Population Status of Central Mountain Caribou Herds in British Columbia and Response to Recovery Management Actions, 2018

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1.0 Background

The South Peace region of British Columbia contains several caribou herds (Figure 1) that have been declining rapidly over the past few decades, and one herd (Burnt Pine) has recently been extirpated (Seip and Jones 2016). First Nations traditional knowledge and reports by early explorers indicate that historically, caribou were abundant in the South Peace (West Moberly First Nations 2009).

Caribou that occur south of the Peace River (i.e., not including the Graham herd) have been classified as Central Mountain caribou by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2011). As recently as 20 years ago there were at least 672 Central Mountain Caribou in British Columbia. By 2015 the estimated number of Central Mountain caribou in British Columbia had declined to 248 - 263 (Seip and Jones 2016).

The decline in numbers of caribou in the South Peace region resulted in them being nationally listed as Threatened in 2003. In April 2014, COSEWIC re-evaluated the status of Central Mountain caribou and recommended they be classified as Endangered due to ongoing population declines.

http://www.cosewic.gc.ca/eng/sct1/searchdetail_e.cfm?id=1266&StartRow=1&boxStatus=All&boxTaxonomic=All&location=All&change=All&board=All&commonName=caribou&scienceName=&returnFlag=0&Page=1

The immediate (proximate) cause of the decline in Central Mountain caribou is excessive predation, primarily by wolves (Seip and Jones 2016). It is generally believed, however, that the underlying cause of increased predation is industrial landscape change which has created conditions that allow wolves to be more effective at killing caribou. Over the long term, protection and restoration of habitat will be necessary to re-establish self-sustaining populations of Central Mountain caribou.

Unfortunately, recovery of disturbed caribou habitat is a lengthy process that takes decades. During that time, the habitat remains unsuitable for the survival of caribou and caribou herds will continue to decline. If populations of Central Mountain caribou are to be maintained in the interim, immediate and more direct measures are required to reduce the excessive level of predation. If caribou habitat is not protected and restored to pre-disturbance conditions, predator management will have to be used as a permanent solution to maintain caribou herds in this area.

Since 2014, the West Moberly and Saulteau First Nations have been conducting a maternal penning project in the Klinse-Za (formerly Moberly/Scott) herd to capture and hold pregnant

adult female caribou in a pen throughout the calving period in order to protect the newborn calves from predators (McNay et al. 2016, 2018). Results from the first year indicated that calves could be successfully produced and protected within the pen, but when calves were released back to the wild they experienced very high mortality from wolf predation. It appears that maternal penning is only successful if it is accompanied by wolf control.

In an effort to halt the decline of Central Mountain caribou, the Government of British Columbia approved a wolf control program which began in 2015. The objective of the program is to reduce the number of wolves on, and immediately adjacent to, the ranges of five threatened caribou herds in the Central Mountain caribou population (Figure 2). The response of caribou populations to reduced wolf numbers is being monitored by evaluating the survival rate of radio-collared adult caribou, conducting calf recruitment counts, and conducting periodic population counts. In addition to wolf control, the West Moberly First Nations and Saulteau First Nations have continued the maternal penning project for the Klinse-Za caribou herd. The Kennedy Siding caribou herd is also being provided with supplemental feed during the period that caribou are using low-elevation winter range (Heard and Zimmerman 2016, 2017 and 2018).

The purpose of this report is to update the status of Central Mountain caribou herds in British Columbia during 2018, and to evaluate the response of the herds to the different recovery management actions.

2.0 Wolf Reduction (Winter 2016 – Spring 2017)

A total of 103 wolves were killed within, or immediately adjacent to, the wolf control treatment areas (Figure 3); 62 by shooting from the air, 31 by trapping, and 10 by shooting on the ground. Thirteen wolves from different packs were radio-collared to assist in finding the packs for subsequent removal. Wolves killed outside of the treatment areas were tracked to those locations from within the treatment areas. There were 57 wolves removed from the Klinse-Za treatment area, 11 from Kennedy Siding area, and 35 within, or on the boundary of, the Quintette area. At the end of the control program in spring 2017, it was estimated that there were at least 20 - 30 wolves remaining in the treatment areas based on radio-collared packs that were still present.

These numbers indicate that prior to the start of the 2017 removal program, there were at least 123 - 133 wolves present within the wolf control treatment areas. This is less than the 201 wolves present in 2016, but still indicates a substantial recovery of the wolf population within one year of removing almost all of the wolves in the treatment areas (Seip and Jones 2016). This

finding indicates that a very intensive effort will be required every year to continue to keep wolf numbers at low levels, at least until habitat conditions improve.

3.0 Caribou Population Status

3.1 Quintette Caribou

Population Census: An aerial census of the high-elevation winter range for Quintette caribou was conducted on March 28 and 29, 2018. A route following alpine and subalpine habitat was flown by helicopter within the entire high-elevation winter range (Figure 4), with the exception of the Mt. Crum area. The Mt. Crum range is very rugged and rarely has caribou present during late winter. This area has not been included in previous censuses, except in 2013, when radio-collar data indicated presence of collared caribou. The flight route was recorded using a handheld GPS.

Survey conditions were very good with fresh snow and clear skies. Four observers (including the helicopter pilot) searched for caribou along the route without knowledge of where the radio-collared caribou were located. When caribou were sighted we used a radio-telemetry receiver to determine if any radio-collared caribou were in the observed group. Locations of caribou were recorded using a handheld GPS (Figure 4).

During the census there were 16 caribou with functioning radio-collars known to be in the high-elevation winter range, and two radio-collared caribou known to be outside of the high-elevation winter range. At the completion of the census we had not observed four of the 16 radio-collared caribou known to be in the high-elevation winter range. We used radio-telemetry to locate and count the number of caribou in those groups, as well as the number of caribou in the two groups containing radio collared caribou outside of the high-elevation winter range. The total number of adult caribou and calves, the number of collared caribou in each group, and the method of detection are presented in Table 1.

Minimum Count: The total number of caribou counted during the population census was used to provide an account of the minimum number of caribou in the Quintette population. There were 49 caribou observed in the high-elevation winter range without the use of telemetry, and nine caribou counted using telemetry (Table 1). Therefore, the minimum number of Quintette caribou in the high-elevation winter range was 58. The nine caribou counted outside of the high-elevation winter range results in a minimum count for the entire Quintette caribou herd of 67 animals (Table 1).

