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Results of the 2022 Mark-Resight Survey of the Aishihik Bison (*Bison bison*) Population

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Government of Yukon
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Authors

Thomas S. Jung, Ryan Drummond, Shawn D. Taylor, Kazuhisa Kuba, Russel Oborne, Catherine Pinard, and TJ Grantham

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Copies available from:

Government of Yukon
Fish and Wildlife Branch, V-5
Box 2703, Whitehorse, Yukon Y1A 2C6
Phone 867-667-5721
Email: environmentyukon@yukon.ca
Online: Yukon.ca and open.yukon.ca

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Executive Summary

- We report the results of the 2022 survey of the Aishihik bison population. This survey builds upon those conducted in a similar fashion in previous years. Results are intended to provide information on the current size of the population.
- During 29 June to 4 July 2022, we conducted a mark-resight survey to estimate the size and trend of the population. We used the locations from GPS-collared bison to determine our survey area. We then marked 122 bison with paintballs and subsequently conducted three independent resighting surveys within 1-4 days of marking bison.
- The 2022 estimated population size is 1,951 (95% confidence intervals [CI] = 1,688–2,295). This is substantially greater than the 2016 estimated population size of 1,325 (95% CI = 1,157−1,552) and amounts to a 47% increase in population size in the past six years.
- A key result from our survey is that the population has grown since the last survey in 2016.
- While our estimated population size is plausible, there is evidence that it may be an overestimate. For example, if we forecast from the estimated population size in 2016, using an average lambda of 1.0425, the estimated population size in 2022 would be 1,701 animals.
- Given that a key conclusion from this work is that the modeled population size is possibly an overestimate, a precautionary approach would be to consider that the true population size may be less than 1,951.
- Total cost was about $48,000, exclusive of staff time.
- Two next steps are recommended: First, it would be prudent to conduct another mark-resight survey in 2023 or 2024 to provide resolution on the accuracy of our 2022 survey. Second, we recommend using all available information on the population ecology of the herd to develop an integrated population model that can (1) better predict population size and trends and (2) be used to forecast into the future.

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Introduction

From 1998 to 2006, bison (*Bison bison*) in southwestern Yukon were surveyed annually, using the so-called “total count” method, where all bison found during an aerial survey were tallied. This method had been used elsewhere to survey bison (Fuller 1950, Wolfe and Kimball 1989) and was practical in the Yukon when the herd was small and occupied a small range. In later years, this methodology became difficult because the herd had grown and begun to use habitats where they were increasingly challenging to locate and count, such as in the forest. Presently, for bison in the Yukon, total counts fail to provide reliable information that is statistically robust and defensible; rather, they are better considered as a “minimum number known alive” (Jung et al. 2020, 2022).

Because the Aishihik Bison Herd was relatively small, legally listed as a species at risk, and harvested at unsustainable rates (by design), it was crucial to closely track the size of the population (Government of Yukon 2012). Unfortunately, unlike moose (*Alces americanus*) or caribou (*Rangifer tarandus*), little information exists from other jurisdictions on how to count bison. Biologists in the NWT use strip transects (Bradley and Wilmshurt 2005, Larter et al. 2007) or quadrats (Larter et al. 2000) to count bison from aerial surveys, but those methods are not suitable for use in the mountainous environment bison inhabit in the Yukon.

In July 2007, we used a sample of radio-collared bison to test the use of mark-resight methods to survey the herd. Mark-resight techniques simply rely on the ability to resight a marked sample of the population and allow for the estimation of population size based on the number of marked and unmarked animals seen. Statistical models are used to estimate the population size and associated confidence intervals. This technique has been successfully used to inventory a number of ungulate species, including caribou (Mahoney et al. 1998, Jung et al. 2000, Hegel et al. 2012), elk (*Cervus canadensis*; Skalski et al. 2005), sheep (*Ovis canadensis*; Neal et al. 1993), mountain goats (*Oreamnos americanus*; Pauley and Crenshaw 2006), and elephants (*Loxodonta africana*; Morley and van Aarde 2007). A particular strength of the method is that it is intuitive, and the results may be more accessible to non-scientists.

We found that a mark-resight framework for counting bison could provide a robust and reliable estimate of the population's size that was both defensible and acceptable to our bison management partners. The method was cost-efficient and provided estimates with acceptable confidence intervals (Hegel et al. 2012). Application of the method inspired enough confidence with the Yukon Bison Technical Team that they recommended that the population be surveyed periodically using mark-resight methods, rather than annually by total counts.

