

POPULATION ESTIMATE
CHISANA CARIBOU HERD
2013

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Summary

In October 2013, we conducted a collaborative survey to estimate the composition and size of the Chisana caribou herd. Partner agencies included Environment Yukon, Alaska Department of Fish & Game, and US National Park Service (Wrangell-St. Elias National Park).

The survey was conducted to assess the status of the herd 7 years after completion of a captive rearing project undertaken on the herd, and to provide information set out in the *Management Plan for the Chisana Caribou Herd (2010 – 2015)* that is required to determine if harvest of the herd can be continued in Alaska. Licenced harvest in Yukon has not yet resumed.

Key Findings

- There were an estimated 701 animals (90% confidence interval: 639 – 763) in the Chisana caribou herd.
- Based on estimates from 2003, 2005, 2007, 2010, and 2013, the current trend of the herd is assessed as stable.
- We classified 631 animals to estimate the herd's composition. We estimated an adult sex ratio of 49 bulls per 100 cows and a recruitment ratio of 16 calves per 100 cows.
- Overall, calves and bulls made up approximately 10% and 30% of the herd, respectively.
- Based on results from this survey, the status of the herd currently meets the thresholds for continued hunting of the herd, as outlined in the management plan.
- This survey fulfills the recommendation of conducting one population estimate of the herd within the life of the management plan.

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Introduction

From 2003 to 2006, the Chisana caribou herd was the focus of a captive rearing program that attempted to halt a perceived decline in the herd's size (Chisana Caribou Recovery Team 2010). Management authorities in both Alaska and Yukon closed the herd to harvest due to this decline. Given the substantial resources devoted to management of the herd, there is considerable interest in its status. The herd's size has been estimated in 2003, 2005, 2007, and 2010 and was generally stable. The population size ranged from a low of 682 animals in 2010 to a high of 766 animals in 2007 (Adams 2003; Adams and Roffler 2005, 2007; Hegel et al. 2013).

Following results from the 2010 population estimate, the status of the herd met the requirements outlined in the interjurisdictional "Management Plan for the Chisana Caribou Herd (2010-2015)" (Chisana Caribou Herd Working Group 2012; hereby referred to as "the Plan") for re-establishing a harvest. These requirements were:

- the herd is stable or increasing (based on the October 2010 population estimate);
- a sex ratio of at least 35 bulls per 100 cows observed during fall composition surveys; and
- a rolling 3-year average October calf recruitment of more than 15 calves per 100 cows.

Harvest of the herd resumed in 2012 in Alaska, with 2 and 3 bulls harvested in 2012 and 2013, respectively. A regulatory change to

Yukon's *Wildlife Act* was required to re-establish harvest in Yukon. This change was approved following a public review process; however a licenced harvest has not yet been implemented.

Thus, to provide an assessment of the herd's status 7 years after the large-scale captive rearing program, and to inform management authorities on whether or not harvest should continue as per criteria outlined in the Plan, Environment Yukon, Alaska Department of Fish & Game, and Wrangell-St. Elias National Park coordinated a population estimate and composition survey of the herd in October 2013.

Methods

The general approach used to estimate the herd's size followed that used by Adams and Roffler during the previous 4 estimates (2003, 2005, 2007, and 2010). Using radio-collared animals, a sightability model was developed to account for animals missed during the composition survey. On 6 October 2013 a fixed-wing Piper PA18 Supercub equipped with a radio-telemetry receiver located all active radio-collared cows in the herd to focus survey efforts prior to the formal survey (Figure 1).

During the formal survey (11 and 12 October 2013), the Supercub again searched for all active radio-collars in the herd, noting the group size associated with a radio-collared female when located. Concurrently, a helicopter survey crew conducted a composition survey of the herd. A Robinson R44 helicopter was used during the Alaskan portion of the

survey on 11 October and an AStar (AS350 B1) helicopter was used during the Yukon portion of the survey on 12 October. We searched the herd's late-fall range based on current radio-collar distribution and movement data from prior surveys. Radio-telemetry receivers were not used in order to not bias the sightability estimate. When groups were located, animals were classified as calves, cows, or bulls. As per jurisdiction-specific survey protocols, Alaskan crews classified bulls as small, medium, or large, while Yukon crews distinguished bulls as either small or large. The presence of any radio-collared female in an observed group was also noted. Marked groups (i.e., a group having at least one radio-collared female) missed by the helicopter crew were subsequently located, using information from the fixed-wing pilot, and those animals were also classified.

