block was delineated to capture a larger area that includes the Project area.

This work was performed in accordance with a Professional Services Agreement between Hemmera Envirochem Inc. ("Hemmera") and Constantine Metal Resources Ltd. ("Client"), dated October 12, 2017 ("Contract"). This Report has been prepared by Hemmera, based on fieldwork conducted by Hemmera and Wildfor Consultants Ltd., for sole benefit and use by the Client. In performing this work, Hemmera has relied in good faith on information provided by others and has assumed that the information provided by those individuals is both complete and accurate. This work was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work and project terms of reference; further, the findings are time sensitive and are considered valid only at the time the Report was produced. The conclusions and recommendations contained in this Report are based upon the applicable guidelines, regulations, and legislation existing at the time the Report was produced; any changes in the regulatory regime may alter the conclusions and/or recommendations. This Executive Summary is not intended to be a "stand-alone" document, but a summary of findings as described in the following Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

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1.0 INTRODUCTION

Constantine Mining LLC. (Constantine) is advancing a mineral exploration project near Haines Alaska (Palmer Exploration Project, or Project). To support the exploration and potential advancement to future mine feasibility and development, Constantine initiated baseline wildlife studies in 2014 and engaged Hemmera to conduct mountain goat (*Oreamnos americanus*) surveys commencing in 2015. Mountain goat was selected for assessment to inform the integration of focused species management considerations into Project development mountain goat is known to occur in the region surrounding the Project area. There is also recognition of potential for Project-related effects to mountain goat due to disturbance from helicopters. These concerns were presented in the Bureau of Land Management's (BLM) Ring of Fire Resource Management Planning process and documented in the Project's Draft Environmental Assessment (US BLM 2016: DOI-BLM-AK-A020-2016-006-EA). In 2015, Constantine began studies to develop an improved understanding of mountain goat habitat use and distribution within and surrounding the Project. An understanding of use and distribution within the study area has been used annually, during planning processes, to inform focused management for mountain goat.

The focus of aerial surveys conducted between 2015 and 2018 was within a biologically relevant mountain goat subpopulation unit bounded by the Tsirku River, Klehini River, and icefields to the west. This area is referred to as the Tsirku-Klehini mountain goat survey block (Tsirku-Klehini Block) (**Figure 1**). It is anticipated that the information presented in this report will be used to inform the integration of goat management in future work planning processes, including community engagement and consultation during regulatory approval processes. These activities will benefit and be supported by an understanding of mountain goat abundance, distribution, habitat association, and habitat use in and surrounding the Project area.

Specific objectives of the 2015-2018 mountain goat survey and assessment program include:

1. Measure annual abundance and distribution of mountain goat in the Tsirku-Klehini Block.
2. Assess population productivity through consideration of adult/kid ratios in June (i.e., post-kidding period).
3. Assess juvenile (kid) survivorship through consideration of adult/kid ratios in September (i.e., post summer season).
4. Assess goat winter use of habitats in the Tsirku-Klehini Block and within a smaller area surrounding the Project site (i.e., within the local area bounding the area of intensive exploration activity at the head of Glacier Creek valley), hereafter referred to as the Project area.

Findings from four years of survey are reported herein. All reported field studies, analysis, and presentation of results were completed between June 2015 and March 2018.

This work was performed in accordance with a Professional Services Agreement between Hemmera Envirochem Inc. ("Hemmera") and Constantine Metal Resources Ltd. ("Client"), dated October 12, 2017 ("Contract"). This Report has been prepared by Hemmera, based on fieldwork conducted by Hemmera and Wildfor Consultants Ltd., for sole benefit and use by the Client. In performing this work, Hemmera has relied in good faith on information provided by others, and has assumed that the information provided by those individuals is both complete and accurate. This work was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work and project terms of reference; further, the findings are time sensitive and are considered valid only at the time the Report was produced. The conclusions and recommendations contained in this Report are based upon the applicable guidelines, regulations, and legislation existing at the time the Report was produced; any changes in the regulatory regime may alter the conclusions and/or recommendations. This Executive Summary is not intended to be a "stand-alone" document, but a summary of findings as described in the following Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

2.0 SPECIES BACKGROUND INFORMATION

Mountain goats are common and widespread in the mountains of southeast Alaska. They are recognized as an important harvestable game animal by the Alaska Department of Fish and Game (ADFG), and have been, and continue to be, an important focal species for monitoring and research in the Haines mountain goat census area, including the Tsirku-Klehini Block.

Mountain goat populations are generally associated with steep escape terrain, which is critical for predator avoidance. The angle that constitutes suitable escape terrain can vary depending on geology and terrain; however, slopes ≥ 40º are typically used (Mountain Goat Management Team 2010). When dispersing, mountain goats rarely venture more than 400 – 500 m from escape terrain except when making long distance movements such as seasonal range movements and excursions to mineral licks (Chadwick 1973, Poole and Heard 2003, Taylor et al. 2006). The quality of seasonal ranges is therefore dependent on the combination of forage habitat in proximity to escape terrain (Mountain Goat Management Team 2010). Four habitat types are generally recognized when considering annual mountain goat life requisites: winter habitat, summer habitat, natal areas, and mineral licks. Distances among different habitat types and associated seasonal movement patterns varies widely among populations and geographic regions and can include substantial differences in elevation as well as horizontal distances of up to 35 km (21.75 miles) (Nichols 1985, Poole and Heard 2003).

Annual home range estimates for mountain goat, based on values presented for southeast Alaska, vary from 6.3 – 44.9 km^2 ((3.91-17.34 square miles)(Peek 2000). Typically, males are reported to have significantly smaller home ranges than females. For example, in Alberta male mountain goats have been reported to occupy 5 km^2 (1.93 square miles) annual home ranges while females occupy 25 km^2 (9.65 square miles) annual home ranges (Côté unpublished data). In Alaska, however, average male home ranges are reported to be larger than home range movements for females. Irrespective of home range size differences between sexes, mountain goats in southeastern Alaska have reported home ranges of between 10 – 20 km^2 (3.86-7.72 square miles) with a maximum reported home range of up to 90 km^2 (34.75 square miles)(Smith 1985 cited in Fox et al. 1989). For the purposes of this study, 20 km^2 (7.72 square miles) as accepted as an upper estimate of home range size within the Tsirku-Klehini Block.

The winter season presents the most limiting conditions for mountain goats due to reduced forage availability, cold temperatures, and high energetic cost of travelling through deep snow (Chadwick 1973, Fox et al. 1989, Côté and Festa-Bianchet 2003, Taylor and Brunt 2007, Poole et al. 2009). In addition to escape terrain and forage availability, winter habitat typically occurs in areas where geophysical attributes result in reduced snow depths. These attributes can include, independently or in combination, slopes steep enough to shed snow, low elevation, south aspect, windblown ridges, and forest canopy that provides snow interception (Hebert and Turnbull 1977, Taylor et al. 2006, Taylor and Brunt 2007, Poole et al. 2009). Winter ranges typically comprise a small proportion of an annual home range and may be as small as 8 – 20 ha (Fox et al. 1989, Taylor et al. 2006). Two types of winter habitat are typically described in the literature:

1. In lower elevation or maritime influenced areas with steep, warm aspect slopes, goat winter habitat typically occurs at or below treeline where the combination of aspect, lower elevation, and forest canopy reduces snow depths. In the Haines mountain goat census area, White et al. (2011b) subdivided lower elevation habitat use into two types: mid elevation areas at or below treeline and low elevation areas well below treeline, in lower slope positions, often near valley bottoms or by the ocean.

2. In high elevation areas, goat winter habitat occurs along windblown ridges and mountain tops. Limited telemetry data and snow depth information suggests that mountain goats in interior regions of the Tsirku-Klehini Block primarily use high elevation alpine type habitat, with secondary use of mid-elevation treeline habitats (K. White pers. comm.).

Generally, use of low elevation winter habitat is associated with coastal areas. In contrast, use of upper elevation winter habitat is associated with interior (mountainous) areas (Hebert and Turnbull 1977). Local data suggests that mountain goats in the Haines census area use both types of habitats; with use of low elevation habitats being more common in maritime influenced regions. In more interior regions, deep snow continues down to valley bottom elevations and likely precludes use of low elevation habitats. Both types of winter habitat may occur and be used by mountain goats within the Tsirku-Klehini Block. More detailed information (i.e., winter surveys or more intensive telemetry studies) are required to confirm winter habitat use in the Tsirku-Klehini Block.

Summer habitat includes a wider range of biophysical characteristics relative to winter use areas; however, proximity to escape terrain remains a key factor in determining habitat quality. Mountain goats tend to travel more frequently and over greater distances in the summer than in the winter (Côté and Festa-Bianchet 2003). Habitat use and seasonal movements in southeast Alaska often include an elevational shift that follows the progression of green-up (BLM 2012).

Natal sites are described as areas where nannies give birth (in late May and June) and then spend their first few days in isolation with their kids. These areas generally occur near or within winter habitat areas (Mountain Goat Management Team 2010). Natal areas are generally secluded. These areas provide security habitat (i.e., vegetative cover) and are not regularly frequented by other goats. Several days after birth, nannies with kids tend to form nursery groups that may include other adult females and sub-adults of both sexes. Shortly after birthing, nannies and kids begin moving toward summer ranges for forage.

Mineral licks can be important habitat areas for mountain goats in many areas, especially in interior populations. The primary mineral being sought is believed to be sodium; possibly due to the low sodium content in most alpine plants (Mountain Goat Management Team 2010). Elevated levels of magnesium, manganese, iron, and copper have also been reported at lick sites and are known to be important mineral supplements for other ungulates (Dormaar and Walker 1996, Ayotte et al. 2006). Many populations of mountain goat make regular use of natural mineral licks; often travelling to low elevation sites or areas distant from their usual home ranges to reach these mineral licks (Rideout 1974, Hebert and Turnbull 1977, Hopkins et al. 1992, Ayotte et al. 2006, Poole et al. 2010). The use of mineral licks by mountain goats in coastal areas, however, is currently unreported in the Haines mountain goat census area (Mountain Goat Management Team 2010, K. White pers comm. 2015).

3.0 PHYSICAL SETTING

The Palmer Project is a mineral exploration project owned by Constantine Mining LLC. (Constantine) and operated by Constantine North Inc. (a subsidiary of Constantine Metal Resource Ltd.). The Project is located in coastal southeast Alaska, on the southeast margin of the Saint Elias Mountain Range. The Project area is accessible by existing road infrastructure (Highway 7 and Highway 3) connecting Haines, Alaska, through British Columbia, with Haines Junction in the Yukon. The Project area hosts high-grade copper-zinc-silver-gold mineralization within the Alexander Triassic Metallogenic Belt. A mineral exploration project is underway by Constantine. Project activities in 2014 through 2017 included exploration drilling, road construction, construction of an equipment laydown area along the south side of Glacier Creek, and ongoing environmental and geotechnical studies.

The year-round deep-sea port of Haines is located 60 km (37.28 miles) south of the Project area. Average annual weather patterns are described for Haines as follows. Average temperature varies from -7°C to 18°C and rarely falls below -15°C. The warm season extends from May 18 through September 8 with average daily high temperatures above 14°C. The cold season extends from November 14 through March 14 with average daily high temperatures below 2°C. Daylight hours at the summer solstice (June 21) are 18:34 hours; by winter solstice there are only 6:06 hours of daylight. Median cloud cover ranges from 69% (partly cloudy) to 99% (overcast). The climate is temperate rainforest with average precipitation of 119 cm (47 inches), approximately two-thirds of which occurs as snow.

The Project area includes the Glacier Creek watershed and portions of the Porcupine Creek watershed and portions of the Klehini River drainage catchment (**Figure 1**). The Project area is in steep, mountainous terrain, with 1,219 m (4,000 feet (ft.)) of relief. The Tsirku-Klehini Block has an elevation relief of 1,939 m (6,361 ft.) with a lower elevation limit of 291 m (954 ft.) and an upper elevation limit of 2,230 m (7,316 ft.). At upper elevations, several glaciers originate from the summit of Mt. Henry Clay located at the western edge of the Project area. The Klehini River runs through the northern extent of the Tsirku-Klehini Block. The Tsirku River defines the southern extent of the Tsirku-Klehini Block.