Population Estimate: A sightability correction factor based on the number of collared caribou observed without the use of radio-telemetry was applied to estimate the total number of Quintette caribou within the high-elevation winter range, and within the entire Quintette caribou range.

The population estimate for Quintette caribou was calculated as follows:

- **i)** 12 of the 16 radio-collared caribou (75%) known to be in the high-elevation winter range were found without the use of telemetry (Table 1). Therefore, the sightability correction factor was 1.33 (100/75) for the high-elevation winter range.
- **ii)** Correcting for sightability results in a population estimate of 65 caribou in the high-elevation winter range.
- **iii)** Including the two radio-collared caribou that were outside of the high-elevation winter range, we observed 12 of the 18 radio-collared caribou (66.6%) during the population census. Therefore, the sightability correction factor was 1.5 (100/66.6) for the entire Quintette caribou range.
- **iv)** Correcting for sightability results in a population estimate of 74 caribou in the entire Quintette caribou range.

Caribou Distribution: Of the 58 caribou observed in the high-elevation winter range, three were in the Quintette/Roman/Babcock area, 52 were in the Bullmoose/Spieker/Collier area, and three were in the mountains between the Wolverine and Murray Rivers (Figure 4, Table 1). This distribution reflects a major change in the number and proportion of caribou in the Quintette/Roman/Babcock area from 2002 - 2018. In three censuses conducted between 2002 and 2013 that area contained between 34 - 50 caribou, representing 22 - 32% of the population.

The Quintette/Roman/Babcock population has plummeted in recent years in association with increased mining activity in the high-elevation range. Subsequent to mining expansion in 2011, caribou appeared to abandon the alpine winter range and began wintering in low-elevation forests where they experience increased exposure to wolf predation. Given that only three caribou were observed in this area in 2018, this portion of the herd is close to extirpation. That leaves the Bullmoose/Spieker/Collier area as the only area in the Quintette range that contains enough animals to support recovery.

Table 1. Population census and calf recruitment survey details for Quintette caribou, March 2018.

Reference Number (Figure 4)	Total Number of Caribou	Number of Adults	Number of Calves	Number of Collared Caribou	Method of Detection[1]
1	5	4	1	1	Visual
2	8	6	2	3	Visual
3	10	8	2	3	Visual
4	1	1	0	1	Visual
5	2	1	1	0	Visual
6	11	9	2	2	Visual
7	7	7	0	3	Telemetry
8	8	4	4	1	Visual
9	3	3	0	0	Visual
10	2	1	1	1	Telemetry
11	1	1	0	1	Visual
12	4	4	0	1	Telemetry[2]
13	5	5	0	1	Telemetry[2]
Totals	**67**	**54**	**13**	**18**	

[1] Method of detection was defined as 'visual' if caribou were observed without using telemetry.
[2] Caribou located outside of survey area.

***Adult Mortality*:** A total of 15 radio-collared adult female caribou were monitored in the Quintette herd between March 2017 and March 2018. During that period, none of the caribou died which equates to an annual mortality rate of 0%. The sample size of radio-collared females represents almost half of the adult females in the population.

Calf Recruitment: During the aerial census, a total of 13 calves and 54 adults were counted. This corresponds to 19.4% calves in the population or 24 calves/100 adults. Assuming that 60% of the adult caribou were female (as per the results from the Kennedy Siding herd photo census, see following Section 3.2), this would correspond to 13 calves/32 adult females, or 40.6 calves/100 adult females. If half of the calves are female, there would be 20.3 female calves/100 adult females.

The census included two groups of caribou that were located outside of the high-elevation winter range, and outside the wolf control treatment areas. Those two groups contained a total of nine adults and no calves. In the high-elevation winter range (within the wolf control treatment areas) there were 45 adults and 13 calves, or 22.4% calves. This corresponds to 28.9 calves/100 adults, or 48.1 calves/100 adult females.

***Population trend*:** These population census results suggest that the Quintette caribou herd is showing a positive population response to the wolf control program (Figure 5). Prior to the start of the wolf control program in 2015, the population estimate for the Quintette herd had declined from 166 within the high-elevation winter range in 2008, to 98 in 2013. The minimum count declined from 173 to 100 during the same period. That decline represents a decline of almost exactly 10% per year during that period. The decline continued and by the next complete census in 2016, the population estimate in the high-elevation winter range was down to 41, and the minimum count was 33. The population trend in response to wolf control during this period is difficult to interpret because it includes two years without wolf control and one year with wolf control. Nonetheless, it does provide a population starting point to compare subsequent responses of caribou numbers to wolf control.

Between 2016 and 2018:

1. The population estimate in the high-elevation winter range increased from 41 to 65.
2. Minimum count in the high-elevation winter range increased from 33 to 58.
3. Population estimate for the entire Quintette caribou range increased from 62 to 74.
4. Minimum count for the entire Quintette caribou range increased from 39 to 67.

The increase in the population estimate for the high-elevation winter range between 2016 and 2018 represents a growth rate of 26% per year. The annual growth rate for the entire population was only 9% per year, but that includes caribou living outside of the Quintette wolf control treatment area. If the herd continues to grow at 26% annually, the population in the high-elevation winter range will exceed 200 caribou in another five years.

The increasing population is to be expected given the low adult mortality rate, and relatively high calf recruitment during the wolf control treatment. Prior to effective wolf control, annual adult mortality for Quintette caribou averaged 15.6% (2003 to 2016). Since 2016, there has been only one mortality during 27 caribou years of monitoring for an annual adult mortality rate of 3.7%. The one mortality was a wolf kill of a caribou that had left the Quintette wolf control treatment area in the summer.

Prior to effective wolf control (2003 to 2016), there was an average of 14.4% calves in the population or 16.6 calves/100 adults. Over the past two years, calf recruitment has averaged

19.0% of the Quintette population, or 23.4 calves/100 adults. Calf recruitment was even higher (28.9 calves/100 adults) in the high-elevation winter range.

The data do not show a relationship between the number of wolves removed and the subsequent calf recruitment (as in the Kennedy Siding herd, see following Section 3.2), possibly because wolf removal on the Quintette range has been relatively high in all three years.

