Government of Northwest Territories
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Analysis of Hunter Observations of Redstone and Bonnet Plume Northern Mountain Caribou, 1991-2016

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ABSTRACT

The northern mountain population (NMP) of woodland caribou was listed as a species of Special Concern under the federal *Species at Risk Act* in 2004 and the status was reaffirmed in 2014. The Redstone and the Bonnet Plume are two of the larger NMP herds shared by the Yukon and Northwest Territories. Aerial survey data from both of these herds are lacking. Data from voluntary wildlife observations, collected from Mackenzie Mountain Outfitters and their clients from 1991-2010, were used to explore demographic parameters of these herds prior to the 2014 Committee on the Status of Endangered Wildlife in Canada reassessment of NMP. The ratios of calves and adult males per 100 adult females were distinctly different between the two herds but showed remarkable consistency within herds over a 20 year period (Larter 2012). With an additional six more years of observation data, there is some evidence of decreasing trends in the ratio of calves per 100 adult females and percent calves. Conversely, there is some evidence of increasing trends in the ratio of adult males per 100 adult females. Additionally, the difference in demographic parameters between herds is becoming less distinct. These changes are discussed in relation to the overall time series and the time series partitioned into nine year generation periods for NMP.

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INTRODUCTION

The northern mountain population (NMP) of woodland caribou was reassessed as a species of Special Concern by the Committee on Status of Endangered Wildlife in Canada (COSEWIC) in 2014. This population is scheduled to be assessed by the Northwest Territories Species at Risk Committee (NWT SARC) in 2020. The Redstone and Bonnet Plume are two of the larger herds of NMP as delineated by Environment Canada (2011). They reside in the Mackenzie Mountains and are shared by the Yukon (YT) and Northwest Territories (NWT) (Figure 1).

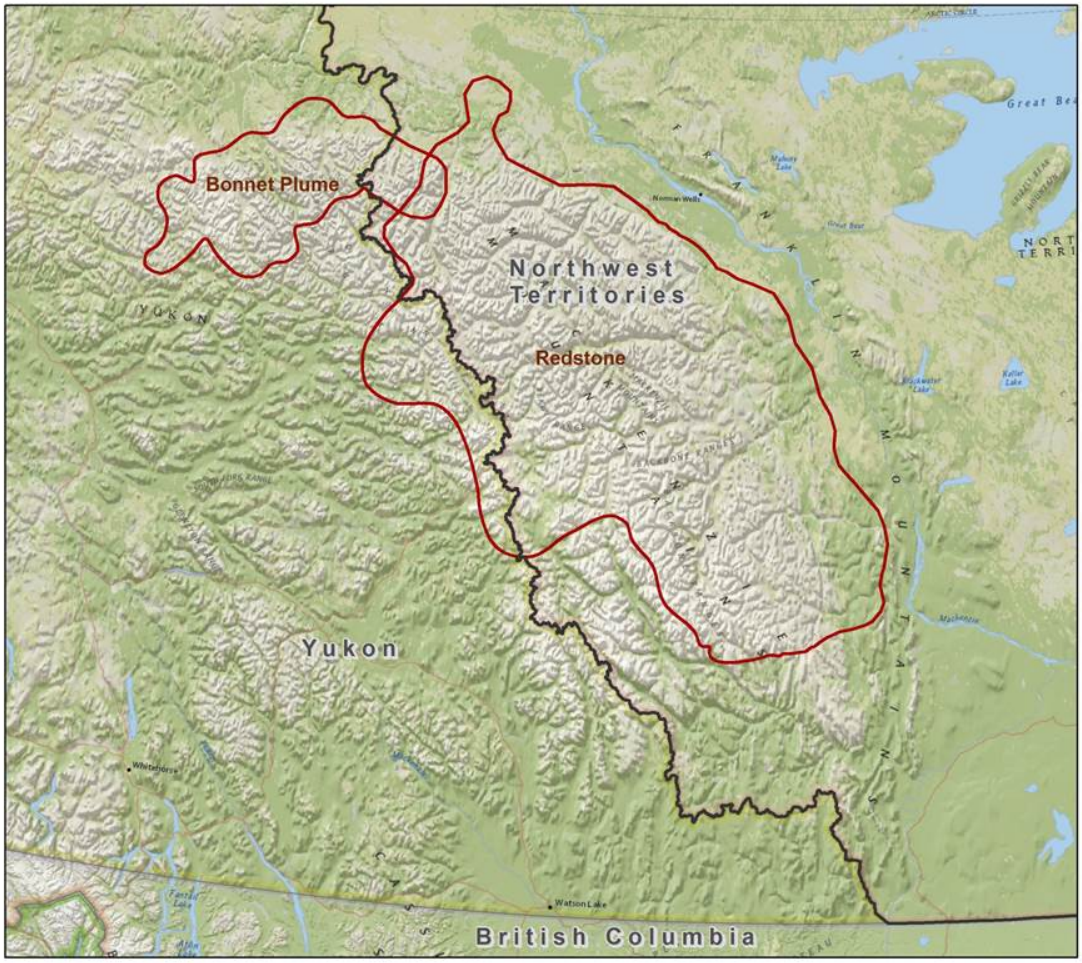

Figure 1: Distribution of the Bonnet Plume and Redstone northern mountain caribou herds. Map: GNWT/B. Fournier, ENR.