The extent of the Tsirku-Klehini Block study area encompasses a large area (348 km^2); 134 square miles) surrounding the Palmer Project. This Tsirku-Klehini Block was tailored to account for ecological factors (see **Section 5.0**) and considered potential Project interactions with goats in the Tsirku-Klehini Block. A Project area within the Tsirku-Klehini Block was defined to delineate a zone of high mineral exploration activity. Within this area, goats may be directly and indirectly affected by disturbance from Project activities. Disturbance is primarily associated with operation of helicopters, heavy machinery, vehicles, generators, and potential blasting activities. The Project area encompasses a total area of 24 km^2 (9.3 square miles)(2,401 ha) (**Figure 1**).

Terrestrial Wildlife and Habitat Assessment
Constantine Metal Resources
Palmer Project Site

Overall Study Area at the Constantine Palmer Project Site

Legend

- Tsirku-Klehini Block
- Project Area Core
- Federal Mining Claims
- Road
- International Boundary
- Watercourse
- Waterbody

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basedata: Government of Canada, Government of British Columbia, State of Alaska
- Aerial Image: Alaska SPOT 5 m Colour.
- Basemap & Inset: ESRI World Topographic Map

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4.0 METHODS

4.1 Mountain Goat Population Surveys

Study design and aerial survey methods generally followed standards described in the BC Resource Inventory Standards Committee guidelines for mountain goat survey (RISC 2002) and align with methods used by ADFG (White et al. 2014). Standard ADFG forms and data codes were used to maximize consistency of methods for comparison of results to previous and future ADFG surveys in the larger Haines mountain goat census area. ADFG staff participated in the 2015 summer and fall surveys. All other surveys, including those conducted in 2016, 2017, and 2018 were led by Hemmera Senior Biologist Jared Hobbs with assistance provided by Todd Mahon (Senior Biologist: Wildfor Consulting Ltd.) or Andrew Venning (Junior Biologist: Hemmera).

Before survey, a new census area was delineated to include a discrete mountain block bordered to the south and east by the Tsirku River and to the north by the Klehini River valley. The international US/Canada border approximately defined the western extent. The census area is referred to as the Tsirku-Klehini Block. The Tsirku-Klehini Block occurs within the ADFG Haines mountain goat census area and includes an expanded area relative to the ADFG Porcupine Block (**Figure 1**). The Tsirku-Klehini Block was delineated to incorporate additional area on the west side of Porcupine Block based on advice provided by ADFG mountain goat biologist Kevin White (pers. comm.).

A defined route was flown for all surveys in the Tsirku-Klehini Block undertaken between 2015 and 2018 (**Figure 2** and **Figure 3**). Surveys commenced at the eastern end of the Tsirku River. The flight path followed the Tsirku River upstream and then traversed over the Saksai Glacier to Glacier Creek. The survey route continued west along the Klehini River before circling back to survey the area along Flower Mountain and continuing downstream along the Klehini River valley back to the Tsirku River. For the overlapping section of the route along the Tsirku River, observations were assessed to ensure no goats were double counted. This was achieved by reviewing results for observations with identical group size and cohort composition recorded in the same vicinity.

In terms of seasonal chronology, the 2015 and 2016 surveys were conducted to target summer and fall habitat use. In 2017 and 2018, seasonal scope was expanded to also consider goat winter habitat use in the Project area (**Figure 1**) with a specific focus on the south side of the Glacier Creek valley.

Surveys consisted of aerial transects using an estimated 1 km (0.62 mile) fixed-width distance or as limited by extent of sightability (see **Results** and **Discussion** sections). Seven surveys of the Tsirku-Klehini Block were conducted: two in 2015 (June 23 and September 22), one in 2016 (September 11), three in 2017 (February 19, June 23, and September 7) and one in 2018 (February 6). All surveys were conducted in the morning to take advantage of cooler conditions (<10°C during the summer and fall) when goats are most active and visible.

- **2015**: An A-Star 350B2 helicopter was used for the 2015 summer survey (June 23): Kevin White, Jared Hobbs, and Todd Mahon were observers. The 2015 fall survey was conducted on September 22 using a Cessna 172 fixed-wing aircraft: Jared Hobbs, Carl Koch, and Andrew Venning were observers.
- **2016**: The 2016 fall survey (September 11) utilized a Dehavilland Beaver floatplane with stall kit for low speed flying. Jared Hobbs, Darsie Culbeck, and Todd Mahon were observers.

- **<u>2017</u>**: The 2017 winter (February 19) and summer surveys (June 23) were conducted using a Cessna 172 fixed-wing aircraft: Jared Hobbs and Todd Mahon were observers. The fall survey was completed on September 7 using a Jet Ranger helicopter: Todd Mahon and Jared Hobbs were observers. Population census was not an objective for winter surveys in 2017 and 2018 – instead effort was focused on a high-intensity survey of winter habitat, and winter habitat use by goats, within the Project area only. Incidental observations were noted, when goats were encountered, throughout the rest of the Tsirku-Klehini Block but a relatively high altitude flight was conducted to avoid disturbance to goats during the sensitive winter period.
- **<u>2018</u>**: The 2018 winter (February 6) survey was conducted using a Jet Ranger helicopter: Todd Mahon and Jared Hobbs were observers. Population census was not an objective for winter surveys in 2017 and 2018 – instead effort was focused on a high-intensity survey of winter habitat, and winter habitat use by goats, within the Project area only. Incidental observations were noted, when goats were encountered, throughout the rest of the Tsirku-Klehini Block but a relatively high altitude flight was conducted to avoid disturbance to goats during the sensitive winter period.

All alpine and sub-alpine habitats, areas of broken or discontinuous cliff habitat, and avalanche chutes (extending below tree-line) were searched for mountain goats during survey flights. The flight routes were mapped using a Garmin Map60CSX GPS unit. Navigation was aided by an iPad GIS tablet pre-loaded with ortho-imagery of the Tsirku-Klehini Block. All goat observations were geo-referenced by GPS from the aircraft and the location of each goat (or group) was plotted on the iPad using GIS software. Goats were assigned to either adult or kid (<1yr) age cohorts. Goats marked with radio-telemetry collars (n=2 known in study area[2]) were noted when observed. Data on habitat, including terrain type (smooth, broken, very broken) and habitat type (rocky, alpine, thicket, snow, subalpine forest and mature forest) was recorded as per ADFG protocols. Mountain goat behaviour was recorded as bedded, feeding, sleeping, walking, or running.

In 2016, 2017, and 2018, goat groups were photographed using a Canon 7DX Mark II GPS-enabled camera with a 100 – 400mm USMII IS lens. Each photograph was georeferenced, and direction and distance to each goat was recorded by the camera for each image taken. This information was used immediately after the flight to more accurately re-position the recorded location of each goat (or group of goats) observed during the flight and to verify survey counts and age assignments. Incidental sightings of wildlife of management concern, including bear and eagle, were also recorded (available elsewhere).

4.2 Analysis of Modelled Winter Habitat Availability and Use for the 2009 ADFG RSF Model

A resource selection function (RSF) model that predicted distribution of winter habitat within the Haines mountain goat census area was developed in 2009 and procured from ADFG (White et al 2011a) for analysis of predicted winter habitat within the Tsirku-Klehini Block. An updated model was developed and released by ADFG *after* the analysis for this report was completed and is therefore not considered herein (White and Gregovich 2018).

2 Based on observations and communication with Kevin White in 2015 only.

Key information about the ADFG 2009 model is summarized below; refer to White et al. (2011) for more details. The winter habitat RSF model was developed to spatially predict mountain goat winter habitat quality and distribution in the Haines mountain goat census area. It has been used by resource management agencies to support consideration of mountain goat habitat in land management decisions in and around the Haines area. Mountain goat location data used in the current RSF model consisted of 189 locations from 12 goats in the Kelsall area[3] collected between 1981 – 1983[4]. Habitat variables used in the model include: slope, aspect, elevation, distance to vertical escape terrain (areas with slope >40°) from a digital elevation model, and broad habitat type (forested, vegetated, and non-vegetated) from a terrestrial ecosystem land-cover map[5]. A logistic regression model and a k-fold cross validation procedure was used to quantify the relationship between the goat locations and habitat covariates (White et al. 2011). The resulting RSF model was then applied across the Haines mountain goat census area (including the Alaskan portion of the Tsirku-Klehini Block) and RSF ss were categorized into five quantile classes representing a gradient of habitat quality from low (1) to high (5). For this study, RSF classes 2-5 (low-moderate – high value) were combined and considered to be suitable habitat; RSF class 1 (low value) was considered to be unsuitable habitat. White et al. (2011) noted that there are potential limitations to extending the RSF predictions beyond the Kelsall area (where the goat data was collected); however, the model extrapolation was conducted under the circumstance of that information being the best available information at the time. Based on a review of model predictions relative to their experience and expectations, the model authors identified one particular bias: "*the model may accurately reflect use patterns only for mountain goats that exhibit the high-elevation wintering strategy and may not provide a fair representation of mountain goats described by the low and mid elevation wintering strategies*" (White et al. 2011a).

Model predictions from the RSF model have been used in previous mountain goat studies completed for Constantine in two ways:

1. To provide a geospatial summary of the amount and distribution of potential (predicted) winter habitat within the Tsirku-Klehini Block (refer to Hemmera 2015).
2. To provide a comparison of mountain goat density relative to potential (predicted) winter habitat between the Tsirku-Klehini Block and the 13 ADFG study areas (refer to Hemmera 2015).

In this report the performance of the ADFG RSF model was evaluated using goat locations from the past three September surveys (2015-2017). The purpose of this exercise was to use the local survey data to evaluate the performance of the regional ADFG model within the smaller Tsirku-Klehini Block. Specific objectives were to evaluate observed goat distribution relative to RSF values and to identify any apparent biases in the model at the local scale that could allow tailored use of the model for future monitoring or management. Although September is outside the winter period, it is a transitional month during which most goats have moved to winter range or are in the process of moving to winter range. September movements occur in advance of fall snowfalls as snowpack can hinder seasonal movement. Using data from outside the winter period is acknowledged as a potential limitation to this analysis; however, the September survey data is the only independent data currently available to evaluate the model.

[3] The Kelsall area includes portions of the Hiteshitak and Four Winds Mountain areas in **Figure 2**.

[4] A revised winter RSF model is currently under development using a larger dataset of goat locations from across the Haines mountain goat census area collected over the last 10 years (K. White, pers. comm. 2015).

[5] The Nature Conservancy, unpublished data, Juneau, AK.

Model evaluation was undertaken using two approaches:

1. The first approach comprised a comparison of September mountain goat observation locations and random points to RSF predictions using a simple selection index (Manly et al. 2007) across the five RSF bins (quintiles) provided by the model output. The selection index was calculated for each of the five RSF classes using the following formula:

   (% used locations - % available locations) / % available locations

   Using this formula, values > 0 indicate selection and values < 0 indicate avoidance. If the model is performing well in the Tsirku-Klehini Block, then the expectation was that the selection index value would be highest and > 0 (i.e. selected) in the highest RSF class and lowest and < 0 (i.e. avoided) in the lowest RSF class.

   It is important to note that actual goat locations were mapped accurately during surveys (i.e., aircraft location was not used as a surrogate for goat location). Spatial accuracy of the survey locations is estimated to be within 200 m. For this analysis, each unique group of goats was defined as a sample unit. Each group was treated as n = 1 (i.e., groups were not weighted according to group size).