Data from the fixed-wing portion of the survey provided sizes of all radio-collared (i.e., marked) groups in the herd. Data from the helicopter survey provided information on the composition of the observed groups (both marked and unmarked). As not all marked groups were initially observed by the helicopter crew, a sightability model to account for detectability was developed using logistic regression. The group was the basic unit for analysis and the probability of observing a marked group was modeled as a function of covariates. We assumed that the radio-collared females were randomly distributed within the herd. We included 2 possible covariates that may have influenced sightability:

group size and survey crew (Alaska or Yukon). We used a model selection approach in which multiple models, with differing combinations of covariates, were compared using AICc values (Burnham and Anderson 2002). The model with the lowest AICc value was deemed most supported. For the analysis, a '1' represented a marked group observed by the helicopter crew and a '0' a marked group not observed by the helicopter crew (but observed by the fixed-wing flight).

The sightability model was then applied to all groups (both marked and unmarked) observed by the helicopter crew to adjust numbers for detectability. The sum of these adjusted numbers thus represents the estimated herd size. The analysis was conducted using the 'SightabilityModel' package (version 1.2; Fieberg, 2012) for the statistical software R (version 3.1.1; R Core Team, 2014). The sightability correction factor, and associated SE, was calculated using equations provided by Steinhorst and Samuel (1989).

Results

The survey took place over 2 days and approximately 12 hours of flying. Survey conditions were generally favourable (Table 1).

We classified 631 caribou during the survey to estimate herd composition (Table 2). Calf recruitment was 16 calves per 100 cows. The overall sex ratio of the herd was 49 bulls per 100 cows.