Aerial survey data for these herds are lacking, however the Department of Environment and Natural Resources (ENR) has collected voluntary wildlife observation data from the Mackenzie Mountain Outfitters and clients since 1991. Observations of NMP collected from 1991-2010 were analyzed to determine demographic parameters for Redstone and Bonnet Plume herds (Larter 2012). Over that 20 year period the Redstone herd had a consistently higher ratio of calves per 100 adult females and percent calves than the Bonnet Plume herd. However the Redstone herd had a consistently lower ratio of adult males per 100 adult females than the Bonnet Plume herd. There was no trend in either ratios or percent calves over that period for either herd. These data were used for the reassessment of NMP status (COSEWIC 2014).

Recently, there have been concerns that increasing hunting pressure and disturbance on NMP, particularly in the range of the Redstone herd, are negatively affecting NMP (Winbourne et al. 2017). ENR continues to collect annual voluntary wildlife observations from hunters in the Mackenzie Mountains (see Larter and Allaire 2017). Observation data collected from 1991-2016 represented an almost three generation time period for NMP. Data from this extended time series were analyzed for similar demographic parameters as in Larter (2012) over the entire time series (1991-2016) and over three nine-year generation times.

METHODS

Since 1991, ENR has distributed voluntary wildlife observation forms to all clients of guided hunts by outfitters in the Mackenzie Mountains (Appendix C). Observations were collected from guides and clients of all different outfitting zones covering the full range of the Mackenzie Mountains in NWT. Part of the observation data included the number of NMP males, females, and young-of the year (calves). Observations of caribou were generally made during August-September of each year. Forms were collected by ENR following the outfitting season. I removed duplicate (or triplicate) observation forms turned in by each individual in a hunting party. Each observation of a group was treated as a random sample of animals drawn from a herd with replacement. An adequate number of samples with replacement should provide a reasonable estimate of the number of males, females, and calves in the herd. Sampling with replacement can result in the total number of animals classified being greater than the estimated population size. I assumed observations from zones S/OT/02, S/OT/03, S/OT/04, and S/OT/05 were almost exclusively of caribou from the Redstone herd and that observations in zones G/OT/01 and S/OT/01 were almost exclusively of caribou from the Bonnet Plume herd (Figure 2).