The calf recruitment estimate of 28.9 calves/100 adults in combination with a 3.7% annual adult mortality rate is consistent with the observed annual population growth rate of 26% in the Quintette high-elevation winter range.

3.2 Kennedy Siding Caribou

***Adult Mortality*:** A total of nine radio-collared adult female caribou in the Kennedy Siding herd were monitored between March 2017 and March 2018. One radio-collared caribou died, resulting in an annual adult mortality rate of 11.1%. The cause of death was predation by a cougar.

***Calf Recruitment*:** Heard and Zimmerman (2018) used motion-sensitive cameras placed at feeders between September to January to identify all the individual caribou in the Kennedy Siding herd based on antler and other body characteristics. They reported a total of 65 caribou, including 32 adult cows, 24 adult bulls, and nine calves. Six of the calves were females, and three were males. This represents 13.8% calves in the population, 16.1 calves/100 adults, and 28.1 calves/100 adult females. There were 18.8 female calves/100 adult females.

***Population Trend*:** The total count of caribou in the photo census increased from 63 in 2017 to 65 in 2018, resulting in a 3.1% population growth rate. In January, two caribou (one bull, one cow) were shot by a poacher, which reduced the population to 63 caribou, and the population growth rate to 0%.

The population growth this year was very low compared to the growth between 2016 and 2017, when the herd grew by 26.0%. The lower population growth rate was associated with much lower calf recruitment in 2018, compared to 2017. The lower calf recruitment rate this year may be due to a lower level of wolf removal. Calf recruitment over the past three years with wolf control appears to be associated with the number of wolves removed from the Kennedy Siding range of the Kennedy Siding/Burnt Pine treatment area (Table 2).

Table 2. Number of wolves removed from the Kennedy Siding range of the Kennedy Siding/Burnt Pine wolf control treatment area, 2014 to 2017.

Wolf Removal Period	Number of Wolves Removed (Kennedy Siding Range)	Photo Census Survey	Calves/100 Adult Females
Winter 2014 - Spring 2015	2	October 2015 - January 2016	19.2
Winter 2015 - Spring 2016	24	September 2016 - January 2017	67.7
Winter 2016 - Spring 2017	6	August 2017 - January 2018	28.1

In addition, lower calf recruitment in 2017-18 could in part be the result of a high proportion of non-breeding yearlings in the Kennedy Siding population. There were seven female calves in the 2016-17 population. If all seven calves survived to become yearlings in the 2017-18 population, only 25 of the 32 females classified as adults would be old enough to produce calves. The number of calves/100 adult females based on this number only increases from 28.1 to 36.0, still well below the 2016-17 rate. This result further supports the likelihood that the number of wolves removed from the Kennedy Siding range has the largest impact on calf recruitment.

Although the herd is also receiving supplemental feed, the feeding program in the absence of effective wolf control in 2014-15 did not result in a positive population response (Heard and Zimmerman 2016). Feeding is improving the nutritional status of the caribou, and may be providing some benefit to the herd (Heard and Zimmerman 2018), but effective wolf control appears to be the primary management action having a positive influence on calf survival and population growth.

3.3 Klinse-Za (formerly Moberly/Scott) Caribou

The Klinse-Za herd is the subject of an ongoing maternal penning project led by West Moberly First Nations and the Saulteau First Nations in association with Wildlife Infometrics. The following results are summarized from McNay et al. (2018).

Maternal Penning: In March 2017, nine adult female caribou were captured and put into a maternity pen. Seven of the nine cows produced calves, and all of those calves survived in the

pen until they were released back into the wild with the nine adult cows in July. In March 2018, all seven of the calves born in the maternity pen were still alive. Therefore, the nine cows in the maternity pen recruited 78 calves/100 adult females into the population.

***Calf Recruitment*:** A total of 66 caribou, including 13 calves, were counted during a survey conducted in March 2018. The calf recruitment rate was 19.7% in the total population, or 24.5 calves/100 adults. There were 26 adult cows counted during the survey, so there were 50.0 calves/100 adult females.

Recruited calves included the seven calves that had been born in the maternity pen. The remaining six calves were counted with 17 adult cows that had not been in the pen, corresponding to 35.2 calves/100 adult females for calves born in the wild. The survival rate of calves born in the pen was higher than the survival rate of calves born in the wild.

***Adult Mortality*:** A total of 22 radio-collared adult females were monitored through the year and three died for an annual adult mortality rate of 13.6%. Causes of death included a wolverine kill, a wolf or bear predation, and an unknown cause.

***Population Trend*:** The population estimate of 66 caribou increased from the population estimate of 61 caribou in 2017, an increase of 8.2% in the population. The calf recruitment rate of 24.5 calves/100 adults and the adult mortality rate of 13.6% would be expected to result in a population growth rate of about 11%, similar to the observed rate of 8%. The combination of maternal penning and wolf control has improved both adult and calf survival resulting in an increasing population.

3.4 Bearhole-Redwillow Caribou

The Bearhole-Redwillow herd is a small remnant herd of caribou that winter in low-elevation boreal forest. Ongoing monitoring of this herd was limited to maintaining a few radio-collared caribou in the herd to provide information on adult mortality, calf recruitment and minimum population size.

The final two radio-collars in this herd stopped transmitting locations in fall 2017, so we have not been able to monitor population parameters for this herd. Given their very low density, it is virtually impossible to aerially locate any remaining caribou within their wide range of dense forest cover. The Bearhole-Redwillow caribou range is outside the wolf control treatment areas so they are likely continuing to experience the very high adult mortality rate (22.2%), and low calf recruitment rate (9.5 calves/100 adults), averaged annually between 2007 and 2014.

Sample size of radio-collared female Bearhole-Redwillow caribou after 2014 was inadequate to examine population parameters.

There were only nine caribou counted in this herd in 2017, down from 18 in 2016 and 49 in 2008. It is likely that this herd is very close to being extirpated, but there is no practical way to monitor the few remaining animals.