Here, we report the results of the 2022 survey of the Aishihik bison population. This survey builds upon those conducted in a similar fashion in 2007, 2009, 2011, 2014, and 2016 (Hegel et al. 2012; Jung and Egli 2012, 2014). Results from the survey are intended to inform bison managers and the public on the current size of the population.

Methods

From 29 June to 4 July 2022, we conducted a mark-resight survey to estimate the population size and trend of the Aishihik Bison Herd. To ensure that our survey area aligned with the distribution of the population, we used the locations from 25 GPS-collared bison, recorded on 28 June 2022. (**Fig. 1**).

We marked a segment of the population using a paint-ball gun, fired from a helicopter. Paint-balling is a useful way to temporarily mark animals because a large percentage of the population can be marked in a short amount of time, presumably with less stress then conventional marking techniques (e.g. radio-collars, ear-tags, etc.) because it does not require capturing animals (Skalski et al. 2005, Hegel et al. 2012). On 29 June 2022, we used an A-Star helicopter to locate and paint-ball bison using a Tippman A-5 paint-ball gun and blue-coloured paint-balls (**Fig. 2**). We chose blue because we had conducted previous trials with captive bison from the Yukon Wildlife Preserve to determine what colours were the most visible. Additionally, we determined in our trial that blue paint balls would remain visible for up to two weeks in the summer, if they were marked on the upper rear end area. When bison wallow, they do not roll over completely, so the paint-ball marks located behind the hump are somewhat protected from being covered with dirt. We aimed to mark each individual bison with 8 to 12 paint-balls to facilitate resighting. Our goal was to mark at least 10% of the bison in each group encountered.

Figure 1. Photograph of a “marked” bison after being paint-balled from a helicopter. Photo by TS Jung.

Three independent resighting surveys were completed on 30 June, and 2 and 4 July 2022. Resighting surveys were conducted by a crew of three observers and a pilot in a Eurocopter EC120 helicopter. Each resighting crew had different members to ensure surveys were done independently. Each crew had an experienced member who was familiar with where to look for bison during the survey period. Crews were instructed to search areas where bison were believed to be seasonally congregated, based on information (local knowledge, aerial surveys, GPS-collar data) previously collected in July, during other survey years. To meet the assumptions of our model, resighting crews did not use radio-telemetry to help find bison.

When bison were located, crews recorded the number of marked and unmarked animals in each group, as well as their geographic location using a GPS. To obtain data on the composition of the population, crews recorded the number of adults (>1 year old), dominant bulls (~8 years or older) and calves (<1 year old) seen in each group.