2. The second approach was to calculate a utilization distribution of seasonal range use and compare that to the ADFG RSF model predictions. A utilization distribution is a quantitative estimate of spatial use of habitats by animals (van Winkle 1975), which in this case, is estimated by a bivariate normal kernel function (Worton 1989). Often utilization distributions are used to calculate home ranges for individual animals, but they can also be used to calculate space use for a group of animals. Two utilization distributions were generated: one for June and one for September. For both seasons, goat locations were combined across years, n = 2 for June and n = 3 for September. Utilization distributions were calculated in ArcGIS 10.5.1 using the kernel density function in spatial analyst, the reference bandwidth option, and a 30 m pixel size. The September utilization distribution was qualitatively compared to the ADFG winter RSF output to determine locations across the study area where utilization distribution and winter RSF predictions aligned and where they differed. See **Section 6.2 - Figure 9** and **Figure 10.**

4.3 Analysis of Survey Data to Inform Assessment of Population Trend

Linear mixed-effects models were used to analyze mountain goat survey results (i.e., individual goat counts, whether grouped or solitary) to determine if either the total number of mountain goats detected or the kid/adult ratio (reproductive rate) of groups was related to:

- Survey year
- Habitat classification (rocky, alpine, thicket)

Both total counts and kid/adult ratio were expected to vary with season (Côté and Festa-Bianchet 2001); therefore, survey-season was included to account for this variation. Data from the June 2017 survey was excluded due to poor survey conditions resulting in low detectability of goats. Four detections where habitat was not classified (two from 2015, two from 2016) were also excluded. Survey identity was included to account for the lack of statistical independence of observations within surveys.

All analyses were completed using SAS 9.3 (SAS Institute Inc.). To account for the unbalanced number of observations among surveys, PROC MIXED was used. Errors were estimated using restricted maximum likelihood estimation and degrees of freedom were calculated using a Kenward-Roger's correction (Schaalje et al. 2001). Results were considered significant at the $P \leq 0.05$ level. When appropriate, post-hoc tests were conducted using a Bonferroni correction for multiple comparisons.

A power analysis was also conducted (see Soper 2018) to determine the statistical power of the current survey data to detect a population trend using multiple linear regression. The number and timing of future surveys needed to detect small, moderate, or strong changes in goat numbers under two scenarios was calculated:

- All surveys conducted in the same season (fall)
- Surveys completed at different times of year

5.0 RESULTS

Between 2015 and 2018, Hemmera conducted aerial surveys for mountain goats within the area defined as the Tsirku-Klehini Block using methods described in **Section 4.1**. These studies provide a baseline understanding of mountain goat distribution, abundance, productivity, and survivorship within the Tsirku-Klehini Block. Results from each survey are presented by season (i.e., summer 2015 and 2017; fall 2015, 2016 and 2017; and, winter 2017 and 2018).

Understanding potential Project-related effects on mountain goats requires an assessment of anticipated interaction at the subpopulation level. Mountain goats are estimated to occupy a median annual home range area of 20 km^2 (7.72 square miles) in southeast Alaska (Smith 1985: cited in Fox et al. 1989) (**Section 2**). The delineated extents of the Tsirku-Klehini Block therefore account for annual home range areas estimated for mountain goat in Alaska and represent a reasonable boundary for the mountain goat subpopulation that may interact with Project activities. The Tsirku-Klehini Block is bounded by large rivers on the north, east, and south, and by icefields to the west. These geophysical barriers restrict immigration and emigration to occasional dispersal events and form a natural subpopulation unit. In consideration of reported average home range size for mountain goats in southeast Alaska, and in consideration of geophysical barriers that likely limit mountain goat movement (e.g., large icefields and rivers), the Tsirku-Klehini Block is anticipated to include typical annual long-distance movements exhibited by mountain goats within the study area. Resident goats are anticipated to remain within the Tsirku-Klehini Block to meet annual habitat requirements (e.g., using different winter and summer ranges) and life requisites (e.g. breeding and rearing of young). The Tsirku-Klehini Block defines a sensible census area for the resident mountain goat subpopulation using habitats within a likely area of influence from the Project.

5.1 Mountain Goat Population Surveys

At a coarse scale, the distribution and abundance of goats in the Tsirku-Klehini Block is similar between all surveys. Highest concentrations of goats were observed in the southeast portion of the study area; smaller numbers of goats were observed in areas near Porcupine Peak and south aspect slopes above Tsirku and Jarvis Glaciers. No goats were observed during summer and fall surveys in the Saksaia Glacier and Flower Mountain areas. Three goats (a nanny with two kids) were observed within the Project area on the south side the Glacier Creek valley in fall 2016 and again (a nanny and one kid) in winter (February) 2017. In addition, there were 18 incident mountain goat observations reported by Constantine field staff (including helicopter pilots) between 2014 and 2017 within the Project area; however, it remains impossible to quantify the actual number of animals, or the actual intensity of use, based on incidental observations. **Table 1** presents goat counts summarized by year for each survey. **Sections 5.1.1** through **5.1.3** provide a brief written summary of each survey by season.

Table 1 Summary of survey results for all years and all seasons

Survey Date	Adults	Kids	Total	Kid/Adult Ratio	Method
Summer Surveys					
June 23, 2015	83	33	116	39.8%	A-star 350B2 Helicopter
June 23, 2017	72	23	95	31.9%	Cessna 172 Fixed-wing
Fall Surveys					
September 22, 2015	109	25	134	22.9%	Cessna 172 Fixed-wing
September 11, 2016	83	26	109	31.3%	Dehavilland Beaver Floatplane
September 7, 2017	130	41	171	31.5%	Jet Ranger Helicopter
Winter Habitat Assessment					
February 19, 2017	18	5	23	27.8%	Cessna 172 Fixed-wing
February 7, 2018	19	4	23	21.1%	Jet Ranger Helicopter

5.1.1 Summary of Summer Survey Results (June 2015 and June 2017)

Aerial surveys were conducted during the summer (June 23 both years) in 2015 and 2017 as described in **Section 4.1**. For both years, summer survey temperatures were mild with unlimited visibility, no precipitation, and winds were calm. In terms of seasonal chronology, both surveys were conducted during mid-summer shortly after the kidding period. Alpine snow melt was largely complete in 2015 but less advanced in 2017; residual snow patches were limited to accumulation zones (e.g., avalanche tracks), cool (north) aspect slopes, and high elevation areas.

- **June 23, 2015**: The survey was conducted by three biologists (J. Hobbs, T. Mahon, and K. White) and the pilot (Tighe Dougherty) utilizing an A-star helicopter flying at approximately 70 kilometers per hour (km/h) (43.5 mph). A total of 116 goats were observed during the summer survey in 2015, which consisted of 83 adults and 33 kids (39.8% kid/adult ratio) in 20 distinct groups (Figure 2). A single additional incidental goat sighting was added to the dataset from a separate flight undertaken on June 28, 2015. Universal Transverse Mercator (UTM) coordinates were recorded for each group. To reduce disturbance to goats, the animal's position was marked from the helicopter without approaching goats directly during the first survey in 2015[6]. UTM positions ranged from 673 to 1322 m above sea level (ASL) with an average elevation of 1,057 m ASL. Group size ranged from 1 to 33 animals. Two radio-collared animals were sighted during the survey, which represents all known collared mountain goats within the Tsirku-Klehini Block in 2015 (K. White pers. comm.). No goats were observed in the Saksaia Glacier and Flower Mountain areas, including the Project area.

6 This was corrected for subsequent surveys by using an iPad Air with GIS capability to manually correct the position recorded for each observation.

- **June 23, 2017**: The survey was conducted by two biologists (J. Hobbs and T. Mahon) and the pilot (D. Olson) utilizing a Cessna 172 flying at approximately 70 km/h (43.5 mph). A total of 95 goats were observed during the summer survey in 2017, which consisted of 72 adults and 23 kids (31.9% kids/adult ratio) in 34 distinct locations (Figure 2). An iPad Air with GIS capability was used to manually correct the UTM coordinates recorded for each observation. Poor sightability was noted as a result of late snow melt. Under these conditions, sightability was further challenged by aircraft selection; a helicopter was used in June 2015 and a Cessna 172 fixed-wing aircraft was used in June 2017. Decreased maneuverability of a fixed wing aircraft, relative to a helicopter, further limited sightability during the 2017 summer survey relative to the 2015 summer survey[7]. No goats were observed in the Saksaia Glacier and Flower Mountain areas, including the Project area.

7 During consideration for future surveys, aircraft selection (i.e., fixed wing versus helicopter) alters the observability of the animals. Helicopter surveys appear to be more efficient for detection, and cause fewer disturbances due to lower aircraft noise and reduced need for multiple approaches. This finding is supported in the literature for aerial surveys of other large ungulates species (Frid 2002).

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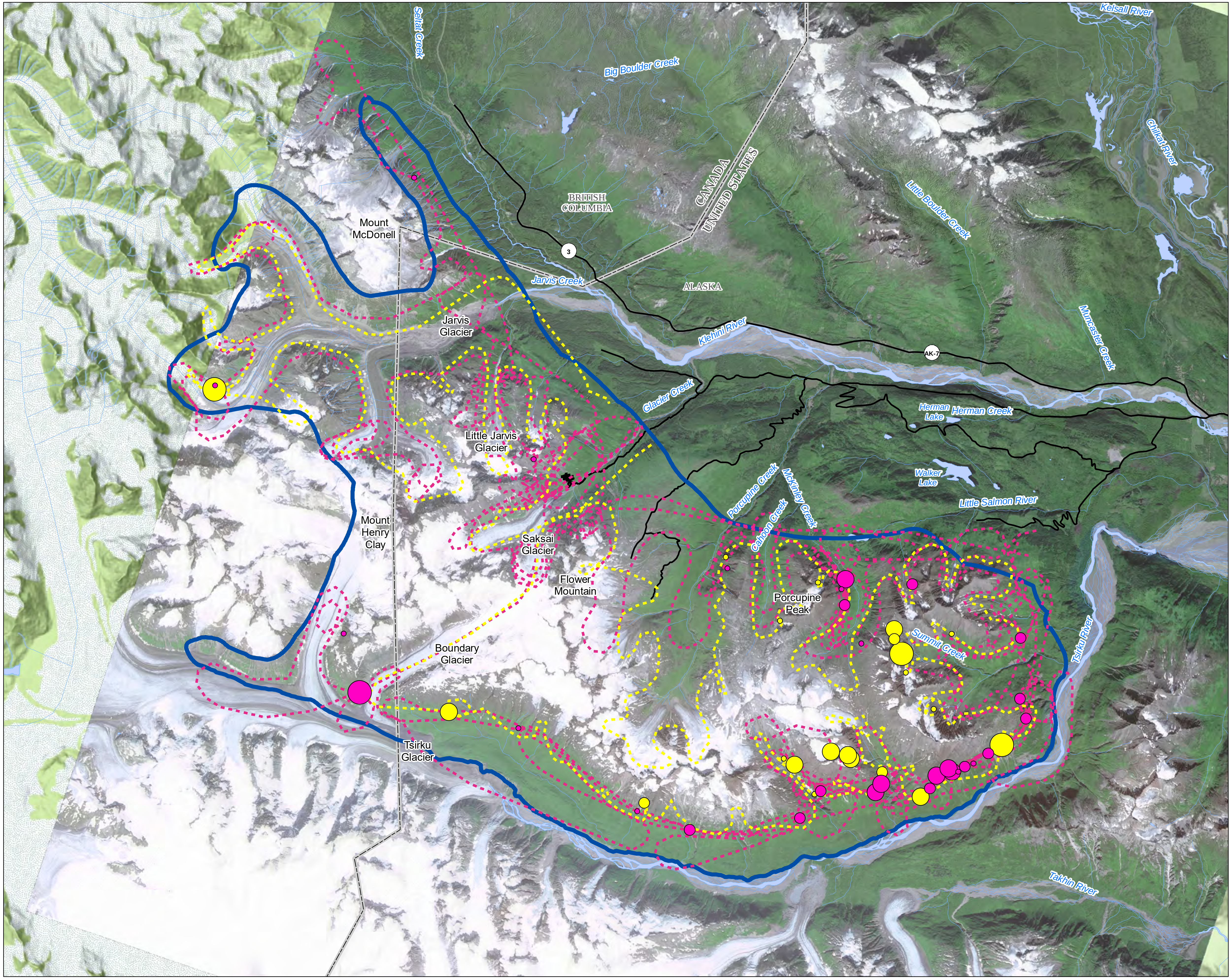
Flight Path and Survey Observations from Two Summer Mountain Goat Surveys within the Tsirku-Klehini Block



Legend

Summer Mountain Goat Aerial Survey Observations

Total Number of Mountain Goats Observed

June 2015	June 2017
1	1
2 - 3	2 - 3
4 - 9	4 - 9
10 - 33	10 - 33

Aerial Survey Flight Path

- June 2015
- June 2017
- Tsirku-Klehini Block
- Road
- International Boundary
- Watercourse
- Waterbody

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basedata: Government of Canada, Government of British Columbia, State of Alaska
- Aerial Image: Alaska SPOT 5 m Colour.
- Basemap & Inset: ESRI World Topographic Map

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5.1.2 Summary of Fall Survey Results (September 2015, 2016, and 2017)

Aerial surveys were conducted during the fall (September) of 2015, 2016 and 2017 following methods described in **Section 4.1**. For all three fall surveys, temperatures were cool, with unlimited visibility, no precipitation, and winds were calm. In terms of seasonal chronology, surveys were conducted shortly before the onset of first snow; a time when goats are anticipated to be foraging close to winter use areas. Fall surveys were intentionally timed to occur during the transition period between the summer and winter periods for mountain goats.