3.5 South Narraway Caribou

Data for the South Narraway herd were provided by the Alberta Ministry of Environment and Parks. A total of 26 caribou, including four calves were counted during the calf recruitment survey in March 2018. Calves represented 15.3% of the population, or 18.2 calves/100 adults. The minimum population count in 2017 was 23 caribou so the population may have slightly increased, or the difference may be due to not observing some caribou during the 2017 calf recruitment survey.

3.6 Graham Caribou

The Graham herd lives in the Rocky Mountains north of the Peace River (Figure 1) and is not part of the Central Mountain caribou population. It is being monitored as the “no wolf control” comparison for the South Peace wolf control program. Between March 2017 and March 2018, eight of 20 collared adult females died for and annual adult mortality rate of 40.0%.

In March 2018, the entire range was searched as part of a capture and collaring program. A total of 37 caribou were counted, including 22 cows, nine bulls and six calves. This results in a calf recruitment rate of 19.4 calves/100 adults or 27.2 calves/100 adult females. The calf recruitment count was reasonably high, but still insufficient to offset the very high adult mortality rate. Consequently, it is very likely that the Graham caribou herd is continuing to decline.

4.0 Population Status Summary for Central Mountain Caribou, 2018

Based on the preceding information the population estimate for Central Mountain caribou in British Columbia in March 2018 was:

Kennedy Siding	63
Klinse-Za	66
Quintette	74
South Narraway	26
Burnt-Pine	extirpated
Bearhole-Redwillow	unknown, very few.
TOTAL	**229**

The current population numbers indicate that the three herds within the wolf control treatment areas have stopped declining and started to increase in response to the population management actions (Figure 5). The South Narraway population did not appear to decline over the past year (based on a minimum count of the population), but has been declining over the past decade. The initiation of a wolf control program in the South Narraway range this year may reverse that decline. The Bearhole-Redwillow herd, along with the Burnt-Pine herd, may now be functionally extirpated.

5.0 Wolf Reduction (Winter 2017 – Spring 2018)

A total of 115 wolves were killed by aerial gunning within, or immediately adjacent to, the wolf control treatment areas (Figure 6). Eleven wolves were radio-collared at the beginning of the program to assist in finding the packs for subsequent removal. There were also four radio-collared wolves remaining from the previous year. All of the wolves killed outside the treatment areas had been previously located within the treatment areas.

There were 44 aerial removals associated with the Quintette treatment area, 59 associated with the Klinse-Za area, and 13 associated with the Kennedy Siding area (Figure 6). In addition, several wolves were removed from the Klinse-Za range by ground trapping.

At the end of the spring 2018, there was little evidence of any wolves remaining within the wolf control treatment areas. The removal crew estimated that there were only about 10 wolves

remaining within all of the treatment areas at the end of March, and that the program had removed 92% of the starting population. Based on results from previous years, this level of removal should result in significant population growth in all three herds over the upcoming year.

The high number of wolves present within the treatment areas at the beginning of winter 2017, despite significant removals over the previous three years, confirms that wolf population recovery is very rapid as soon as wolf removal stops.

The number of wolves removed in each year is as follows:

Winter 2014 - Spring 2015	57 wolves killed
Winter 2015 - Spring 2016	201 wolves killed
Winter 2016 - Spring 2017	103 wolves killed
Winter 2017 – Spring 2018	115 wolves killed

The 201 wolves killed in 2015/16 likely represents the original wolf population, and each subsequent year the population recovers to about 50 - 60% of that level.

6.0 Summary of Management Actions

1. The Quintette herd appeared to benefit from reduced wolf numbers resulting in little, or no adult mortality, and high calf recruitment. The population has increased since the last census in 2016. The population in the high-elevation winter range has increased by 26% annually over the past two years, from 41 to 65 caribou. However most of the remaining caribou are now living north of the Wolverine River and the sub-population that lived on the Quintette/Roman/Babcock block is down to three remaining caribou.

2. The Kennedy Siding herd experienced some growth over the past year, but the growth rate was much lower than the previous year. The lower growth rate may be associated with a lower number of wolves being removed from the range compared to the previous year. Two adult caribou were killed by a poacher which eliminated all of the population growth for this year. The herd continues to receive supplemental feeding to improve their nutritional status, but any benefit of the feeding is masked by the more significant impact of the wolf control program.

3. The combination of maternal penning and wolf control in the Klinse-Za population improved the survival of adults and calves leading to an increasing population. Survival of calves born in the maternity pen was 100%, and over half of the calves recruited into the herd came from the pen.

4. It appears that all of the herds within the wolf control treatment areas experienced a population increase over the past few years in response to wolf control and maternal penning (Klinse-Za herd). Prior to these management actions, all of these herds had been declining.

5. Between 2016 and 2018, the three herds within the wolf control treatment areas increased from 166 to 203, a total of 37 caribou. Prior to wolf control the herds had been declining by about 10% per year, so in the absence of wolf control and maternal penning, it is likely the herds would have lost an additional 32 caribou, and declined to 134. If so, wolf control in combination with the Klinse-Za maternal penning resulted in an additional 69 caribou added to the population over the past two years.

6. The Graham herd which is the "no wolf control" comparison continues to have high adult mortality, low calf recruitment and the population decline is likely continuing.

7. The Bearhole-Redwillow range no longer contains any collared caribou so it is not possible to monitor their population trend. It is likely that the very small population has continued to decline in the absence of wolf control and may be nearing extirpation.

8. The South Narraway minimum population count was similar to the previous year, but this herd has experienced an ongoing population decline over the past decade. Wolf control was expanded to include the low-elevation winter range of this herd in 2018, but any impact will not be apparent until next year.

9. Although wolf control and maternal penning appear to be effectively reversing the decline in Central Mountain caribou herds, there are some significant concerns to be recognized.

i) Wolf numbers recover quickly, so each year at least 100 wolves need to be killed. This process is likely to continue in perpetuity until the habitat conditions that sustain high numbers of wolves and their primary prey are addressed.

ii) A large number of wolves need to be killed to produce a modest increase in caribou numbers. Over the past two years, 304 wolves were killed to add 69 caribou to the population.

iii) Population management techniques are very expensive. The current wolf control program costs about $400,000 per year, corresponding to about $21,000 for each additional caribou added to the population. Maternal penning is even more expensive at more than $100,000 for each additional caribou.

iv) Although the current program appears to be resulting in population recovery, and is effectively preventing extirpation of Central Mountain caribou herds within the wolf control treatment areas, it is not leading to self-sustaining caribou populations.

v) Unless the habitat conditions for these caribou are improved, ongoing wolf control of >100 wolves per year, at a cost of $400,000 per year, will be required to maintain Central Mountain caribou populations.