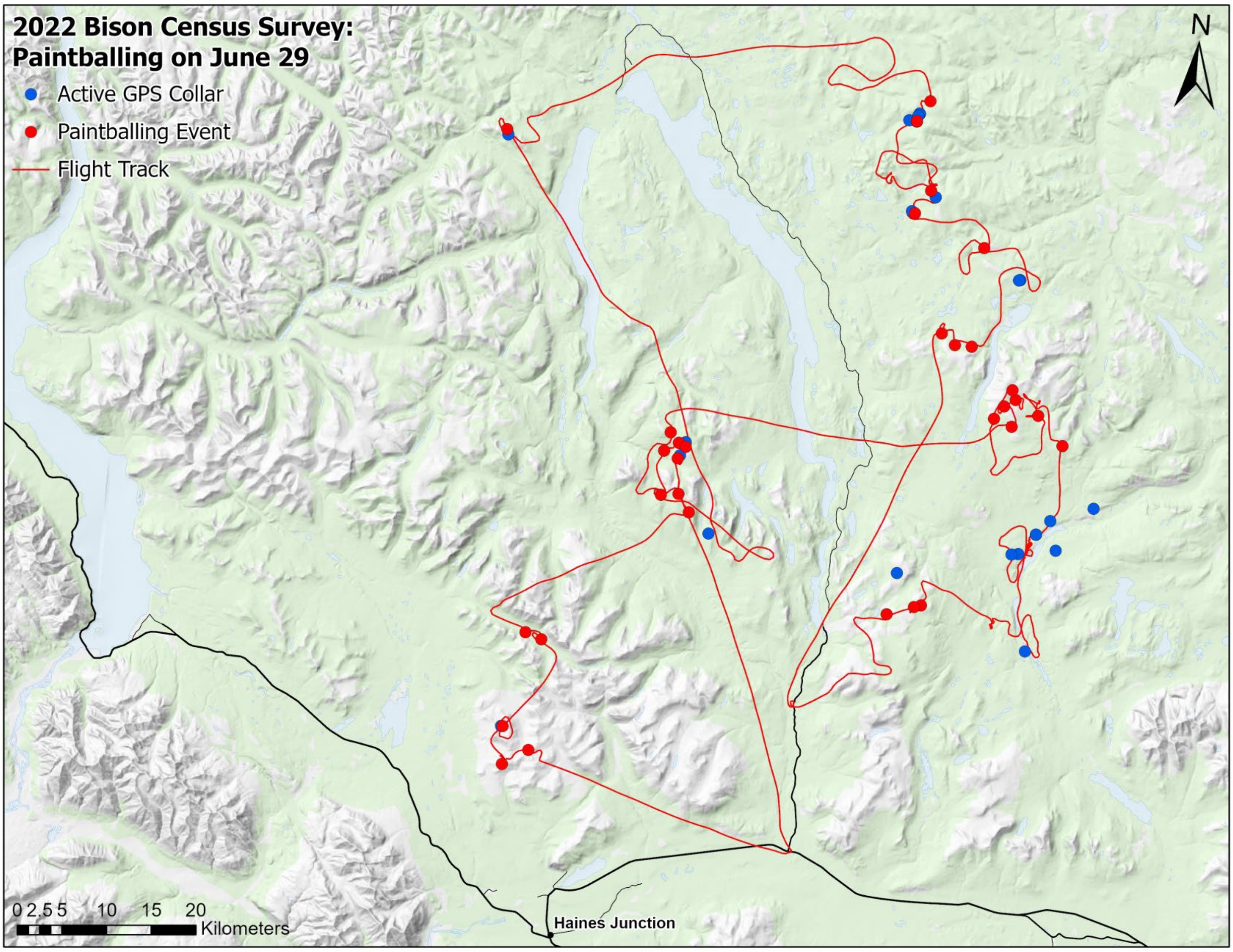

Figure 2. Locations of GPS-collared bison (blue dots) and marking (paint-balling) events (red dots) on 29 June 2022. The red line is the path flown during the marking flight.

A mark-resight population estimate was modeled using the Joint Hypergeometric Maximum Likelihood Estimator algorithm for closed populations. Similar to previous surveys (Jung and Egli 2011, 2014), we used NOREMARK software (White 1996) to model the data and compute population estimates with 95% confidence intervals (CI). Each resighting survey was modeled separately, and then a global model was constructed using all resighting surveys to provide the final estimate and associated confidence intervals. For comparative purposes, Noremark was used to derive survey-specific population estimates and 95% CI were calculated using the Lincoln-Peterson Estimator algorithm.

Results and Discussion

On 29 June 2022, we spent 6.8 hours of helicopter time marking 122 bison from 34 observed groups (**Fig. 1 and 2**). This took more time than in previous surveys (Jung and Egli 2012, 2014), because bison were more broadly distributed across their range than in past survey years. Specifically, we found a considerable number of bison in the northern part of their range, which is unusual for late June. Moreover, GPS-collared bison were found in the Hutshi Lake area at low elevations, which precluded marking them because the area is too forested to safely and reliably do so. Regardless, similar to previous years, the 25 GPS-collared animals greatly facilitated our locating bison to mark and to delineate the area for the subsequent resighting surveys (Jung et al. 2020, 2022), highlighting the value of collared animals for inventories based on mark-resight methods.

We conducted three resighting surveys on 30 June and 2 and 4 July, which occurred 1 to 4 days after marking bison (**Table 1; Fig. 3-5**). Weather conditions were good for the resighting surveys, with the exception of the latter part of the second resighting survey; thunderstorms precluded the crew from accessing some locations to the west of our intended survey area (**Fig. 4**). Cumulatively, the resighting surveys used 23.1 hrs of helicopter time and covered 3,191 km of survey routes (**Table 1; Fig. 3-5**).

Table 1. Summary of results from three resighting surveys for bison in southwestern Yukon, summer 2022. Note that 122 marked bison were available to be observed in each survey.