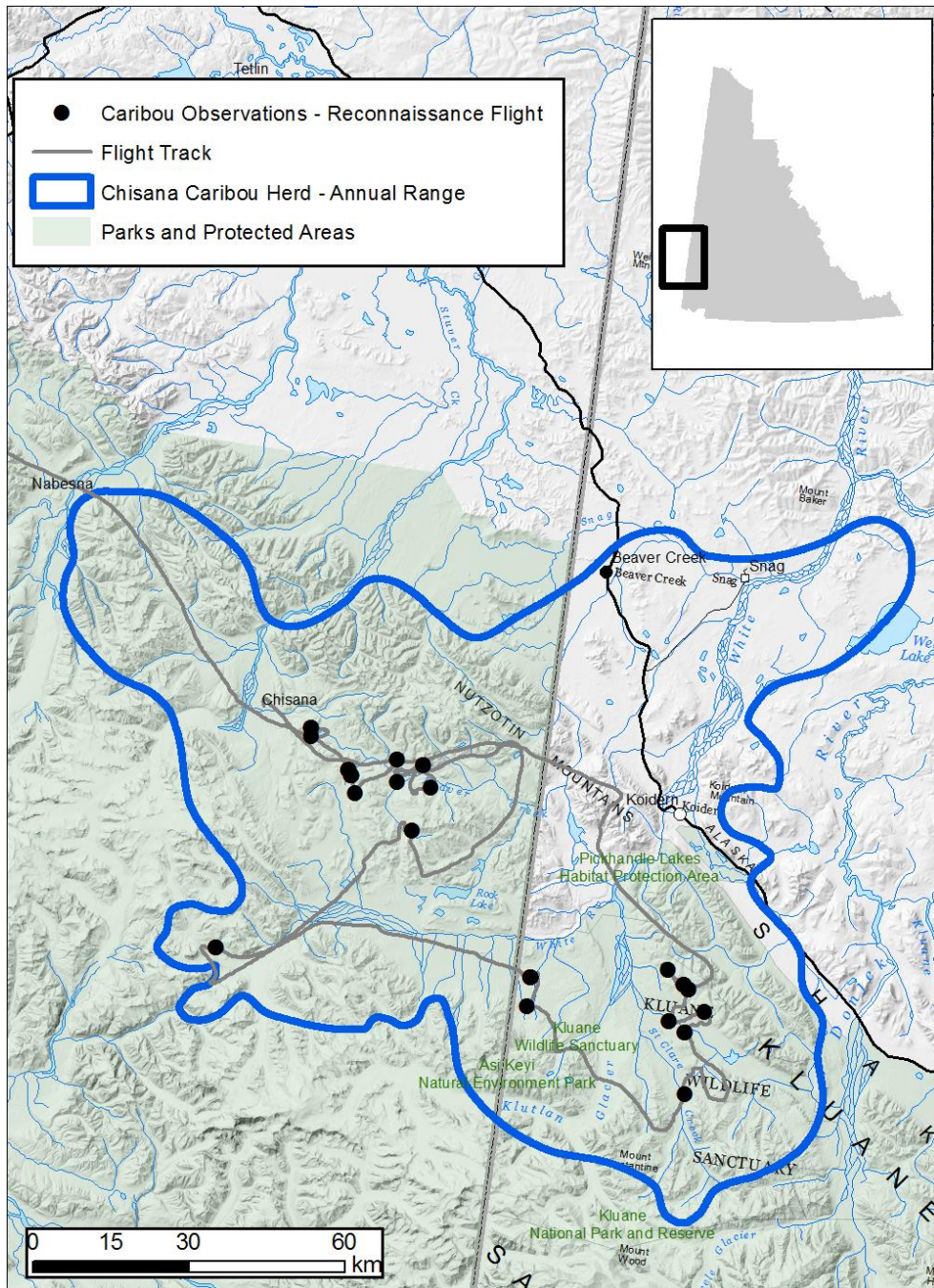


Figure 1. Caribou groups observed during the October 6 fixed-wing reconnaissance flight of the 2013 Chisana caribou herd population and composition survey.

Table 1. Survey details for the 2013 Chisana caribou herd.

Date	Hours Flown	Survey Crew	Snow Conditions	Light Conditions
11 October	6	Alaska	Approximately 90% snow cover	Clear
12 October	6	Yukon	Patchy snow cover	Clear

Table 2. Composition of the Chisana caribou herd – October 2013.

Parameter	Value
Number of caribou classified	631 ^a
Calves: 100 cows	16
Total bulls: 100 cows	49
Number of calves observed	61
Number of cows observed	383
Number of small bulls observed	66
Number of medium bulls observed ^b	40
Number of large bulls observed	81
% calves in the herd	9.7
% bulls in the herd	29.6

a: This number is higher than the number used to estimate the herd size, as marked groups initially missed by the helicopter crew were revisited for classification.

b: Alaska distinguishes bulls into small, medium, and large categories whereas Yukon categorizes bulls into small and large. The medium category only includes bulls classified by Alaska. This distinction has no effect on the estimates of the size and overall sex ratio of the herd.

Twenty-two marked groups (i.e., a caribou group having at least one radio-collared cow) were present in the herd during the formal survey (Table 3). Of these, 17 groups were observed by the helicopter composition crew (Table 4; Figure 2). Using these data on observed and unobserved groups, 4 candidate sightability models were fitted (Table 5). The model with the lowest AICc value included group size as a covariate (Table 6) with the null model (constant sightability) ranked second (Table 5). The sightability-group size relationship observed in the 2003, 2005, 2007, and 2013 estimates were generally similar, with 2010 apparently an outlier (Table 7).

Using this sightability value, the estimated size of the herd, based on groups located *within the survey area*, was 622 (SE = 34). However, some marked (collared) caribou were located outside of the survey area in subsequent fixed-wing flights. Nine radio-collared females were not located by either the helicopter or fixed-wing crews during the survey. Including these groups in the data used to train the sightability model would be inappropriate, as they were not “available” to be observed by the helicopter crew. This situation also occurred during previous population estimates. To account for these groups located outside the survey area we adopted Adams and Roffler’s (2007) approach and adjusted the

within-survey area population estimate from the sightability model (i.e., 622) by the proportion of all radio-collared females located in the survey area relative to the total number of radio-collars in the herd (Table 4). Nine of the 71 active collars were not located during the survey; thus the within-survey area population estimate was inflated by 12.7%, resulting in a final population estimate of 701 animals (SE = 62).