7.0 Acknowledgements

Funding for this ongoing monitoring was provided by the Province of British Columbia and the Peace Northern Caribou Plan Offsetting Fund. The photo census data for Kennedy Siding caribou were provided by Doug Heard. The data for Klinse-Za caribou were provided by Wildlife Infometrics. Data for South Narraway caribou were provided by the Alberta Ministry of Environment and Parks. Information on wolf removals was provided by the British Columbia Ministry of Forests, Lands, Natural Resource Operations and Rural Development.

Trevor Hann, Inge-Jean Hansen, Hillary Morgan and Justin Strong assisted with the Quintette caribou population census.

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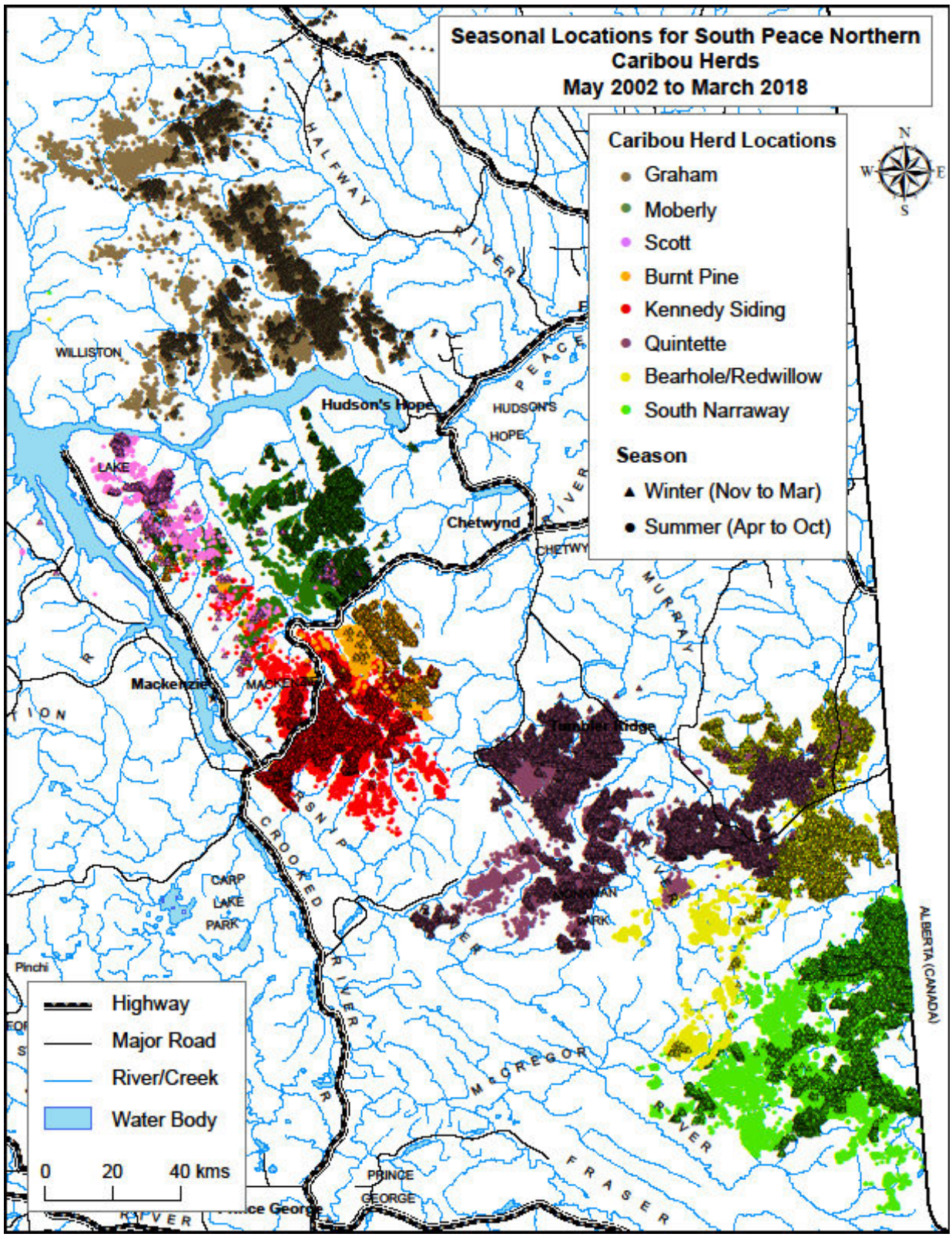

Figure 1. Radio-telemetry locations of caribou herds in the South Peace region of British Columbia, 2002 to 2018.