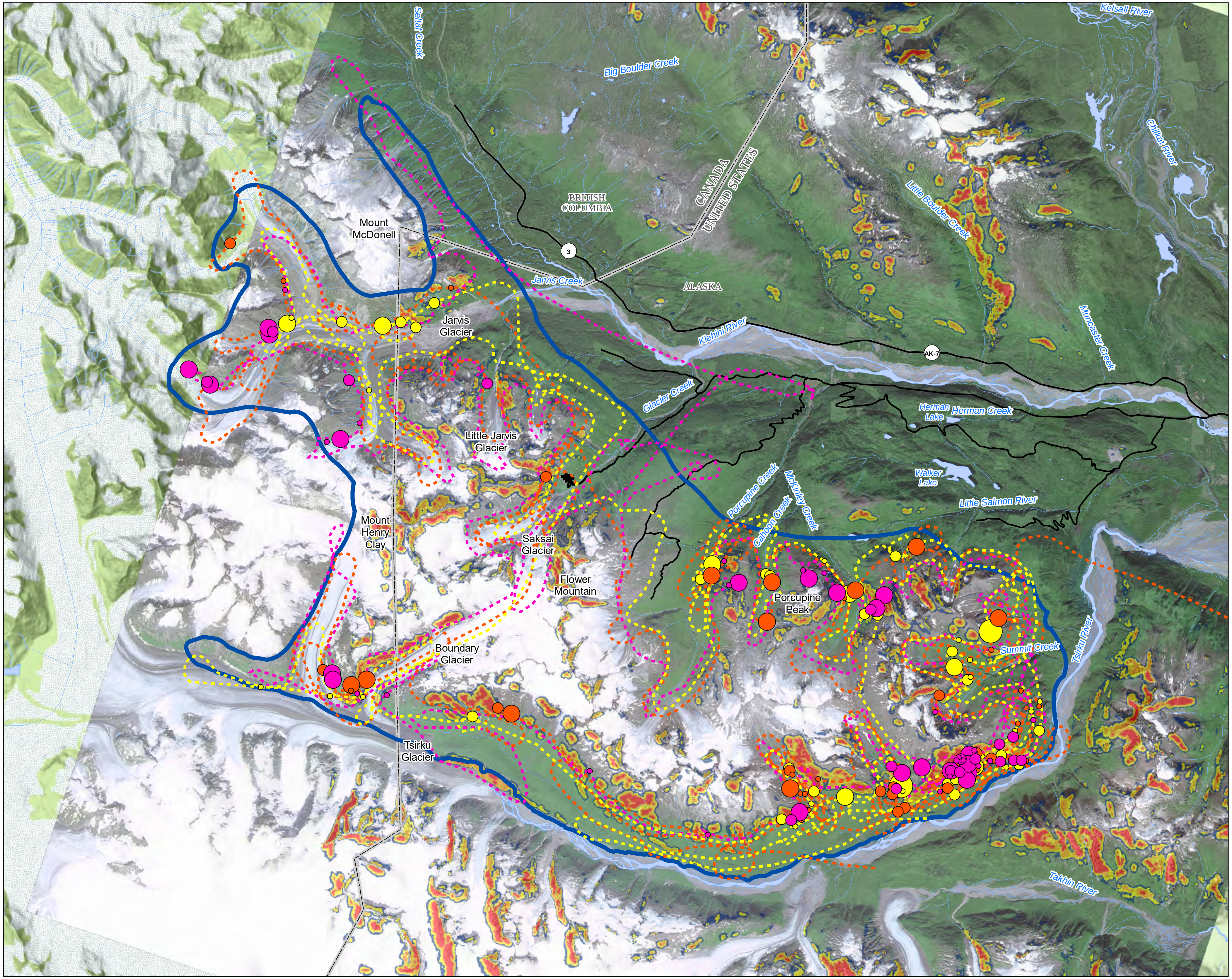
During fall surveys, herbaceous forage in the alpine was mostly senescent. Alpine snow melt was complete, with snow limited to permanent accumulation zones (e.g., glaciers) in high elevation areas. Fresh snow was also present at higher elevations in 2015 but not to the extent that would hinder travel by mountain goats.

<u>September 22, 2015</u>: The survey was conducted by two biologists (J. Hobbs and A. Venning) and the pilot (D. Olson) utilizing a fixed-wing aircraft (Cessna 172) flying at approximately 70 km/h (43.5 mph). A total of 134 goats were observed, which consisted of 109 adults and 25 kids (22.9% kid/adult ratio) in 50 distinct groups (**Figure 3**). Group size ranged from 1 to 12 animals. Two medium-sized groups were detected (12 and11 goats). Average group size was 2.7 (2.3 excluding the two largest groups). Similar to June surveys, the position of each group was marked from the aircraft without approaching goats directly. As such, UTM coordinates do not reflect the precise group location in most instances. UTM positions ranged from 278 to 1,231 m ASL with an average elevation of 764 m ASL. The distance between the Cessna 172 fixed-wing aircraft and the mountain goats was too large to permit the detection of any radio-collared animals. No goats were observed in the Project area.

<u>September 11, 2016</u>: The survey was conducted by two biologists (J. Hobbs and T. Mahon), a data recorder (D. Culbeck), and the pilot (P. Swanstrom) utilizing a fixed-wing aircraft (Dehavilland Beaver) flying at approximately 70 km/h (43.5 mph). Conditions during the survey were excellent with clear skies, light winds, and moderate temperatures (4ºC to 9ºC). A total of 109 goats were observed, consisting of 83 adults and 26 kids (31.3% kid/adult ratio) in 43 distinct groups. Group size ranged from 1 to 9 animals, with an average of 2.5 animals per group. The distribution of goats was very similar to the distribution noted in 2015 and consistent with historic surveys by ADFG. The majority of observations were concentrated in the southeastern portion of the study area, and smaller numbers were present in the Porcupine Mountain area and along south aspect slopes above Tsirku and Jarvis Glaciers. One group of three goats was observed on the south aspect slope above Glacier Creek within the Project area. Neither of the two radio-collared animals observed in June 2015 were detected[8].

<u>September 7, 2017</u>: The survey was conducted by two biologists (J. Hobbs and T. Mahon) and the pilot (D. Hailey) utilizing a helicopter (Jet Ranger 500B) flying at approximately 70 km/h (43.5 mph). A total of 171 goats were observed, which consisted of 130 adults and 41 kids (31.5% kid/adult ratio) in 60 distinct groups (**Figure 3**). Group size ranged from 1 to 8 animals. Average group size was larger relative to previous years at 2.9 goats per group. The distribution of goats was very similar to 2015 and 2016 and consistent with historic surveys by ADFG. The majority of observations were concentrated in the southeastern portion of the study area, and smaller numbers were present in the Porcupine Mountain area and along south aspect slopes above Tsirku and Jarvis Glaciers. No goats were observed within the Project area. Neither of the two radio-collared animals observed in June 2015 were detected[9].

8 ADFG biologist K. White confirmed that the two radio-collared animals remained in the Porcupine area but only one of the radio-transmitters was still functional (email dated December 14, 2016).
9 ADFG biologist K. White confirmed that the two radio-collared animals remained in the Porcupine area but only one of the radio-transmitters was still functional (email dated December 14, 2016).



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Flight Path and Survey Observations from Three Fall Mountain Goat Surveys within the Tsirku-Klehini Block

Legend

Fall Mountain Goat Aerial Survey Observations

Total Number of Mountain Goats Observed

September 2015	September 2016	September 2017
1	1	1
2 - 3	2 - 3	2 - 3
4 - 9	4 - 9	4 - 9
10 - 33	10 - 33	10 - 33

Aerial Survey Flight Path
- September 2015
- September 2016
- September 2017
- Tsirku-Klehini Block
- Road
- International Boundary
- Watercourse

- Waterbody

RSF Predicted Levels of Winter Use
- High Use
- Moderate - High Use
- Moderate Use
- Low - Moderate Use
- Low Use

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basedata: Government of Canada, Government of British Columbia, State of Alaska
- Aerial Image: Alaska SPOT 5 m Colour.
- Basemap & Inset: ESRI World Topographic Map

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5.1.3 Summary of Winter Survey Results (February 2017 and February 2018) in the Project Area.

To limit disturbance during the sensitive winter phenological stage, a census of goats within the Tsirku-Klehini Block was not conducted. Efforts were instead focused on briefly assessing the suspected (as reported by ADFG) high-use winter habitat area within the Tsirku-Klehini Block before conducting a more focused survey in a relatively restricted area of the Project area (**Figure 5**). A complete census of goats in the Tsirku-Klehini Block was not a survey objective for either winter survey.

February 19, 2017: An intensive survey, for goats, within the Project area was conducted by two biologists (J. Hobbs and T. Mahon) and the pilot (D. Olson) utilizing a Cessna 172 flying at approximately 70 km/h (43.5 mph). One group (nanny with a single kid) was observed on the south aspect slope above Glacier Creek in the Project area (**Figure 4b**) in the same area where a nanny with two kids was observed during the preceding September 2016 fall survey.

A second area of modelled high-use winter habitat along the Tsirku River was opportunistically assessed to compare conditions between higher elevation (1,238 m) interior areas that characterize habitat within the Project area and lower elevation (510 m) temperate maritime-influenced habitat where mountain goats are known to overwinter in the Tsirku-Klehini Block[10] (**Figure 4a and 4b**).

Figure 4a **RSF modelled winter habitat within the maritime influenced area along Tsirku River.**

Figure 4b **RSF modelled winter habitat within the higher elevation inland Project area.**

A total of 23 goats were observed; including 21 goats observed incidentally near the Tsirku River (i.e., outside the area of intensive survey in the Project area). In total goat observations consisted of 18 adults and 5 kids (27.8% kid/adult ratio) in six distinct groups. Except for one group, behaviour was noted as bedded, standing, or walking. Only two goats were observed in the Project area (a nanny with a single kid).