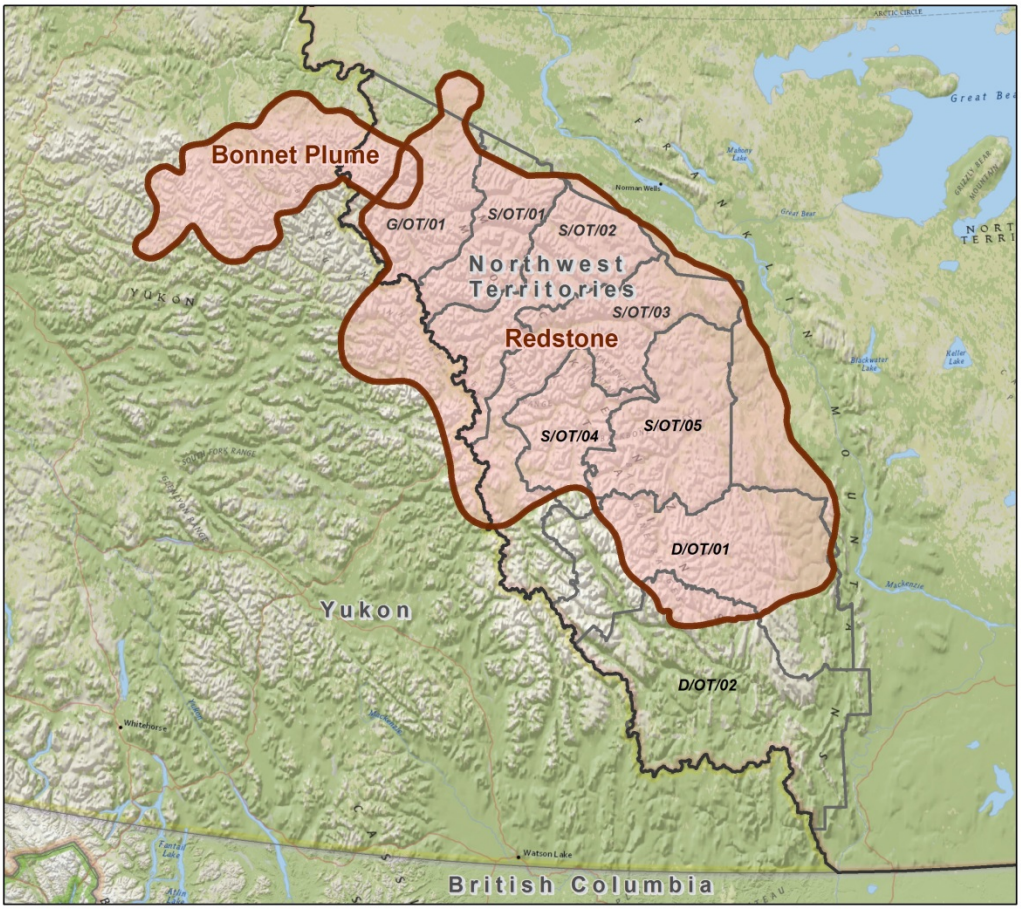

Figure 2. Distribution of Bonnet Plume and Redstone northern mountain caribou herds. Map: GNWT/B. Fournier, ENR.

I calculated the ratios of calves per 100 adult females (reported as calf:female) and adult females to adult males, the total number of animals classified, and the percent calves of the total observed for each year for both herds (see Appendices A and B). The generation time for NMP is reported as nine years (COSEWIC, 2014). Data are presented over the full 26 year time series and over the three generations: 1991-1999, 2000-2008, and 2009-2016.

RESULTS

Observations were collected over a 26 year period (1991-2016). For the Redstone herd the mean (±standard deviation (SD)) number of caribou classified annually was 15,244±6,560 from a mean annual 87±21 observations. For the Bonnet Plume herd the mean number of caribou classified annually was 3,613±1,640 from a mean annual 55±14 observations (see Appendices A and B).

With the addition of the last six years of data to the initial 20-year data set, there has not only been a decrease in the mean and median number of calves per 100 adult females and percent calves for both herds, but the lowest number of calves per 100 adult females and percent calves was recorded during the past six years (last generation). Conversely, for the number of adult males per 100 adult females the mean and median values increased, but the maximum values were not recorded during the last generation, but in the previous two generations.

Table 1. The ratios of calves per 100 adult females (Ca:100F), adult males per 100 adult females (M:100F), and the percent calves of the total number of caribou observed for the Redstone and Bonnet Plume northern mountain caribou herds. Values in black on the top of the cells are for 1991-2010. Values in coloured font on the bottom of the cells are for 1991-2016. Red, green, and blue indicate lower, higher, and equal values.

	Redstone Herd				Bonnet Plume Herd		
	Ca:100F	**M:100F**	**% Calves**		**Ca:100F**	**M:100F**	**% Calves**
Mean	47.78 46.15	30.49 30.73	26.62 26.02	**Mean**	34.69 33.27	80.78 85.93	16.24 15.34
Median	46.35 45.40	29.38 30.30	25.94 25.44	**Median**	32.84 32.25	73.04 81.14	15.98 15.76
Minimum	35.55 32.25	15.35 15.35	20.88 19.56	**Minimum**	28.90 24.05	54.26 54.26	10.71 10.51
Maximum	63.39 63.39	54.79 54.79	34.06 34.06	**Maximum**	45.45 45.45	140.83 140.83	20.75 20.75

Calf:Female

From 1991-2016 there is a very minor decreasing trend in the ratio of calves per adult female for both the Redstone and the Bonnet Plume herds (Figure 3). When partitioned into the three generation periods, the greatest decline observed is for the Redstone herd; it occurs during the last generation (R^2 0.561). Also during the last generation, the rate of decline in ratio appears greater for the Redstone than the Bonnet Plume herds and they actually converge for the first time in the 26 year time series (Figure 3).