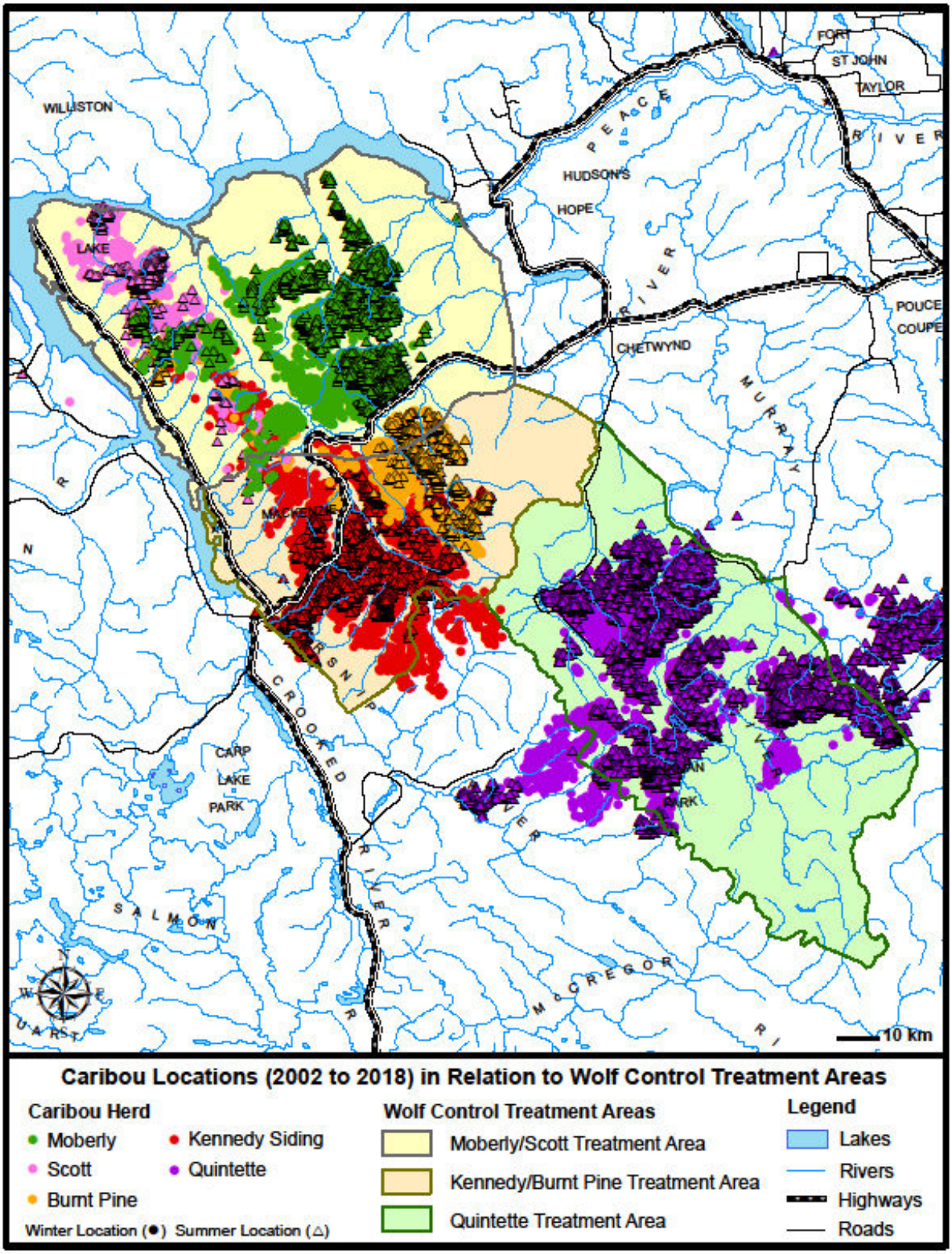

Figure 2. Radio-telemetry locations of Central Mountain caribou (2002 to 2018) and wolf control treatment areas in the South Peace region of British Columbia.

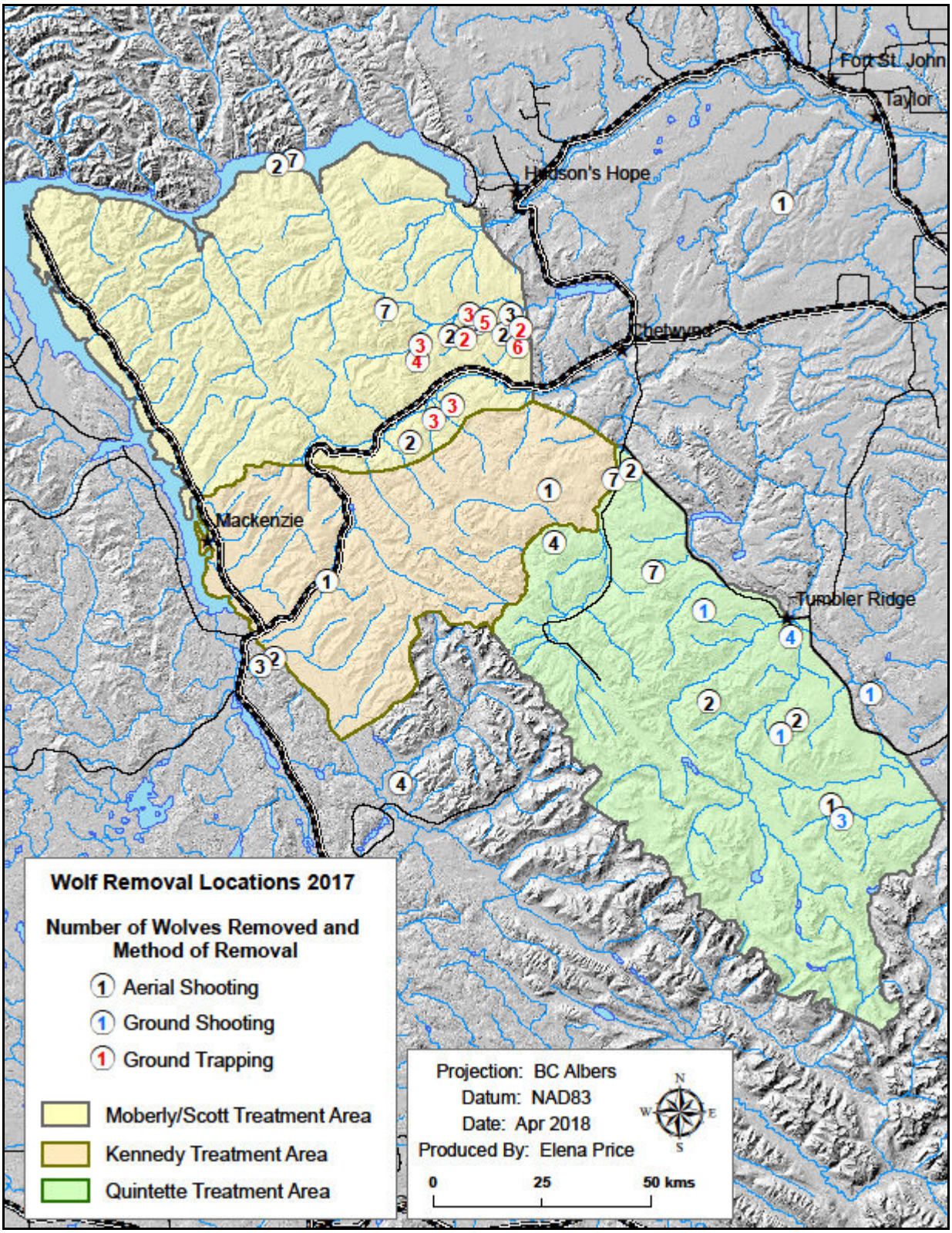

Figure 3. Wolf removal locations and treatment areas in the South Peace region of British Columbia, Winter 2016 – Spring 2017.