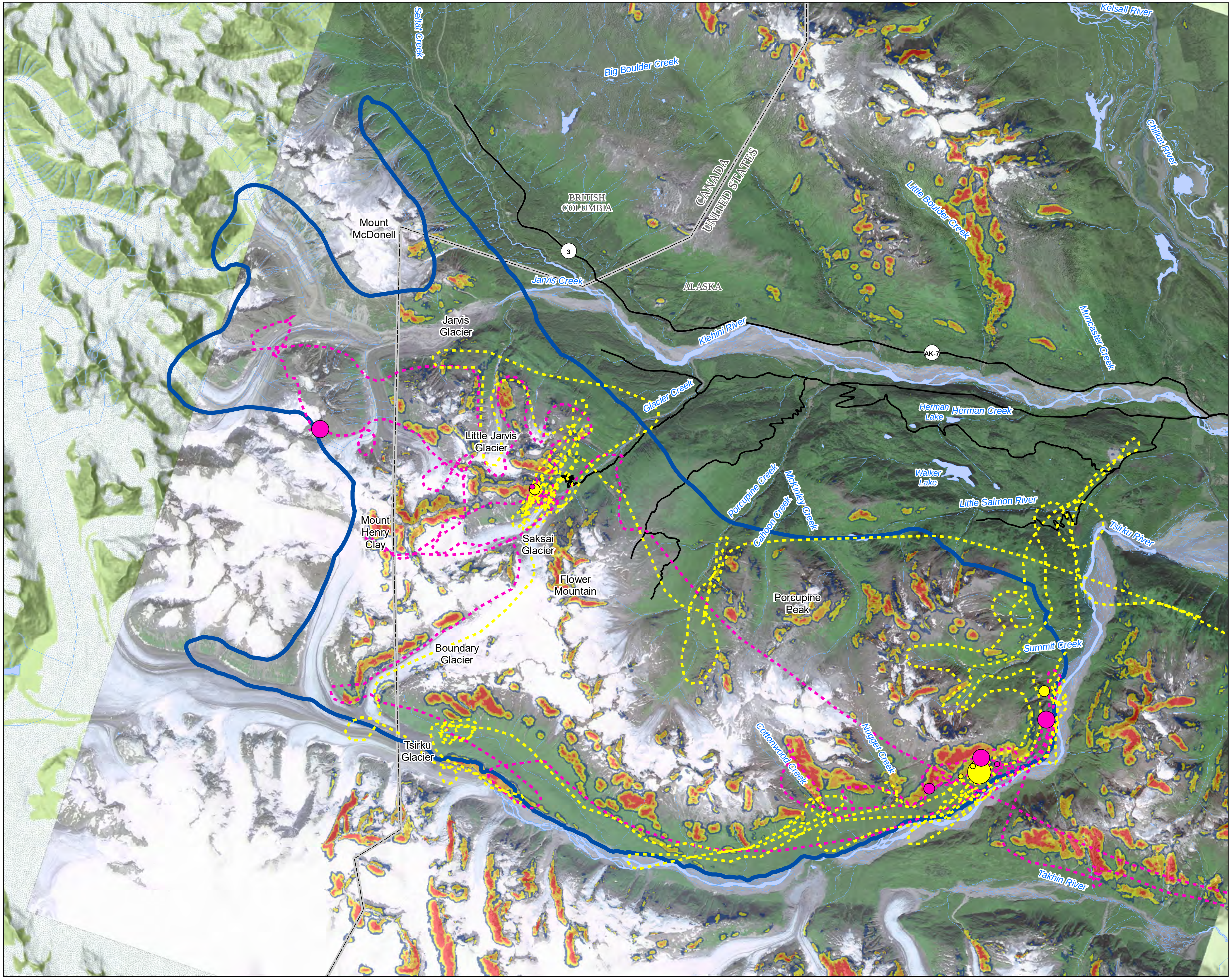
[10] ADFG biologist K. White provided direction to an area of confirmed mountain goat winter use between Summit and Nugget creeks – to the west and northwest of the Tsirku river.

<u>February 7, 2018</u>: A second year of winter survey in the Project area was conducted on February 7, 2018 by two biologists (J. Hobbs and T. Mahon) and the pilot (D. Hailey). Surveys were conducted utilizing a helicopter (Bell 206 Jet Ranger) flying at approximately 70 km/h (43.5 mph). Conditions were excellent with fresh snow last reported three days prior to survey (i.e., a fresh track plate). Observers were again focused on assessing potential high-use winter mountain goat habitat within the Project area. Goats and goat tracks were recorded. A solitary adult male mountain goat was observed on the south aspect slope above the glacier toe over Glacier Creek within the Project area. Based on track abundance and signs of use (beds), it appears the solitary goat had been using an exposed windblown ridge that featured less cover than the surrounding area. The area of high-use spanned the entire ridge, from valley bottom to the ridgeline, and featured ample sign indicating extended use of winter habitat in this area. This was the same area occupied by a nanny and kid during the previous winter survey of the Project area completed in February 2017.

As in 2017, the same area of modelled high-use winter habitat (above the Tsirku River) was again assessed on route to the Project area. Thirteen goats were observed in three areas that featured relatively less snow cover than adjacent areas.

During habitat assessment in the Klehini River Valley (including Sara Creek, Little Jarvis Creek and the slopes above Jarvis Glacier and Little Jarvis glacier) an additional group of nine goats was observed on an exposed windblown southwest aspect ridge on the south slope of the Alsek Ranges. This observation was outside the Project area boundary.

In total, 23 goats were observed, which consisted of 19 adults and 4 kids (17% kid/adult ratio) but only one goat (adult male) was observed within the Project area. Consistent with the winter habitat assessment completed in February 2017, efforts were focused on completing an aerial assessment to identify areas of potential over-winter use by mountain goat in the Project area (**Figure 5**).



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Flight Path and Incidental Goat Observations from Two Winter Habitat Assessments within the Tsirku-Klehini Block

Legend

Winter Mountain Goat Incidental Observations

Total Number of Mountain Goats Observed

February 2017	February 2018
1	1
2 - 3	2 - 3
4 - 9	4 - 9
10 - 33	10 - 33

Aerial Survey Flight Path
- February 2017
- Feburary 2018
- Tsirku-Klehini Block
- Road
- International Boundary
- Watercourse
- Waterbody

RSF Predicted Levels of Winter Use
- High Use
- Moderate - High Use
- Moderate Use
- Low - Moderate Use
- Low Use

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basedata: Government of Canada, Government of British Columbia, State of Alaska
- Aerial Image: Alaska SPOT 5 m Colour.
- Basemap & Inset: ESRI World Topographic Map

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5.2 Analysis of Modelled Winter Habitat Availability and Use for the 2009 ADFG RSF Model

A plot of mountain goat locations and random locations relative to the ADFG winter RSF model predictions is presented in **Figure 6**. Selection indices across the five RSF classes are plotted in **Figure 7**. Results of the analysis provide general support for conformity of survey observations with the ADFG winter RSF model. The relative proportion of goat observations to random points was lower in RSF class 1 (non-suitable habitat), indicating avoidance of these areas by goats, and higher in RSF classes 2 through 5 (suitable habitat), indicating selection of these areas by goats. This supports the original classification of the categories as class 1 being unsuitable and classes 2 through 5 being suitable. This translates to approximately 18% of the Tsirku-Klehini Block classified as suitable winter habitat and 82% classified as unsuitable. Generally, the proportional difference of used to random points increases with increasing value RSF classes (**Figure 7**). In class 1 (non-suitable habitat), goats occurred 0.42 times less than random. In class 5 areas, goats occurred 3 times more than random.

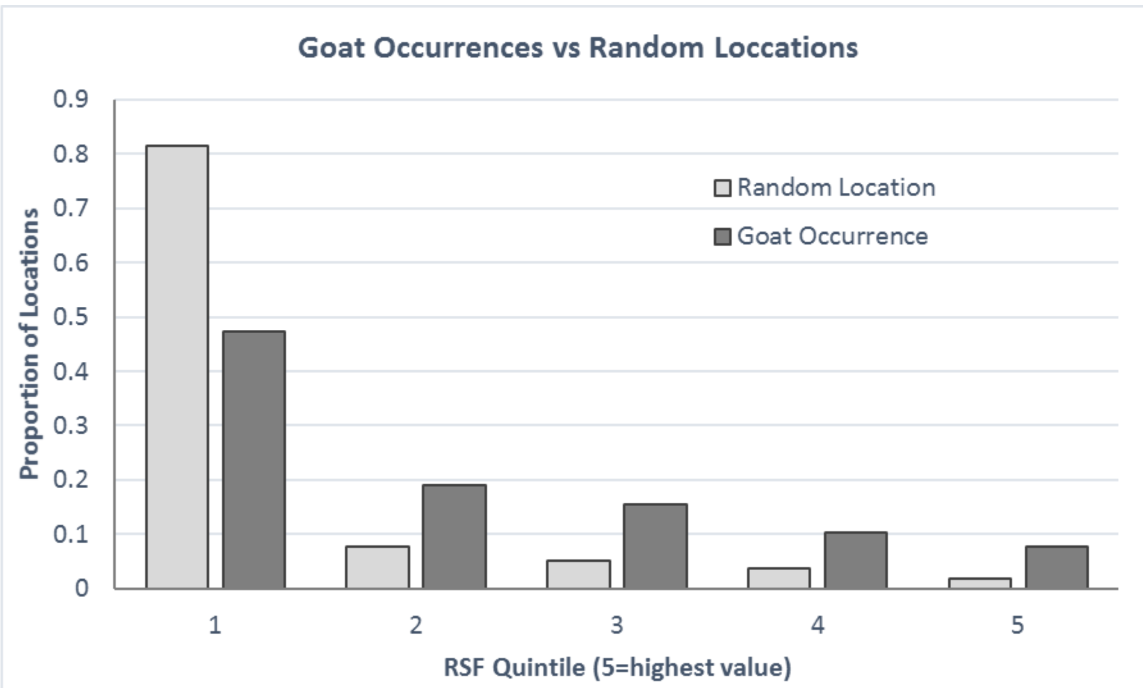


Figure 6 **Comparison of mountain goat locations observed during September 2015-2017 surveys and random locations relative to the ADFG winter RSF model predictions in the Tsirku-Klehini Block**

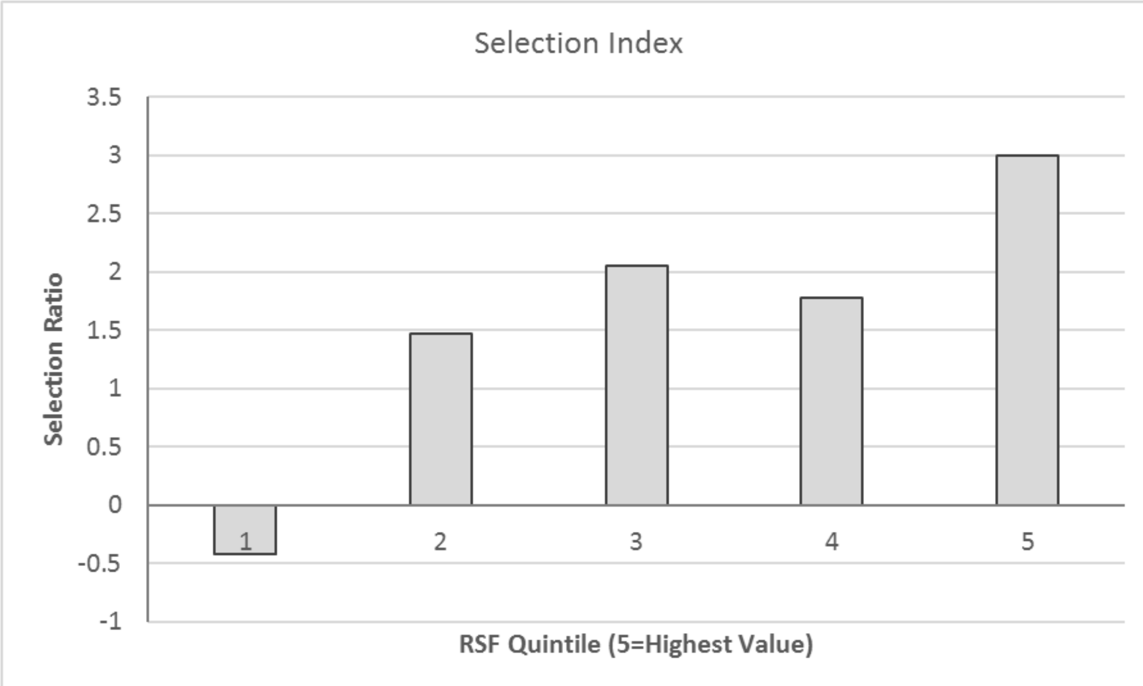


Figure 7 Selection of areas by mountain goats in the Tsirku-Klehini Block during September 2015-2017 surveys relative to the ADFG winter RSF model

A map comparing the observed September utilization distribution to the 2009 ADFG winter RSF model predictions is shown in **Figure 9**[11]. There are several areas where the utilization distribution corresponds well with concentrations of modelled winter habitat. These areas are:

1. Southeastern portion of the study area above the Tsirku River between Summit, Nugget, and Cottonwood creeks.
2. Northeastern portion of the study area in the mountains surrounding upper Porcupine, Cahoon, and McKinley creeks, and north of Summit Creek.
3. Southwestern portion of the study area at the junction of the Tsirku and Boundary glaciers.
4. Northwestern portion of the study area on south aspect slopes above Jarvis Glacier.