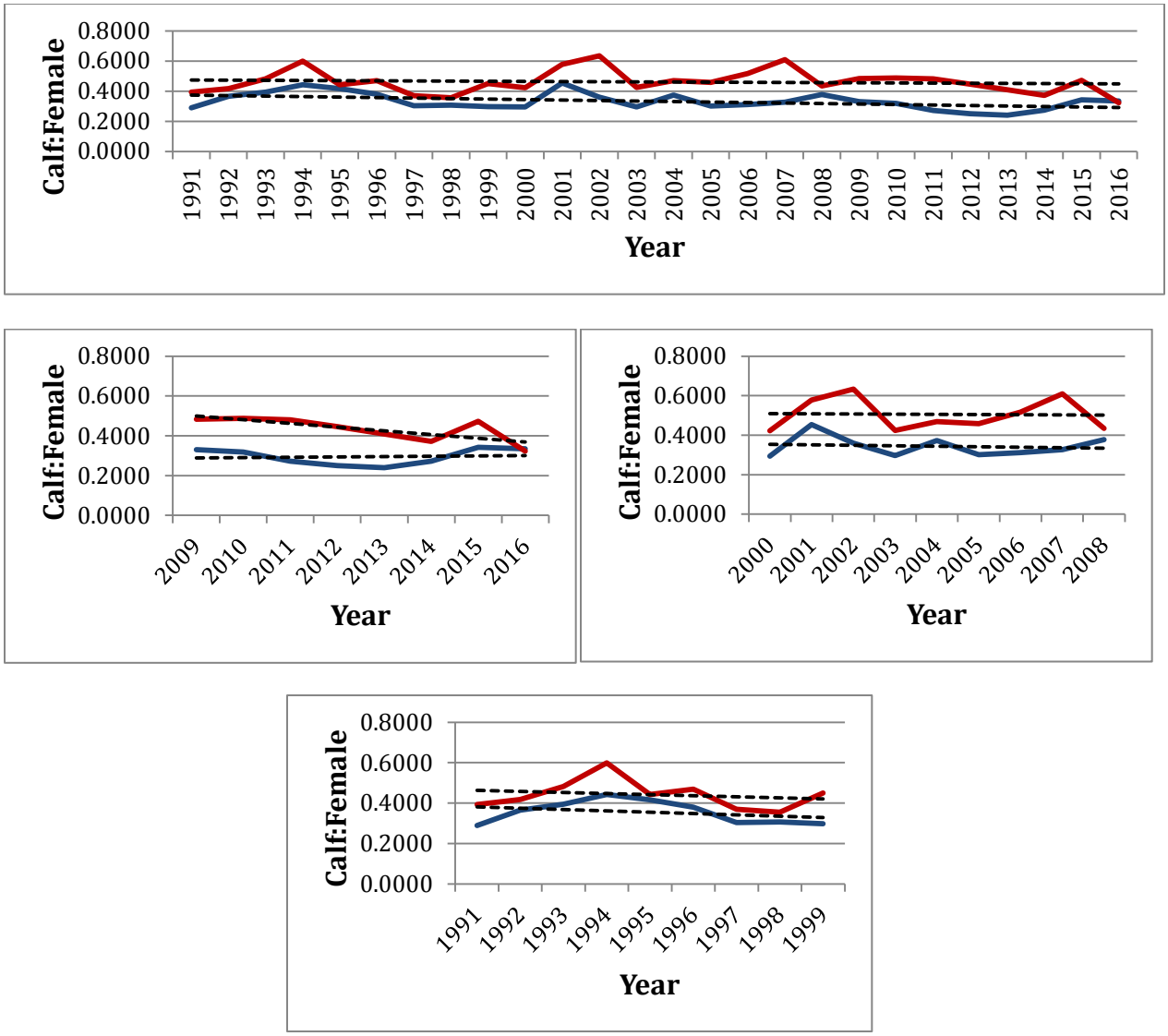

Figure 3. The ratio of calves per adult female for the Redstone (red line) and Bonnet Plume (blue line) mountain caribou herds based upon hunter observations, 1991-2016. The top graph shows entire 26 year time series; below data are partitioned into three generations (2009-2016, 2000-2008, and 1991-1999). The dashed line is the fitted line.

Percent Calves

From 1991-2016 the percent calves for both Redstone and Bonnet Plume herds shows a very similar pattern to the calf:female with minor decreasing trends (Figure 4). The greatest declines are also seen during the last generation, with the decline steeper for the Redstone but not to the extent of convergence in the data as seen for the calf:female (Figure 4). However, 2016 estimates are similar to 1991 estimates for both herds.