Survey Date	Survey Effort	Number of Bison Groups Seen	Total Number of Bison Seen	Number of Marked Adult Bison Seen	Number of Unmarked Adult Bison Seen	Lincoln-Peterson (Adult) Population Estimate (95% CI)	Number of Calves Seen	Number of Calves per 100 Adults
30 June	7.5 hrs 991 km	42	917	47	735	2,005 (1,580-2,431)	135	17
2 July	7.6 hrs 1,176 km	35	371	24	296	1,578 (1,058-2,099)	51	16
4 July	8.0 hrs 1,025 km	33	598	32	499	1,981 (1,430-2,534)	67	13

The total number of animals observed on each independent survey varied from 371 to 917, with the number of marked animals also varying accordingly (**Table 1**). Between 13% and 17% of the bison seen were calves. The number of groups observed during each survey ranged from 33 to 42 and did not correspond strongly to the total number of bison seen. The largest group seen was 92 animals, although most groups were small, as seen in previous years (Jung 2020).

Estimated population sizes from each individual survey varied from 1,578 to 2,005, using the Lincoln-Peterson algorithm (**Table 1**). This reflects differences in proportion of marked and unmarked bison seen and is similar to previous surveys for this population (Hegel et al. 2012, Jung and Egli 2012, 2014). We conduct multiple resighting surveys in order to model the variation in several independent surveys and provide a more accurate population estimate with improved (smaller) confidence intervals.

When considering the data from all three independent surveys, the minimum number known alive (MNKA) was 857 adult bison. This is similar to the total number of bison observed in 2021, but less than that in 2020 (Jung et al. 2020, 2022).

Using the Joint Hypergeometric Maximum Likelihood Estimator model, the estimated size of the population for the herd in 2022 was 1,951 adult bison, with 95% confidence intervals (CI) spanning 1,688 to 2,295. This is the key result from our survey.

The 2022 estimated population size (1,951; 95% = 1,688–2,295) is substantially greater than 2016 estimated population size (1,325; 95% CI = 1,157–1,552), using the same survey methodology. This represents an additional 626 adult bison since 2016, which amounts to a 47% increase in population size in the past six years (**Fig. 6**). This growth is despite a substantial increase in the number of bison harvested by hunters in the same interval; for example, about 280 bison were harvested in each of the past two hunting seasons. Of note is that the CI were much wider for the 2022 survey results than that for previous years (**Table 2**), raising concerns about the precision of our estimate.

Assuming equal growth among years in the 6-year interval between this survey and that in 2016, annual population growth (lambda) was 1.08. This lambda value is quite high for a northern ungulate population and indicates robust annual population growth. The lambda calculated for this survey is also considerably higher than that seen in previous surveys, which averaged about 1.04 (**Table 2**).

Table 2. Summary of results from periodic mark-resight surveys of the Aishihik bison population. All surveys used similar methods and the results do not include calves.

Survey Year	Number of Years Since the Last Survey	Estimated Population Size	95% Confidence Intervals	Minimum Number Known Alive	Estimated Annual Population Growth (Lambda)
2007	--	899	891-1,128	726	--
2009	2	1,004	850-1,220	501	1.06
2011	2	1,053	749-1,266	585	1.02
2014	3	1,192	1,039-1,404	704	1.04
2016	2	1,325	1,157-1,552	734	1.05
2022	6	1,951	1,688-2,295	857	1.08

Robust population growth indicates that the number of births exceed the number of deaths. Calf composition of the population has typically been >20%, although it was lower (~15%) in the 2022 survey (**Table 1**). However, calf survival to recruitment (i.e., 1 year old) is unknown, and typically low for other species of northern ungulates. Adult female survival and longevity appear to be good based on data from GPS-collared animals and the age-at-harvest data (Jung 2021). Our survey, in combination with MNKA values achieved in the two previous years (Jung et al. 2020, 2022) provides evidence that the Aishihik bison population continues to grow and is so far resilient to a high percent of the population being harvested each year.

The estimate of 1,951 adult bison is higher than we anticipated prior to the survey. While the estimated population size we obtained in 2022 is plausible for a growing bison population, there is concern that it may be overestimated by our model. The increase in the annual population growth (lambda) we observed in the interval between this and the 2016 survey (**Table 2**) suggests that our estimate may be higher than the true population size. For example, if we forecast from the estimated population size in 2016, using an average lambda of 1.0425 (**Table 2**), the estimated population size in 2022 would be 1,701 animals.

Factors that may have resulted in an overestimate include the low proportion of marked bison seen, which may have been because either marked animals had changed their behaviour after being marked, or marks were missed by the crew, or both. There is some evidence that marked animals changed their behaviour after being marked because many of the GPS-collared animals moved considerably after we marked those groups, often into the forest where they are difficult to spot during an aerial survey. Conversely, we had no evidence that animals lost their marks during the interval between each resighting session, although some had certainly faded with time.