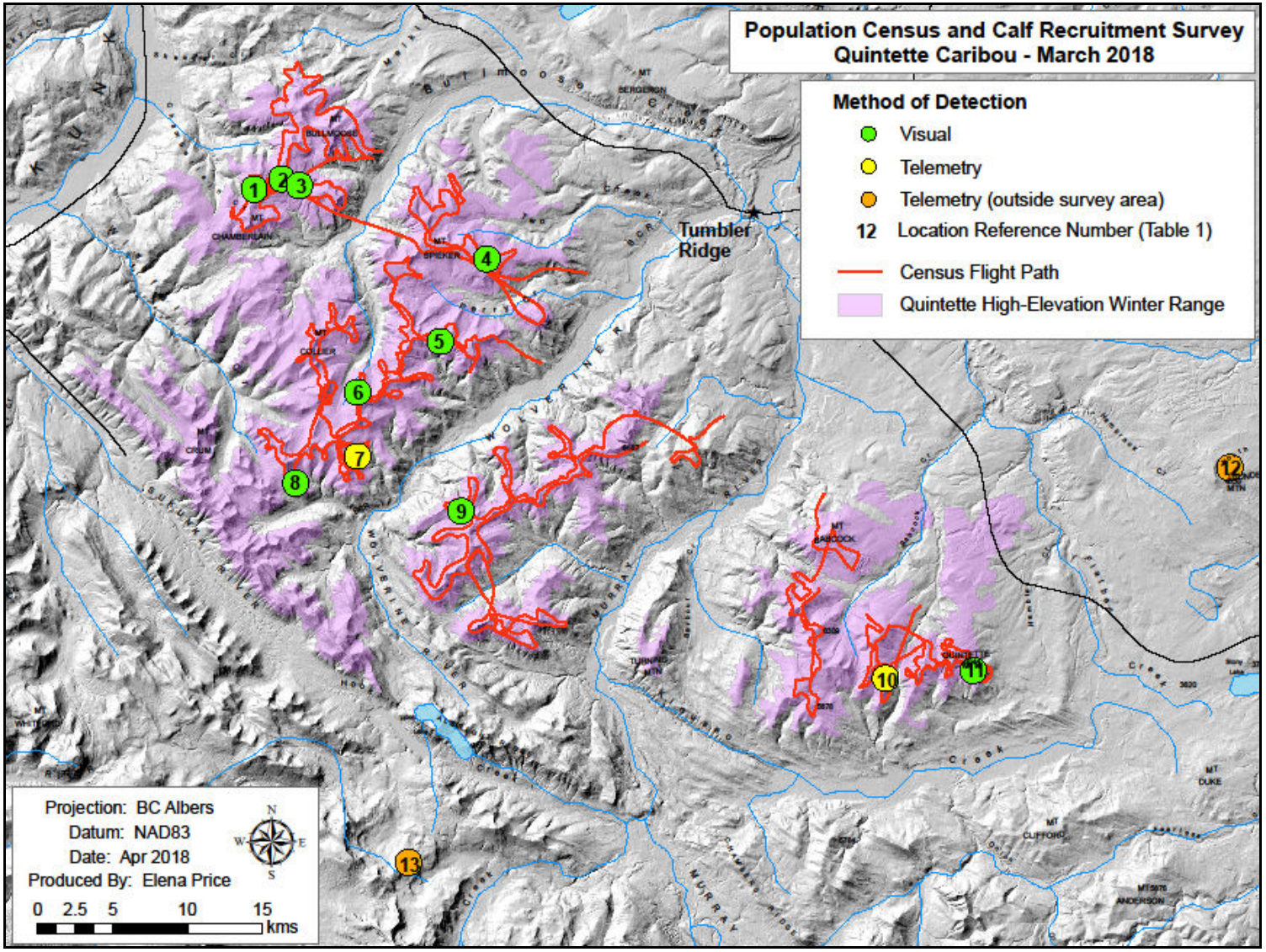

Figure 4. Aerial census route, reference number (see Table 1), and location of caribou groups observed during the Quintette caribou population census, March 28 – 29, 2018.