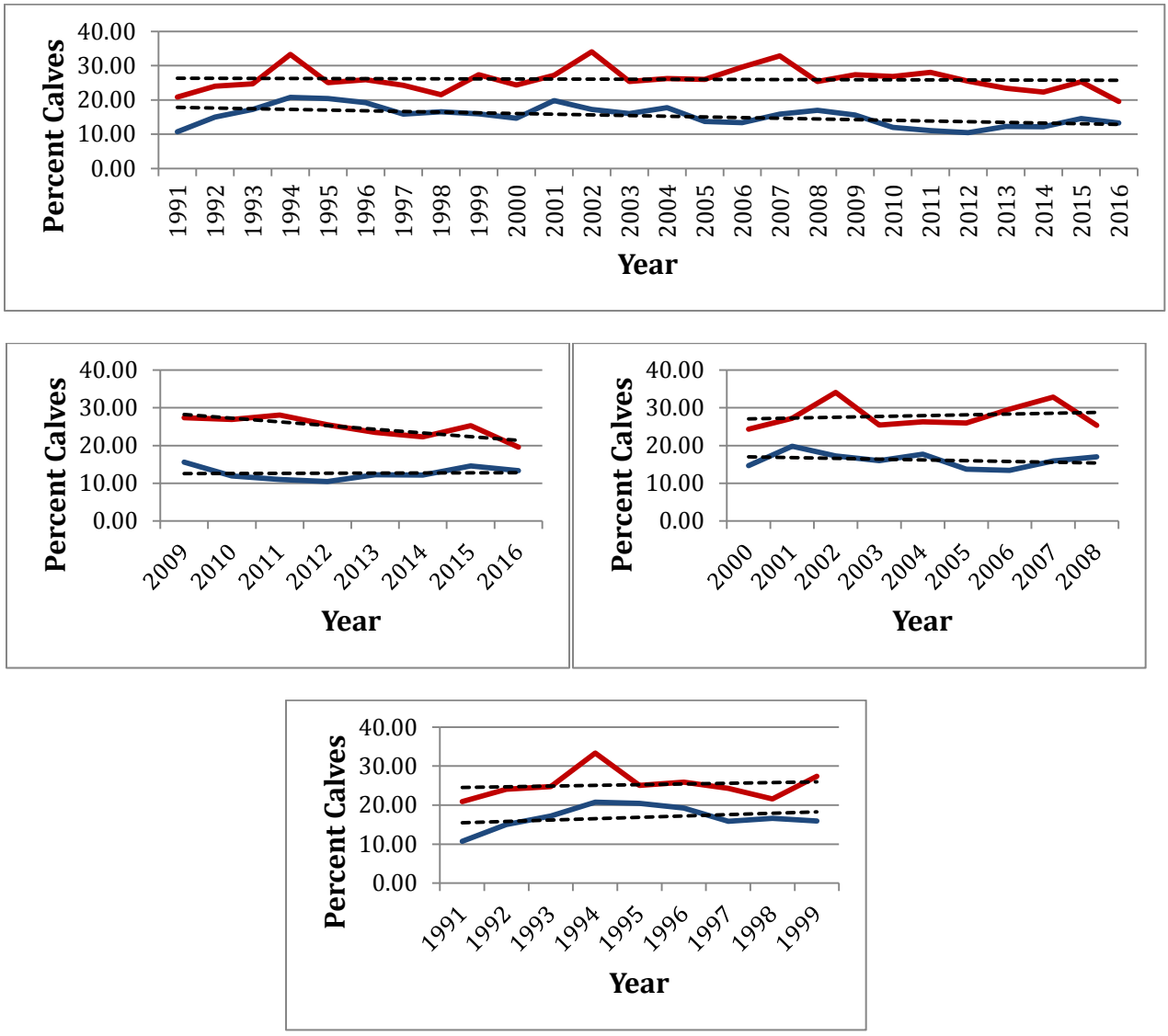

Figure 4. The percent calves for the Redstone (red line) and Bonnet Plume (blue line) mountain caribou herds based upon hunter observations, 1991-2016. The top graph shows entire 26 year time series; below data are partitioned into three generations (2009-2016, 2000-2008, and 1991-1999). The dashed line is the fitted line. The dashed line is the fitted line.

Male:Female

From 1991-2016 there is an increasing trend for the Bonnet Plume herd and no trend for the Redstone herd (Figure 5). This ratio shows the most dramatic change in any generation with both herds showing a large decline from 1991-1999; R^2 values of 0.755 and 0.466 for the Bonnet Plume and Redstone, respectively. During the last generation there is an increasing trend in the ratio for the Bonnet Plume while there is little change in the ratio for the Redstone with the ratios diverging between herds (Figure 5).