By converse, the 2009 ADFG winter RSF model has poor correspondence in at least some areas suggesting potential commission errors (i.e., model falsely classifying areas as suitable). These included high elevation areas on Mount Henry Clay, Flower Mountain, and upper Boundary Glacier (covered by glacier or year-round snowpack or where barren rock above the alpine vegetation zone and did not offer any forage for mountain goats). The low number of goats observed in the Mount Henry Clay–Flower Mountain–Little Jarvis areas is also consistent with longer-term survey results by ADFG (K. White pers. comm.). Evidence of model commission error is further supported by poor correlation of goat use, based on survey results, and RSF modelled goat habitats along the north slope above the Tsirku river. Fall survey observations in this area confirm low or no use of RSF modelled high-use winter habitat (only two goats observed in 2017 and none in 2016 or 2018) despite relatively high availability of modelled “high use” winter goat habitat (based on the 2009 ADFG RSF winter goat habitat model).

11 Note that model predictions are truncated for the western portion of the study area outside the United States border.

5.3 Analysis of Survey Data to Inform Assessment of Population Trend

The total number of goats detected was not related to year ($F_{2,1.82}$ = 0.18, P = 0.85) or habitat ($F_{2,160}$ = 0.48, P = 0.62). In addition, there was no difference in the ratio of kids to adults among years ($F_{2,160}$ = 0.25, P = 0.78). The ratio of kids to adults, however, was related to habitat ($F_{2,162}$ = 4.07, P = 0.02). Post-hoc comparisons revealed that the ratio of kids to adults was significantly higher in thicket habitat compared to alpine habitat. There was also a near-significant trend (P = 0.07) of higher kid to adult ratios in rocky habitat compared to alpine habitat. There was no difference in kid to adult ratios between thicket and rocky habitats.

Power analyses revealed that the five goat surveys (i.e., summer and fall surveys, but excluding counts of incidental goat observations from winter habitat assessments) have low statistical power (0.1) that is too weak to detect even a strong population trend (>26% change in goat numbers). **Table 2** and **Table 3** show the number of surveys needed to detect population changes of different magnitudes (strong, moderate, and weak) when surveys are completed during multiple seasons (**Table 2**) versus when surveys are completed during the same season each year (**Table 3**).

Table 2 Results of power analysis when surveys are completed in multiple seasons

Number of surveys	Power	Effect Size (f^2)	% Population Change (R^2)
31	0.80	Strong	0.26
67	0.80	Moderate	0.13
478	0.80	Weak	0.02
25	0.70	Strong	0.26
54	0.70	Moderate	0.13
382	0.70	Weak	0.02
21	0.60	Strong	0.26
44	0.60	Moderate	0.13
308	0.60	Weak	0.02

Table 3 Results of power analysis when surveys are completed in the same season each year

Number of surveys	Power	Effect Size (f^2)	% Population Change (R^2)
25	0.80	Strong	0.26
54	0.80	Moderate	0.13
385	0.80	Weak	0.02
20	0.70	Strong	0.26
43	0.70	Moderate	0.13
303	0.70	Weak	0.02
16	0.60	Strong	0.26
34	0.60	Moderate	0.13
241	0.60	Weak	0.02

6.0 DISCUSSION

The main objective of the aerial surveys conducted between 2015 and 2018 was to provide an assessment of current baseline conditions for mountain goats within an area that may experience direct and indirect Project-related effects (i.e., the Tsirku-Klehini Block). This information is intended to inform Constantine during planning and management of conservation values during the exploration phase of Project development. Survey results also provide a baseline understanding of goat distribution and abundance to support future regulatory approval processes. Knowledge accumulated from four years of mountain goat surveys are discussed in this section.

6.1 Mountain Goat Population Surveys

At a coarse scale, patterns of goat distribution were similar between the summer and fall surveys. The majority of observations were concentrated in the southeastern portion of the Tsirku-Klehini Block and associated with unnamed mountains at the heads of Cottonwood, Nugget, and Summit creeks (**Figures 9** and **10**). Smaller numbers of goats were also observed on Porcupine Peak, south aspect slopes above Tsirku River and Tsirku Glacier, and south aspect slopes above Jarvis Glacier in the northwest. Relatively few goats were observed during formal surveys (all years) in the Saksaia Glacier and Flower Mountain areas, including the Project area. An additional 18 incidental observations of mountain goats in the Project area have been recorded by Constantine field staff, contractors, and pilots between 2014-2018; however, these additional records were not incorporated into statistical analyses in recognition of bias associated non-standardized quantification of effort during data collection[12].

At a landscape scale, the observed distribution of mountain goats, including the absence or low number of mountain goats in the Project area, is regarded as typical for this part of Alaska (K. White pers. comm.) and is consistent with observations from the ADFG survey conducted in the Porcupine Creek Block prior to 2014 (White et al. 2014).

At a finer scale, differences in group sizes and habitat selection were evident in the survey results. In the summer, mountain goats aggregated into larger groups and were documented using higher elevation habitats as herbaceous forage plants became available. Two types of larger groups were observed: bachelor groups comprised of adult males and nursery groups comprised of nannies with and without kids and sub-adults.

By the fall, goats had broken up into smaller groups and shifted downslope where shrubby browse forage was available. This pattern of observed group associations during the summer and disbanding prior to the winter is consistent with behavioural patterns of group association, population dynamics, and movements associated with seasonal timing factors discussed in the broader literature (Côté and Festa-Bianchet. 2003), including southeast Alaska (BLM 2012). The difference in average elevation between seasons is also consistent with local studies that observed mountain goats foraging on herbaceous plants at higher elevations during the summer and moving to lower elevations in the fall and winter where browse species are more accessible, available, or abundant (Fox and Smith 1989).

12 Incidental observations were not included in statistical analysis due to the likelihood of multiple recorded observations of the same animal(s) within a given exploration season

Intra-annual results from other studies typically report a decrease in total mountain goat population size as the season progresses from summer to fall; this is largely due to kid mortality (Côté and Festa-Bianchet. 2003). This pattern was not observed in the current survey results (refer to **Table 1**). Comparison of total goat count and kid/adult ratios between summer and fall surveys was confounded by differences in observability as well as sample size given that paired summer and fall surveys were only conducted in 2015 and 2017.

6.2 Analysis of Modelled Winter Habitat Availability and Use for the 2009 ADFG RSF Model

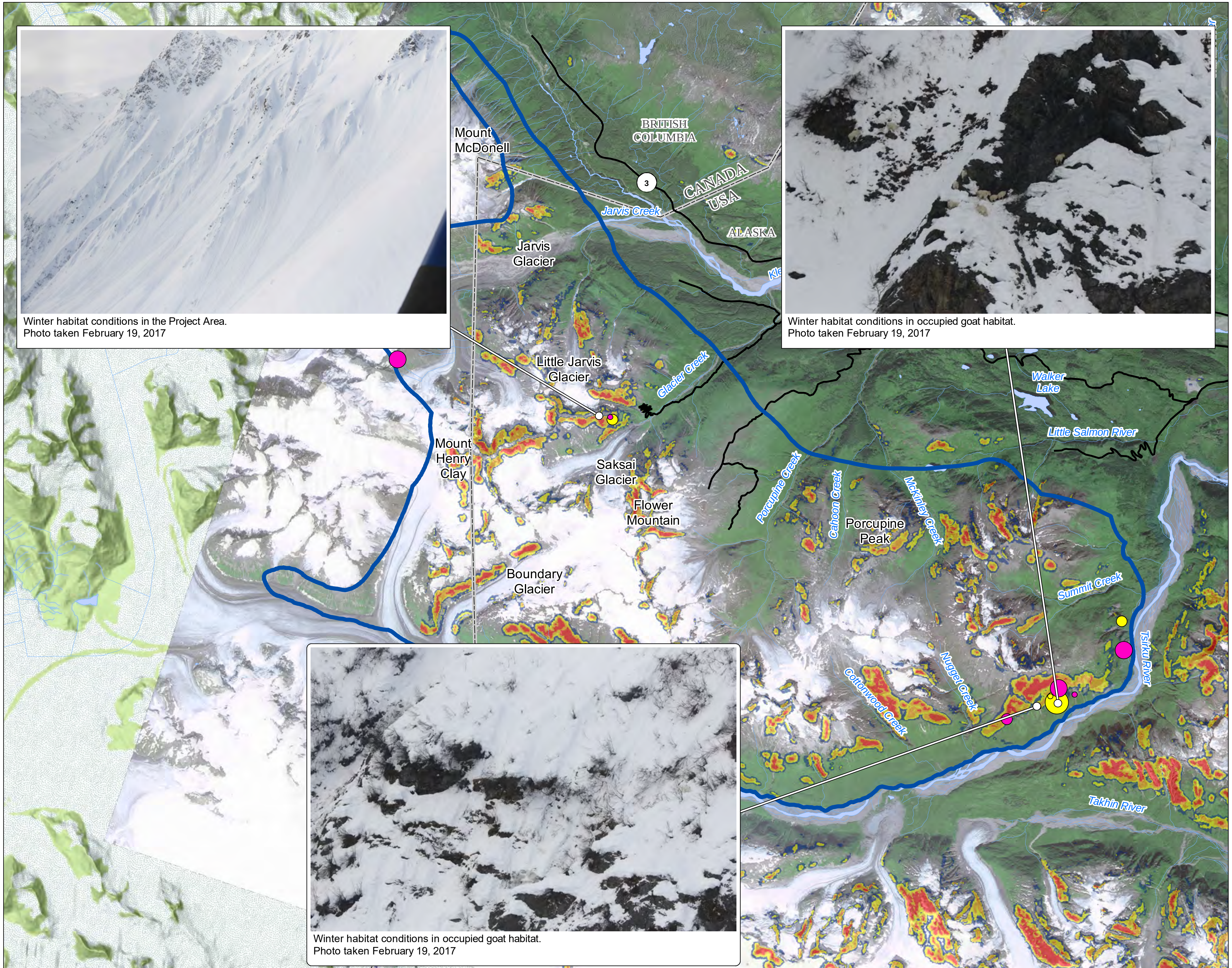
A total of 3,821 hectares of potential RSF modelled winter habitat occurs within the Tsirku-Klehini Block, which is 15% of the total area of the United States portion of the Tsirku-Klehini Block (where model predictions were available). At a landscape scale, potential winter habitat predicted by the RSF model is relatively well distributed across the Tsirku-Klehini Block (**Figure 5**). An analysis of habitat use (based on direct observation of goats from surveys) compared to winter habitat availability as predicted by the ADFG winter RSF model provides general support for application of the model in the Tsirku-Klehini Block. At a more precise scale, however, certain patterns of data from field observations highlight some limitations in model predictions.

The highest concentration and largest patches of contiguous habitat occur along the southern portion of the Tsirku-Klehini Block, above the Tsirku River. In the smaller Palmer Project site, much of the exploration area on the south aspect slopes of the Glacier Creek valley is also predicted to support potential high-suitability goat winter habitat. During the 2017 winter habitat assessment, two goats were observed on a south aspect slope above Glacier Creek (i.e., within the Palmer exploration area) and 21 goats were observed above the Tsirku River near Cottonwood, Nugget, and Summit creeks (**Figure 5**). During the second assessment of winter habitat in February 2018, one goat was observed on the same south aspect slope of above Glacier Creek and 13 goats were observed above the Tsirku River near Cottonwood, Nugget, and Summit Creeks (**Figure 5**). Collectively, this information suggests goats may not make consistent use of RSF-predicted winter habitat as incidental goat observations collected during habitat assessment showed varying levels of use between areas despite similar RSF-predicted suitability ratings.