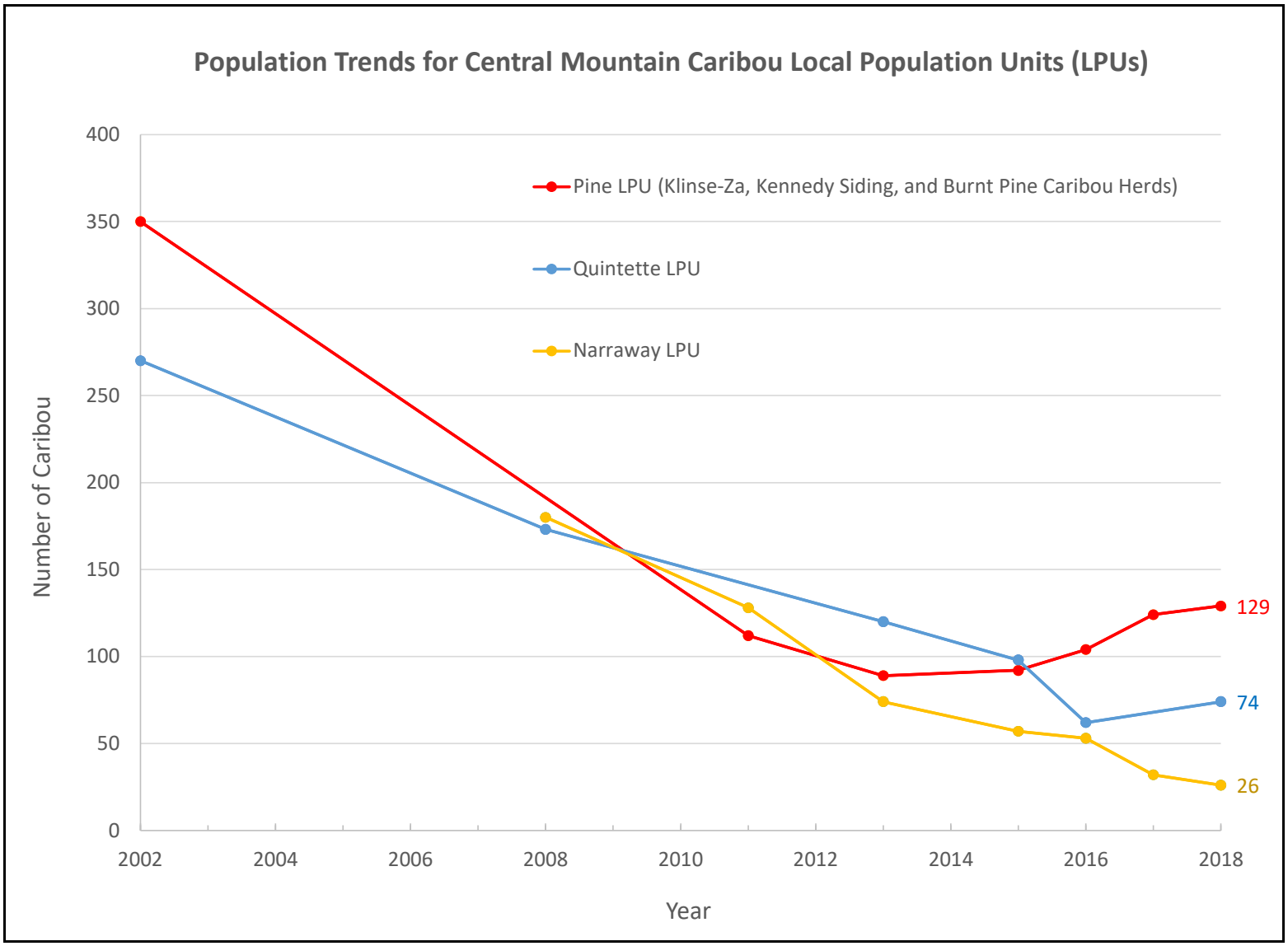

Figure 5. Population estimates and trends for Central Mountain caribou, 2002 to 2018. The Burnt Pine caribou herd was considered extirpated in 2013.

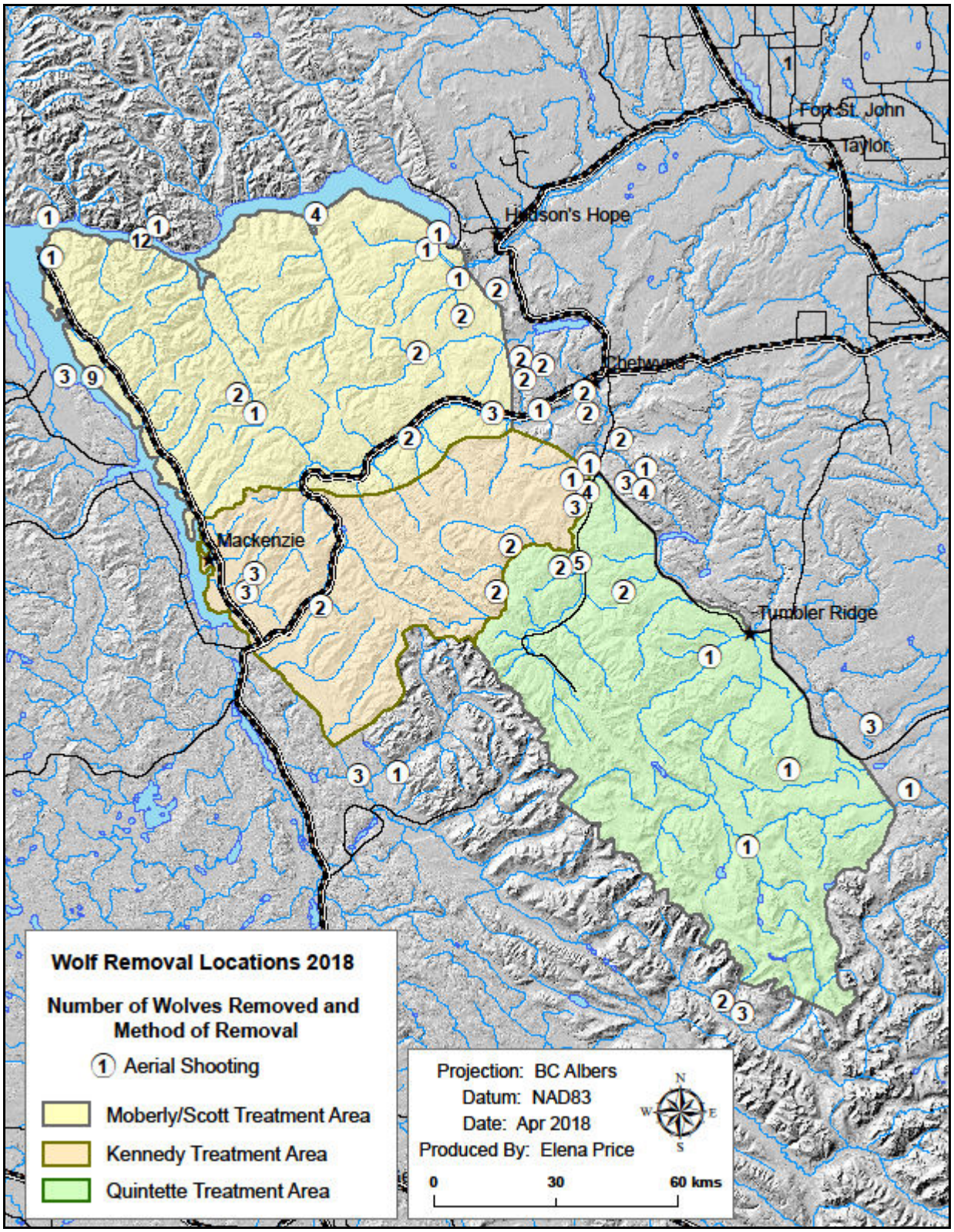

Figure 6. Wolf removal locations and treatment areas in the South Peace region of British Columbia, Winter 2017 – Spring 2018.