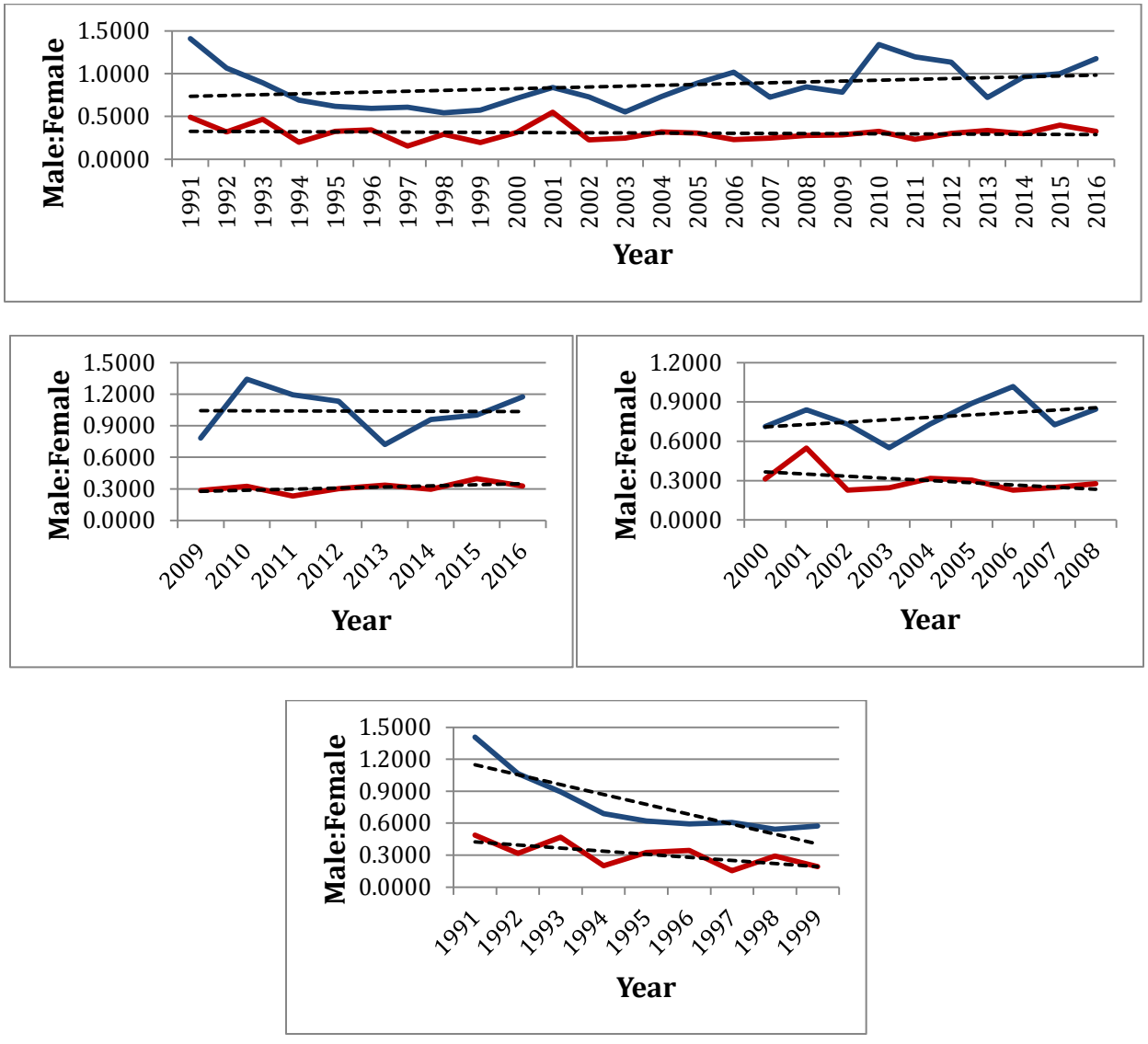

Figure 5. The ratio of adult males to adult females for the Redstone (red line) and Bonnet Plume (blue line) mountain caribou herds based upon hunter observations, 1991-2016. The top graph shows entire 26 year time series; below data are partitioned into three generations (2009-2016, 2000-2008, and 1991-1999). The dashed line is the fitted line.

DISCUSSION

Ground-based hunter observation data of large mammals can have inherent weaknesses and assumptions (see Larter 2012), but when collected in a similar way over an extended period of time, these data can be used to explore various demographic parameters that may otherwise be unknown. For the Redstone and Bonnet Plume NMP herds, there are no other survey data available; hence ground-based observation data were used in the 2014 assessment of the NMP designatable unit by COSEWIC. The most recent population estimates are >10,000 and 5,000 for the Redstone and Bonnet Plume herds, respectively. This translates into an estimated >7,300 and 4,200 mature individuals (COSEWIC 2014).

When doing assessments of species at risk, COSEWIC looks at the trajectories of population estimates in relation to generation times. Depending upon which year in a time series the generations start and end can influence the rates of decline. For NMP the generation time is nine years (COSEWIC 2014). With the additional of another six years of data the time series covers almost three complete generations; granted the data are not a population estimates but they are demographic parameters. These new data are timely in that the species at risk assessments depend upon compiling the best available data; the NWT SARC is scheduled to assess NMP in 2020.