Average group size was larger during this survey as compared to previous surveys (Table 7), largely due to the presence of one group near Beaver Lake which contained 254 animals, which was unique when compared to previous fall surveys of the herd. Based on herd composition data (Table 2), there were an estimated 68 calves, 207 bulls, and 426 cows in the herd in October 2013.

Table 3. Characteristics of marked groups in the Chisana caribou herd during the 2013 population estimate survey.

Parameter	Value	Standard Error
Typical group size ^a	129.5	116.7
Average group size	24.8	11.1
Median Group Size	12	-
Group size coefficient of variation	2.1	-
Range	1 – 254	-

a: From Rettie and Messier, 1998. Typical group size is an animal-centric metric of group size and describes the size of the group an average (i.e. typical) individual in the population would perceive.

Table 4. Observation data used for developing the sightability model and the 2013 population estimate of the Chisana caribou herd.

Variable	Value
Number of radio-collared animals in the herd	71
Number of radio-collared animals in the survey area	62 ^a
Number of marked groups in the herd	27
Number of marked groups in the survey area	22
Number of marked groups in the survey area observed by the helicopter crew	17
Total number of animals observed by the helicopter crew	572

a: This is the number of collars used to develop the sightability model. Nine of the 71 active collars in the herd were not located during the survey by either the helicopter or fixed-wing crews and were thus censored from the sightability analysis.