Images of winter conditions were taken during the February 2017 surveys. **Figure 8** compares images of modelled suitable winter goat habitat within the Project area with images of modelled winter habitat along the Tsirku River (where higher goat abundance was observed). These images illustrate the moderating influence in lower elevation coastal areas (**Figure 8**). Both areas were predicted to be of equal use/value by the ADFG RSF model (as indicated by the red shading on the base map). Biophysical differences in snow-depth and cover in the two areas seem to provide a plausible explanation for differences of observed goat use versus modelled winter habitat. Ultimately, understanding long-term winter use of the Project area by mountain goat will require additional winter surveys.

Terrestrial Wildlife and Habitat Assessment
Constantine Metal Resources
Palmer Project Site

Difference in Winter Snow Conditions between Areas of High-use Occupied Winter Habitat in the Tsirku Klehini-Block



Legend

Winter Mountain Goat Incidental Observations

Total Number of Mountain Goats Observed

February 2017	February 2018
1	1
2 - 3	2 - 3
4 - 9	4 - 9
10 - 33	10 - 33

- Tsirku-Klehini Block
- Road
- International Boundary
- Watercourse
- Waterbody

RSF Predicted Levels of Winter Use

- High Use
- Moderate - High Use
- Moderate Use
- Low - Moderate Use
- Low Use

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basedata: Government of Canada, Government of British Columbia, State of Alaska
- Aerial Image: Alaska SPOT 5 m Colour.
- Basemap & Inset: ESRI World Topographic Map

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Kilometres

NAD 1983 UTM Zone 8N

Page Size: 11" x 17"

989239-02	Production Date: May 24, 2018	Figure 8

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An empirical analysis of all goat observations from fall surveys undertaken in 2015, 2016 and 2017 (Table 1) relative to 5,000 randomly plotted points was completed and is described below. For this analysis, fall goat survey data was used as a surrogate to anticipate areas of winter use by goats because goats are more easily observed in fall relative to winter.

Analysis results of all years yielded a relatively high absolute number of goat locations in RSF class 1 (non-suitable habitat): goat observations in class 1 rated habitat constituted 47% of all locations. This suggests that the model may be biased to errors of omission (i.e., failing to fully identify and categorize suitable habitat where it occurs). A more detailed examination of goat locations within RSF class 1 habitats demonstrates that many of the goat locations are proximal or adjacent to areas of higher RSF-rated winter habitat. This was also true for several incidental field observations of goat locations during the two winter habitat surveys. For example, in February 2017 several goats that were observed in the southeast corner of the study area (above the Tsirku River) occurred immediately below areas of RSF predicted suitable habitat.

There are two possible reasons for this apparent misclassification[13]:

1. The regional model may poorly reflect a broader range of habitat use by goats in the Tsirku-Klehini Block.
2. Field validation of the winter model is likely limited by using fall data for the evaluation.

In terms of a broader-scale comparison between observed goat distribution and the ADFG winter RSF model predictions, poor correspondence in at least some areas indicates apparent commission errors (i.e., model falsely classifying areas as suitable). These included high elevation areas on Mount Henry Clay, Flower Mountain, and upper Boundary Glacier that were covered by glacier or year-round snowpack or where barren rock above the alpine vegetation zone and did not offer any forage for mountain goats. Lower elevation areas in the Project area, and within the Tsirku-Klehini Block overall, offer limited forage due to relatively lower snow-pack (as evidenced during winter surveys completed in February 2017 and 2018)(**Figure 8**). The relatively restricted size of these areas is commensurate with the small number of goats observed in fall and winter surveys. The low number of goats observed in the Mount Henry Clay–Flower Mountain–Little Jarvis areas is also consistent with longer-term survey results by ADFG (K. White pers. comm.). Evidence of model commission error is further supported by poor correlation of goat use, based on survey results, and RSF modelled goat habitats along the north slope above the Tsirku river. Fall survey observations in this area confirm low or no use of RSF modelled high-use winter habitat (only two goats observed in 2017 and none in 2016 or 2018) despite relatively high availability of modelled "high use" winter goat habitat (based on the 2009 ADFG RSF winter goat habitat model). The reason(s) behind these goat distribution patterns is most plausibly attributed to commission errors associated with the ADFG 2009 winter RSF goat habitat use model.

Other potential explanatory factors that may also result in poor correlation of goat use with RSF predicted values (in some areas) may include: avoidance due to high historic hunting pressure, historic and ongoing recreational activities (Flower Ridge is the only portion of the study area that has motorized vehicle access), and historic and ongoing mineral exploration associated with the Palmer Project (K. White pers. comm.). Although plausible, attribution of low observed goat use in some areas, particularly within the Project area, to historic and / or current anthropogenic stressors (e.g., hunting and disturbance) is

13 Examination of relationships between goat locations and model covariates was not feasible due to the paucity of available winter goat survey data for the Tsirku-Klehini Block.

challenged by mapping of natural resources based on Chilkat Indian history; goats are not identified as a natural resource within the Project area despite recognition of other harvest values (e.g., hoary marmot (*Marmota caligata*)) (as referenced in the Haines Borough Comprehensive Plan (Sheinberg, B. J. et al 2012)).

Although the 2009 ADFG winter habitat RSF model (White et al. 2011a) represented the best available information available (at the time of writing this report) for assessing potential winter habitat distribution in the area, there are specific considerations that may limit the accuracy or confidence of interpretation when the ADFG model is applied to the Tsirku-Klehini Block (Hemmera 2016):

1. The 2009 ADFG model was developed from a relatively small dataset. This includes use of a small number of animals (n = 12 from the Kelsall study area), a small number of winters (n = 2) and a relatively small total number of locations (n = 189).
2. A second potential concern specific to assessment of the Palmer Project relates to not having mountain goat data from the Tsirku-Klehini Block included in model development. This may have increased the risk of non-representative sample data if there are differing habitat conditions between the Tsirku-Klehini Block and the Kelsall area.
3. A third issue affecting model confidence is that, prior to the 2017 and 2018 winter surveys led by Hemmera (this report), no formal model validation exercise had been documented within the Tsirku-Klehini Block.

ADFG staff are aware of the potential limitations of the current RSF model and have been collecting additional data from across the Haines mountain goat census area over the last 10 years to inform development of an updated RSF model that incorporates a larger data set from a broader goat population. The updated RSF model was presented in a summary report and in May 2018. The GIS files have been requested by Constantine but were not available for analysis in this report.

One issue that will always be inherent to any habitat model, including the current or updated mountain goat RSF, is limited confidence in using the model predictions for site-specific assessments such as predicting habitat use within the Palmer Project area. The nature of all habitat models is that they are a generalization of habitat use patterns relative to a subset of relevant habitat variables. Actual habitat use at a local scale can vary substantially from model predictions due to several factors. For example, snow depth, which is not a variable in the model, may preclude mountain goats from using an area that otherwise has suitable winter habitat characteristics (White et al. 2015) (as illustrated by **Figure 8**). Ultimately the most accurate way to confidently determine local winter use by mountain goats in the Project area is to conduct winter survey of goats over multiple years and reconcile results against modelled goat winter habitat. There are, however, concerns regarding disturbance as well as consideration of costs and sightability that limit the feasibility of this verification approach.

As a surrogate for winter surveys, goat use patterns were analyzed over two seasons (summer and fall) by assessing utilization distribution of seasonal range use and comparing that to the ADFG RSF model predictions as described in **Section 4.2**. A utilization distribution provides a quantitative estimate of spatial use of habitat by animals (van Winkle 1975), in this case estimated by a bivariate normal kernel function (Worton 1989). For both seasons, goat locations were combined across years (n = 2 for summer and n = 3 for fall). The fall utilization distribution was reconciled with the ADFG winter RSF output to assess overlap with predicted areas of high-use winter habitat within the Tsirku-Klehini Block. **Figure 9** and **Figure 10** illustrate the outcome of this analysis.

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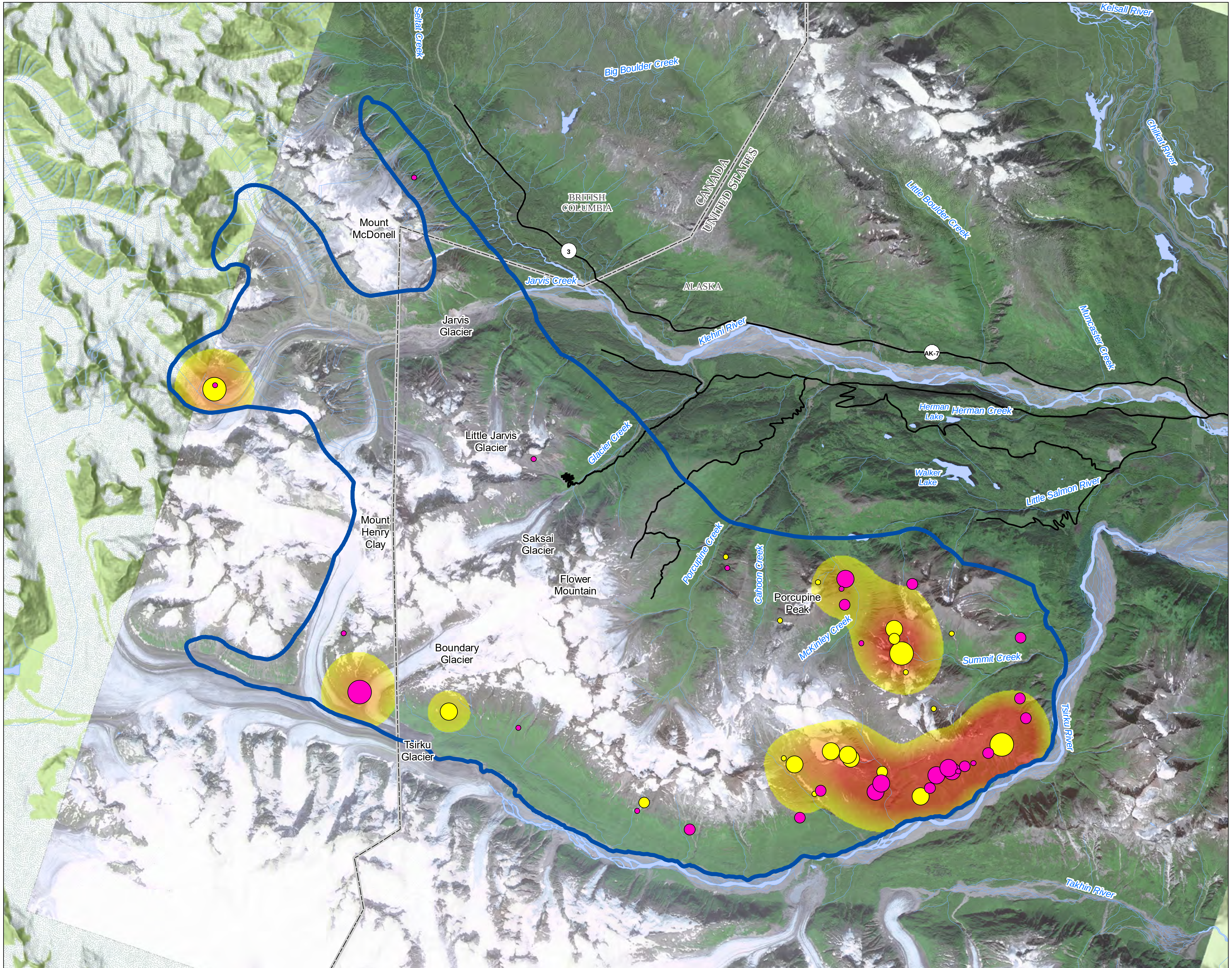
Mountain Goat Summer Use Area Density within the Tsirku-Klehini Block