Both the Redstone and Bonnet Plume herds are harvested for subsistence by Indigenous and local residents of both the NWT and the YT. Additionally, non-resident sport hunting occurs in the Mackenzie Mountains annually mostly during August and September. The annual harvest from the NMP by residents of the NWT is limited. An average estimated 29 caribou have been harvested annually by residents from 2001-2015. However, the estimated harvest for the last five years was greater than the average (Suzanne Carrière, unpublished data). Resident harvest is almost exclusively males and comes from five herds residing in the NWT: Redstone, Bonnet Plume, South Nahanni, Labiche, and Coal River

(nomenclature follows COSEWIC 2014). Using the assumption that caribou harvested from zones S/OT/02, S/OT/03, S/OT/04, and S/OT/05 were almost exclusively caribou from the Redstone herd, and caribou harvested from zones G/OT/01 and S/OT/01 were almost exclusively caribou from the Bonnet Plume herd, the estimated harvest by non-resident hunters since 2000 is 91 and 44 annually from the Redstone and Bonnet Plume herds, respectively. Non-resident harvest is exclusively males. The combined resident and non-resident harvest represents <2% of the estimated number of mature individuals in each herd. The Aboriginal harvest is of both sexes and remains unreported.

Recently there has been concern of increasing harvest pressure on NMP, particularly in the Redstone herd range (Winbourne et al. 2017). It is believed that with more restrictive harvesting of barren-ground caribou, harvest pressure has increased on NMP. There is some evidence that the annual resident harvest of NMP has increased since 2010 and may be closer to 40 males annually, but that harvest is still small and spread out over five herds and would represent <2% of the estimated number of mature individuals. Non-resident harvest pressure has remained relatively constant over the past 20 years. The current and past Aboriginal harvest is unknown.

The convergence of calf:female and percent calves between herds and the divergence of male:female between herds during the last generation suggests that the two herds are experiencing different conditions during the last generation relative to the previous 20 years, where there was consistency between herds for these parameters (Larter 2012).

A declining trend in calf:female and percent calves can be indicative of a decline in population. A decreasing calf:female ratio can occur from one or a combination of factors including: fewer females getting pregnant, fewer pregnant females producing viable calves, and/or decreasing neonatal or summer calf survival. For populations subject to female harvest, the rate of population decline can be greater than implied by the decline in

calf:cow because the denominator of these ratios is not consistent over time and may also have a decreasing trajectory over time (Caughley 1974).

An increasing male:female ratio could occur if either adult or calf male survival remained constant and adult or female calf survival decreased, or if either adult or calf male survival decreased but to a lesser extent than the decrease of adult or calf female survival, and/or if there was a shift in the 50:50 sex ratio presumed for newborn caribou. Given that both of these herds are subject to harvest, the change in ratio between the two herds indicates a difference in the harvest each herd is subjected to. The concern that the harvest of male caribou is depressing the number of males and negatively affecting breeding for these herds is not substantiated by the data because the male:female ratio has been constant, for the Redstone, or increasing, for the Bonnet Plume over time. Although the Bonnet Plume male:female ratio has an increasing trend over the 26 years, it experienced a noticeable decrease during the first generation (1991-1999). Current levels may be returning to historic levels.

These extended time series do suggest that something has changed to affect herd demographics over the past generation. Whether the recent declines in cow:calf and percent calves will continue into the next generation only time will tell. The current low values still fall within the range of those reported over the past 26 years. The implication that harvest, and particularly the harvest of females, is an important factor in these demographic changes is valid and requires further investigation. There should be a desired outcome by all the relevant management authorities to establish accurate harvest recording for each herd and maintain these harvest numbers annually.

ACKNOWLEDGEMENTS

Without the voluntary observations provided by the clients, guides, and operators of the Association of Mackenzie Mountain Outfitters (AMMO), the Department of Environment and Natural Resources (ENR) would have no estimates of demographic parameters for northern mountain population of caribou in the Northwest Territories (NWT). I thank the members of AMMO for supporting the voluntary observation program and for taking the extra time with clients to ensure that wildlife observations were recorded and forwarded to the ENR.

I thank Suzanne Carrière for providing unpublished NWT resident harvest data and Danny Allaire for compiling the non-resident harvest data for the Mackenzie Mountains. I thank Ashley McLaren and James Hodson for comments on earlier drafts of this report. Bonnie Fournier is thanked for drafting Figure 1.

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APPENDIX A

The number of different groups, females, calves, and males observed each year by guides and clients of S/OT/02, S/OT/03, S/OT/04 and S/OT/05. These observations are assumed to be from the Redstone herd of NMP.