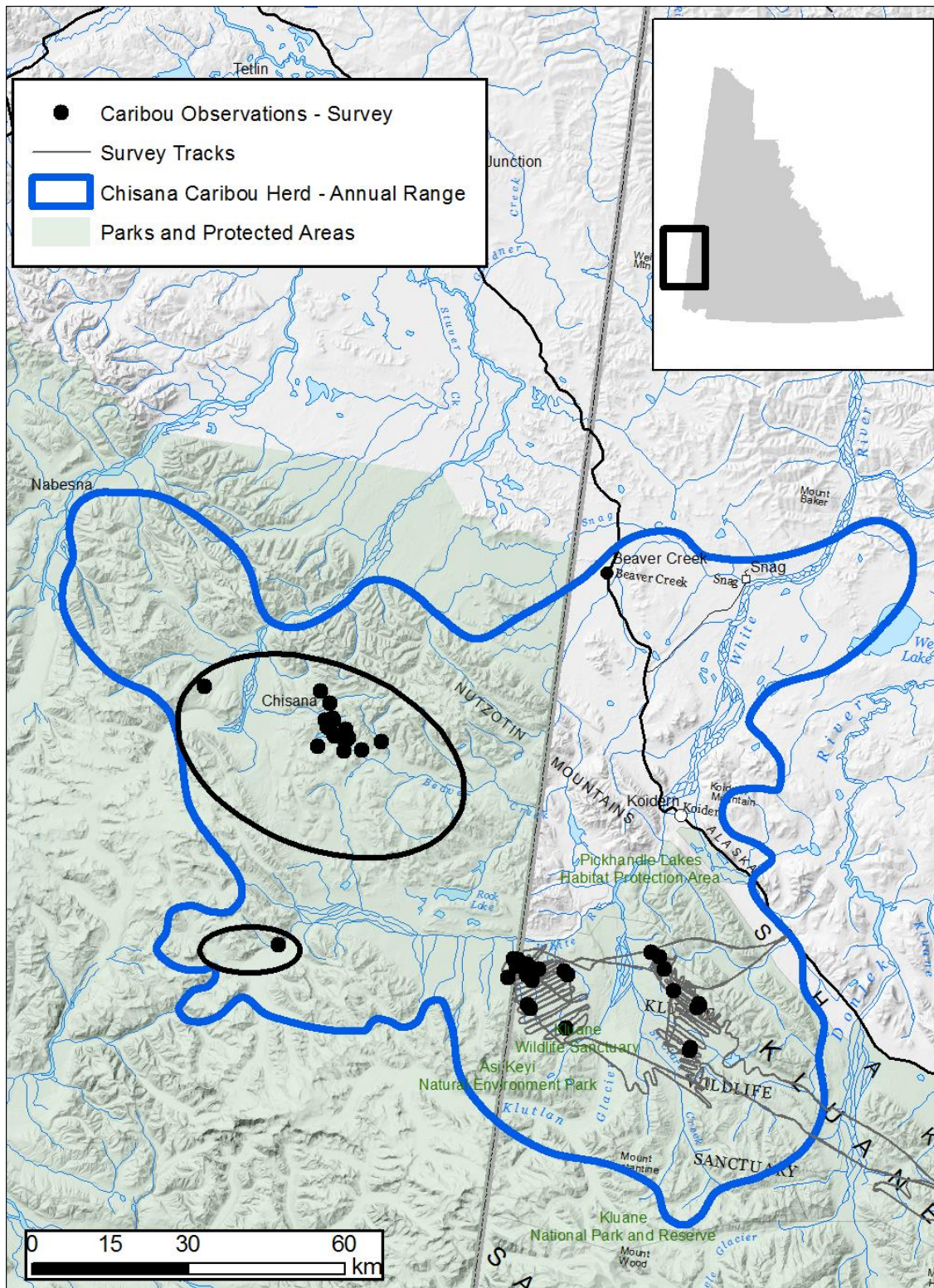


Figure 2. Locations of caribou groups and survey tracks from the helicopter-based surveys of the Chisana herd (11 and 12 October 2013). Survey tracks for the Alaskan portion of the survey are unavailable. Ellipses outlined in black indicate the general survey area for the Alaska portion of this work.

Table 5. Candidate sightability models for the 2013 Chisana caribou population estimate (n = 22) with model selection values.

Sightability Model	AICc	K^b
Null ^a	25.78	1
Group size	24.12	2
Survey crew	28.03	2
Group size + survey crew	n/a ^c	3

a: A null model (i.e., intercept-only) with no covariates was fitted as a comparison against the other models.

b: Number of parameters including the intercept.

c: Could not achieve numerical convergence.

Table 6. Parameter estimates for top candidate sightability model (Table 5) for the 2013 Chisana caribou population estimate.

Model	Parameter	Coefficient	Standard Error
Group size	Intercept	-0.28	0.96
	Group Size	0.13	0.09

Table 7. Comparison of survey results of the 2003, 2005, 2007, 2010, and 2013 population estimates of the Chisana caribou herd.

Parameter	2003^b	2005^{c,d}	2007^d	2010^e	2013
Population estimate	720	706	766	682	701
90% confidence interval ^a	606 – 833	646 – 792	719 – 823	622 – 832	639 – 763
Group size coefficient for the sightability model	0.166	0.175	0.178	0.06	0.13
Number of radio-collared caribou in the herd	39	97	138	96	71
Number of marked groups used to estimate the sightability model	30	45	30	28	22
Number of marked groups in the survey area that were observed	20	35	25	22	17
Average size of marked groups	15.3	10.6	21.5	17.9	24.8
Range of marked groups	1 – 54	1 – 34	1 – 65	4 – 58	1 – 254
Proportion of all radio-collared animals located inside the survey area	1.0	0.92	0.96	0.97	0.97

a: If applicable, the lower limit of the confidence interval is truncated at the minimum number of animals known to be alive in the herd during the survey years (see Table 2 for 2013 numbers).

b: from Adams (2003)

c: from Adams and Roffler (2005)

d: from Adams and Roffler (2007); from Hegel et al. (2013).

Implications for Harvest Management

The Plan outlines 3 criteria that must be met for harvest of the herd to continue: a stable or increasing herd size, an adult sex ratio of at least 35 bulls per 100 cows, and a 3-year moving average of October calf recruitment of at least 15 calves per 100 cows.