Legend

Summer Mountain Goat Aerial Survey Observations

Total Number of Mountain Goats Observed

June 2015	June 2017
1	1
2 - 3	2 - 3
4 - 9	4 - 9
10 - 33	10 - 33

Tsirku-Klehini Block
Road
International Boundary
Watercourse
Waterbody

Goat Summer Area Use Density

Goats/ha

4.36
1.09

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basedata: Government of Canada, Government of British Columbia, State of Alaska
- Aerial Image: Alaska SPOT 5 m Colour.
- Basemap & Inset: ESRI World Topographic Map

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Kilometres

NAD 1983 UTM Zone 8N

Page Size: 11" x 17"

989239-02	Production Date: May 23, 2018	Figure 9

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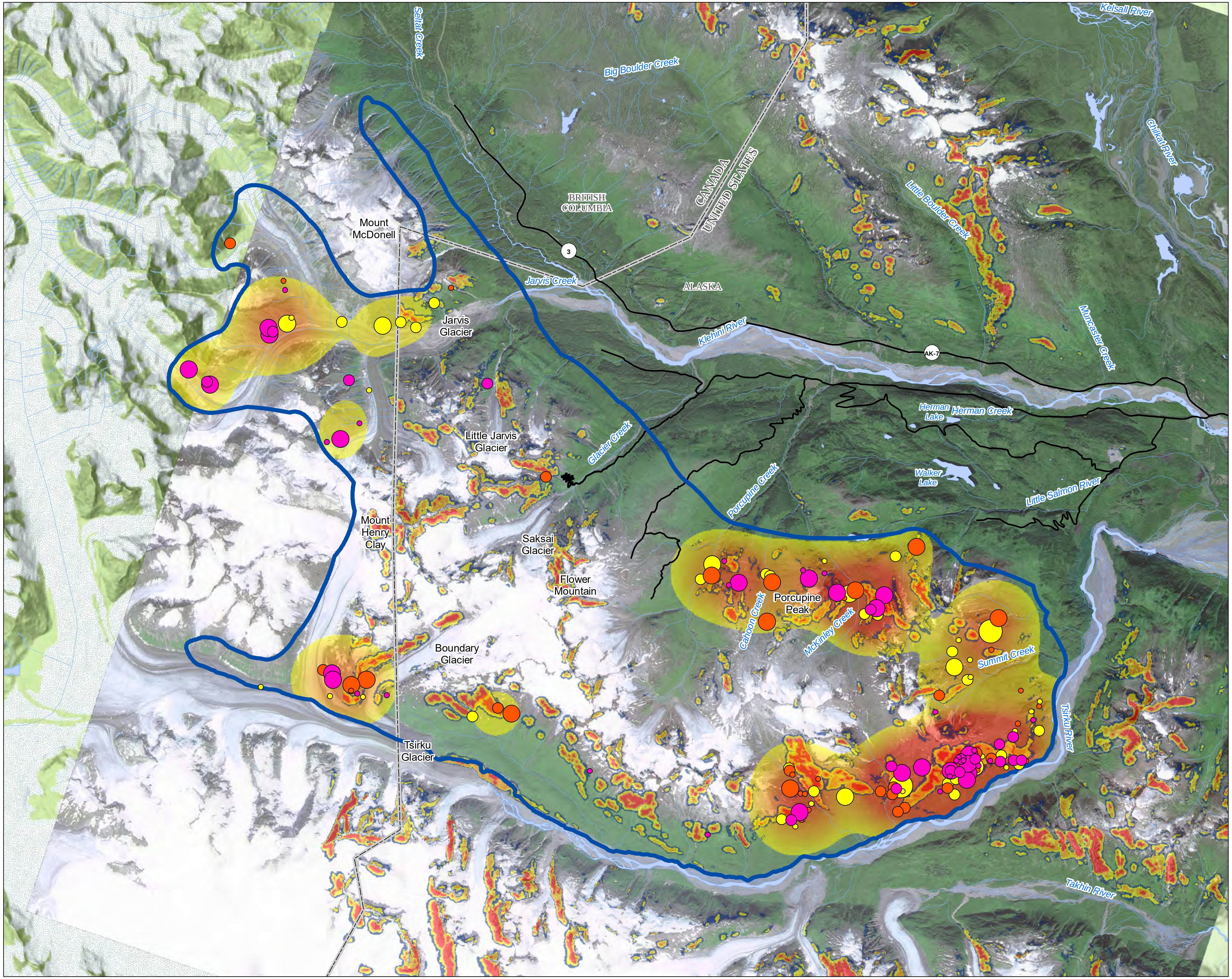

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Predicted Mountain Goat Winter Area based on Fall Observations within the Tsirku-Klehini Block

Legend

Fall Mountain Goat Aerial Survey Observations

Total Number of Mountain Goats Observed

September 2015	September 2016	September 2017
1	1	1
2 - 3	2 - 3	2 - 3
4 - 9	4 - 9	4 - 9
10 - 33	10 - 33	10 - 33

Tsirku-Klehini Block

Road

International Boundary

Watercourse

Waterbody

RSF Predicted Levels of Winter Use

High Use

Moderate - High Use

Moderate Use

Low - Moderate Use

Low Use

Goat Winter Area Use Density

Goats/ha

4.36

1.09

Notes

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0 1 2 3 4 5

Kilometres

NAD 1983 UTM Zone 8N

Page Size: 11" x 17"

989239-02	Production Date: May 23, 2018	Figure 10

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6.3 Analysis of Survey Data to Inform Assessment of Population Trend

For many ungulates, including mountain goats, the ratio of young of the year to adult females is used as a measure of productivity. The kid/adult ratios (productivity) and the total number of goats counted on each survey appeared to be stable across years. However, given the low statistical power to detect a population trend (10% power with currently available survey data), these results should be interpreted with caution. A power analysis showed that 16 to 25 surveys conducted in a consistent season would be sufficient to detect a 26% or greater change in the mountain goat population when assessing productivity of the goat population in the Tsirku-Klehini Block (**Table 3**). It is noted that there is recognition among ecologists that studies not meeting the general recommendation of 80% statistical power may still provide biologically relevant knowledge (Jennions and Møller 2003, Nakagawa 2004), and drastic population changes could be detected with fewer surveys.

As the minimum number of surveys (16) is not feasible or practicable due to constraints on available funding and the need for more immediate information to guide management continued monitoring (i.e., fall surveys) would still provide valuable information about the condition of mountain goat populations in the area. Each additional survey year (subsequent to the four years of survey reported herein) would increase the ability to detect changes in the extant mountain goat population in the Tsirku-Klehini Block.

7.0 MOUNTAIN GOAT MANAGEMENT GUIDANCE

Three primary types of human stressors are known to affect mountain goat populations: human hunting, habitat effects, and disturbance (activity and noise) effects from industrial development and aircraft. Over short periods and especially for small populations, severe winters and natural predation can also be natural factors that interact with human stressors (Mountain Goat Management Team 2010). Mountain goat populations are sensitive to human harvest rates due to relatively low productivity compared to other ungulates. During the 1950's through to the 1980's, a combination of liberal hunting regulations and dramatically increased road access associated with logging and other resource development led to population declines of mountain goats in parts of their range in British Columbia, Alberta, and Washington (Phelps et al. 1983, Hamel et al. 2006, Rice and Gay 2010). Over the last three decades many managed goat populations have stabilized or recovered, with targeted harvest rates typically between 2 to 5% of the total population (Toweill et al. 2004). Local population effects associated with creation of new access routes into mountain goat range continues to be a factor is some areas (Mountain Goat Management Team 2010).

Potential threats to mountain goat habitat include direct and indirect effects. Due to the rugged, high elevation, alpine setting that mountain goats often inhabit, direct threats to habitat are typically limited. Most threats relate to habitat effectiveness, which is the reduction of habitat suitability due to indirect effects such as disturbance. Mountain goats are documented to respond to a range of human disturbances, including aircraft, resource exploration (blasting and drilling), road construction, timber harvesting, and recreational off highway vehicle use (Mountain Goat Management Team 2010). Responses can range from short-duration behavioural changes (e.g., increased vigilance and flight response) and physiological stress, to long term habitat displacement and demographic effects such as reduced fecundity (Mountain Goat Management Team 2010).

Mountain goats can exhibit high sensitivity to helicopter disturbance (Côté 1996, Gordon and Wilson 2004, Goldstein et al. 2005, Hamel and Côté 2007). Responses are inversely related to distance between the helicopter and goats (Côté 1996, Goldstein et al. 2005), with regular responses occurring out to 1,500 m from a flight path (Côté 1996). In addition to distance, factors that affect goat responses are poorly understood, and appear to vary among studies, but may include degree of visual and auditory screening, topography, and degree of prior exposure to helicopters (that may result in either sensitization or habituation) (Mountain Goat Management Team 2010, Penner 1988). Fixed-wing aircraft appear to be less disruptive to goats than helicopters (Frid 2003), but little comparative data exists. Long term mountain goat monitoring programs have been established in areas surrounding the nearby Kensington gold mine, which may help inform future effects assessments for the Palmer Project (White et al. 2015).

The pattern of mountain goat distribution in the Tsirku-Klehini Block, including the low number of mountain goat observations in the Palmer Project area, is regarded as typical for this part of Alaska (K. White pers. comm.). Nevertheless, incidental observations of mountain goats in the Project area have been noted. Goats were observed in the Project area in both consecutive winter habitat surveys (2017 and 2018) within predicted suitable mountain goat habitats. For these reasons, Hemmera recommends development of a Mountain Goat Management Plan to mitigate potential adverse effects to mountain goats within the Project area.

A key component of a Mountain Goat Management Plan should be the inclusion of avalanche control methods that consider winter use of the Project area by mountain goats. Additional components should include the designation of specific flight corridors (including altitudes) to minimize the potential zone of influence of helicopter disturbance during the summer season, and development of modified operating procedures for times when goats are present in the Project area. In Alaska, Goldstein et al. (2005) and the BLM (2012) recommend 1,500 ft (452 m) buffer zones around all wildlife, including mountain goats. This should be the minimum distance maintained between approaching aircraft and mountain goats, where practical and safe to do so. A review of available literature yielded variation in recommended buffer distances for helicopter flights around occupied mountain goat habitat of up to 1,500 m to 2,000 m (Foster and Rahs 1983, Côté 1996, Côté et al 2013, Frid 2003, Festa-Bianchet and Côté 2008, Gordon and Wilson 2004, Hurley 2004, B.C. Ministry of Environment 2006, Côté et al. 2013). Recommendations for vertical separation range from 400 to 600 m (Foster and Rahs 1983, Harrison 1999, Alberta Fish and Wildlife Division 2001, Goldstein et al. 2005). For this reason, it is recommended that the Mountain Goat Management Plan include a provision to adjust flight corridors between the base of operations and established work sites (e.g., drill sites) when goats are present, with a target of achieving >1,500 m separation to the extent practicable.

With respect to ground-based exploration activities, there is less empirical data to guide management. Recommendations for buffer zones vary from 400 to 2,000 m adjacent to mountain goat habitat (Foster and Rahs 1985, Haynes 1992, Lemke 1999). In situations where the application of recommended buffers is not practicable, the Mountain Goat Management Plan could include an adaptive management component that involves monitoring the response of goats to specific Project activities and adjusting activities to meet acceptable response thresholds.

8.0 CLOSURE

Information collected from this study is important for the future assessment of Project-related effects on wildlife species of noted conservation concern. This document provides information regarding baseline conditions for mountain goat distribution and abundance between 2015 and 2018 as described herein. This information is intended to facilitate and inform future monitoring programs should they be required during subsequent stages of Project permitting.

As the Project advances, future studies are recommended to support conservation, mitigation and management of mountain goat within and surrounding the Project area. We sincerely appreciate the opportunity to have assisted you with this project. If there are any questions, please do not hesitate to contact the undersigned.

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