Year	Groups	Females	Males	Calves	Total Caribou
1991	124	7,177	3,510	2,820	13,507
1992	90	7,958	2,529	3,321	13,808
1993	111	9,523	4,455	4,595	18,573
1994	123	19,481	3,895	11,674	35,050
1995	97	8,779	2,853	3,885	15,517
1996	134	13,589	4,661	6,377	24,627
1997	103	18,442	2,831	6,827	28,100
1998	105	13,593	3,979	4,832	22,404
1999	61	9,069	1,753	4,082	14,904
2000	68	4,700	1,470	1,984	8,154
2001	82	5,065	2,775	2,929	10,769
2002	86	12,103	2,748	7,672	22,523
2003	74	6,817	1,679	2,890	11,386
2004	86	6,338	2,014	2,974	11,326
2005	95	6,723	2,043	3,078	11,844
2006	68	6,089	1,390	3,148	10,627
2007	67	8,446	2,091	5,145	15,682
2008	63	5,286	1,461	2,294	9,041
2009	56	8,097	2,302	3,915	14,314
2010	60	9,060	2,940	4,412	16,412
2011	63	9,345	2,167	4,495	16,007
2012	80	5,997	1,812	2,673	10,482
2013	81	5,540	1,866	2,270	9,676
2014	91	7,946	2,356	2,961	13,263
2015	99	4,191	1,660	1,980	7,831
2016	92	6,385	2,084	2,059	10,528

APPENDIX B

The number of different groups, females, calves, and males observed each year by guides and clients of G/OT/01 and S/OT/01. These observations are assumed to be from the Bonnet Plume herd of NMP.

Year	Groups	Females	Males	Calves	Total Caribou
1991	22	218	307	63	588
1992	17	186	198	68	452
1993	35	931	832	367	2,130
1994	34	1,070	737	473	2,280
1995	61	3,345	2,073	1,392	6,810
1996	67	2,703	1,604	1,026	5,333
1997	59	2,369	1,439	719	4,527
1998	75	2,829	1,535	868	5,232
1999	49	1,363	780	406	2,549
2000	55	1,304	929	384	2,617
2001	56	1,230	1,033	559	2,822
2002	63	2,001	1,459	720	4,180
2003	71	3,945	2,174	1,168	7,287
2004	63	1,767	1,293	659	3,719
2005	62	1,367	1,217	411	2,995
2006	68	1,649	1,676	514	3,839
2007	59	2,720	1,974	888	5,582
2008	52	1,299	1,096	491	2,886
2009	55	1,898	1,486	627	4,011
2010	57	1,507	2,022	480	4,009
2011	55	1,282	1,532	349	3,163
2012	54	1,908	2,163	478	4,549
2013	46	1,447	1,043	348	2,838
2014	68	1,725	1,657	471	3,853
2015	68	1,724	1,724	590	4,038
2016	52	655	770	219	1,644

APPENDIX C

Example of a fully completed hunter wildlife observation report form.

MACKENZIE MOUTAINS, NORTHWEST TERRITORIES
HUNTER WILDLIFE OBSERVATION REPORT – 2007

Dear Hunter: The Department of Environment and Natural Resources request your kind assistance with completing this questionnaire about your NWT hunting experience, in order to assist us with the management of Mackenzie Mountain big game populations. All the requested information is completely voluntary, but your providing it to us is most appreciated.

HUNTER INFORMATION

Last Name [redacted]

Address- number and street, box number | Town, City | Province, State, Country

[redacted]

Hunting License # HL[redacted] Outfitter Zone: 6/07/01 Outfitter: [redacted]

Start Date of Hunt 7/15 2007 End Date of Hunt 7/24 2007 Observations Made Over 10 Days

ESTIMATED NUMBER OF DALL'S SHEEP SEEN			
¾ and Full Curl Rams	Less than ¾ Curl Rams	Ewes	Lambs
25	46	24	17

ESTIMATED NUMBER OF WOODLAND CARIBOU SEEN		
Bulls	Cows	Calves
2	1	Ø

ESTIMATED NUMBER OF MOOSE SEEN		
Bulls	Cows	Calves
Ø	Ø	Ø

ESTIMATED NUMBER OF MOUNTAIN GOAT SEEN			
Billys	Nannys	Kids	Unknown Age
Ø	Ø	Ø	Ø

Other Species						
	Wolf	Wolverine	Black Bear		Grizzly Bear	
			Adult	Cub	Adult	Cub
Number(s) Seen	3	Ø	Ø	Ø	1	Ø

How would you rate you overall hunting experience in the Mackenzie Mountains?
Excellent X Very Good ____ Good ____ Fair ____ Poor ____

How many times have you hunted in the Mackenzie Mountains, **including** this year's hunt? 2

Do you plan to return to hunt in the Mackenzie Mountains again? Yes X No ____

COMMENTS: Excellent Area / outfitter.

Thank You! Please give this form to the Officer or Clerk when you are exporting your trophies, or to the guide/outfitter with whom you hunted. We would appreciate receiving this form whether of not you harvested an animal(s).