Based on our results, all three criteria were met and harvest of the herd can continue. When examining

the 5 population estimates from 2003 to 2013, and their degree of uncertainty, there is no clear increasing or decreasing trend (Figure 3). Additionally, the slope of the parameter estimating the trend in the herd's size (\log_e -transformed), based on a linear regression, from 2003 to 2013 was not significantly different from zero ($\beta = -0.004$, $SE = 0.006$). The trend coefficient from a linear regression of natural log-transformed abundance estimates was also not significantly different from zero.

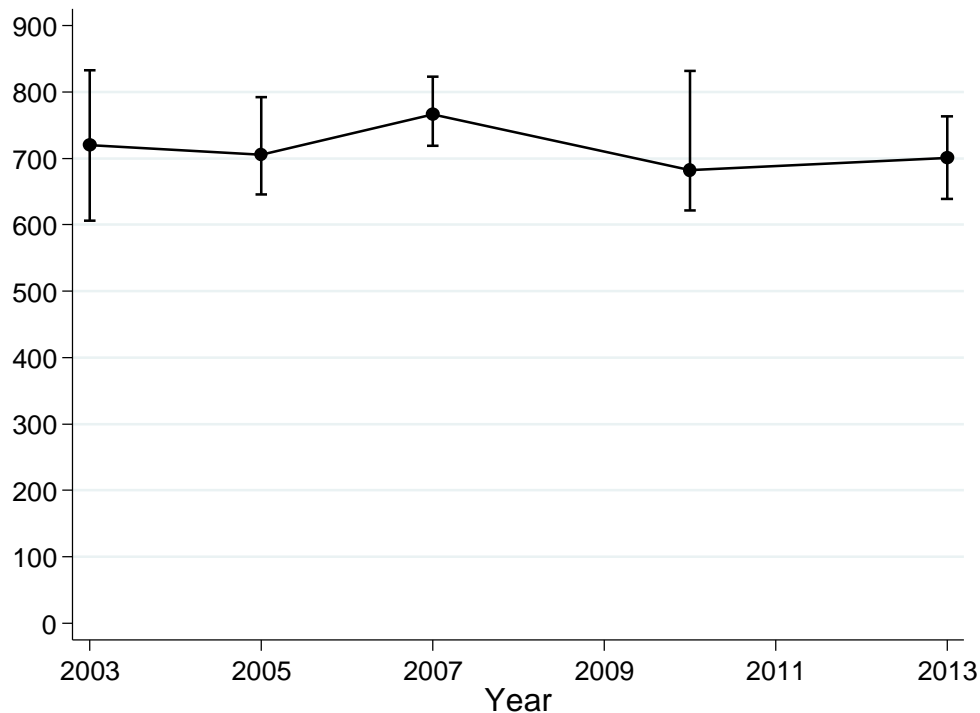


Figure 3. Population estimates of the Chisana caribou herd from 2003 to 2013. The solid black line connects the individual population estimates. The upper and lower bars represent 90% confidence intervals of each year's estimate. Confidence intervals are asymmetric as lower values were truncated by the number of caribou observed during the surveys, if applicable.

The adult sex ratio of the herd in 2013 was estimated at 49 bulls per 100 cows (Table 2), greater than the minimum threshold required under the Plan. The 3-year moving average of October calf recruitment was also greater than the threshold of 15 calves per 100 cows identified in the Plan (Figure 4), with a 2013 value of 16 calves per 100 cows. Since the 2013 survey, two additional fall composition surveys have been

conducted in 2014 and 2015. Adult sex ratios remain above the threshold for continuing the harvest of the herd (41 and 40 bulls per 100 cows, respectively). Recruitment rates were 23 and 18 calves per 100 cows for 2014 and 2015, respectively. The 3-year moving average of calf recruitment also remains above the threshold identified in the Plan (Figure 4).



Figure 4. Three-year moving average calf recruitment (calves per 100 cows) from 1987 to 2015. The year value on the x-axis indicates the final year for each 3-year average. The solid black horizontal line indicates the threshold of 15 calves per 100 cows required to continue harvest of the herd.

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