A key conclusion from this work is that the modelled population size is possibly an overestimate. As such, a precautionary approach would be to consider that the true population size may lay somewhere between the lower 95% confidence interval of 1,688 and the modelled estimate of 1,951.

Total cost of the survey was approximately $48,000, exclusive of staff time. For comparison, recent 1-day “minimum number known alive” surveys cost about $18,000 (Jung et al. 2020, 2022). However, they provide information that is of more limited value for managing the population.

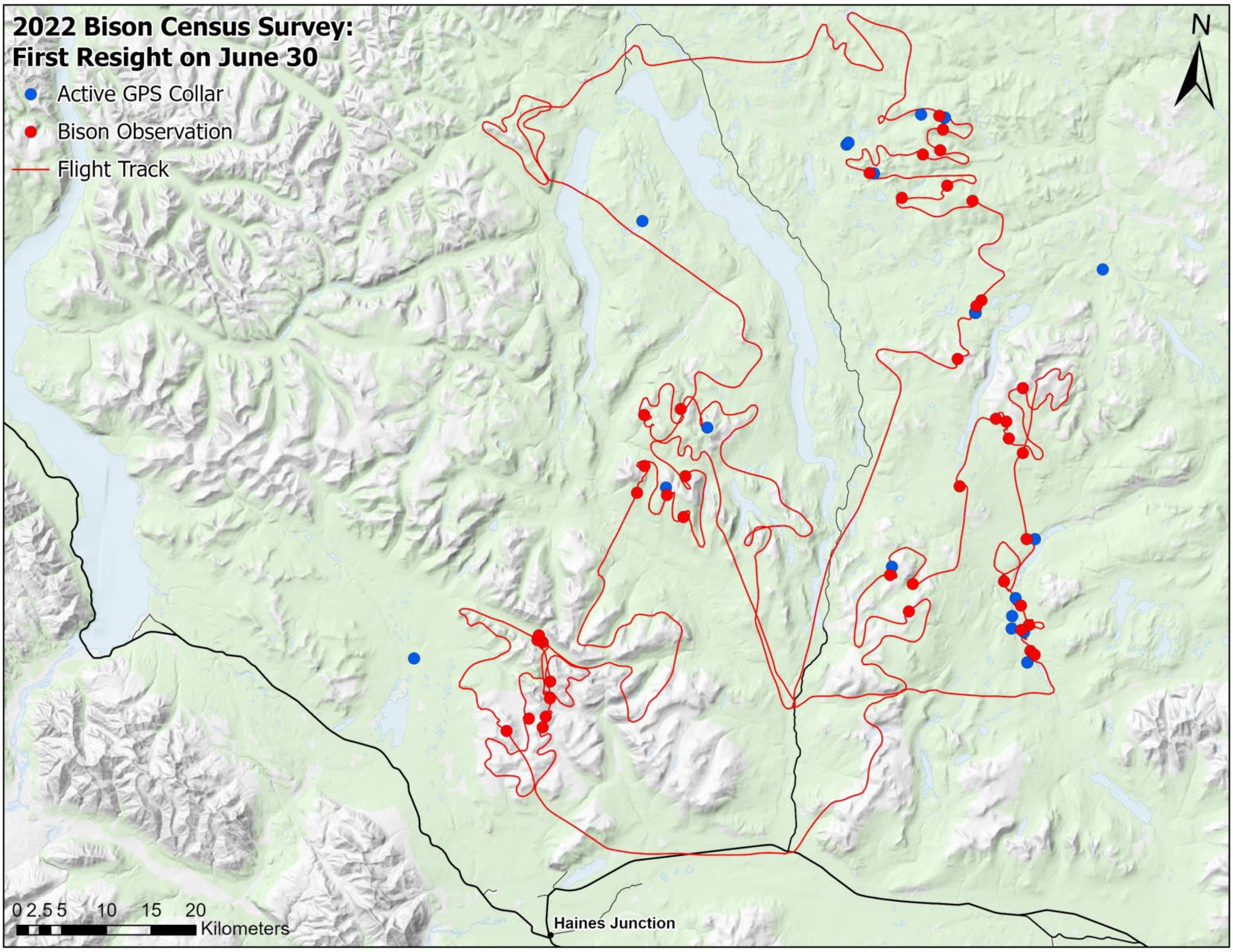

Figure 3. Locations of GPS-collared bison (blue dots) and bison observed (red dots) during the first resighting survey on 30 June 2022. The red line is the path flown during the resighting flight.

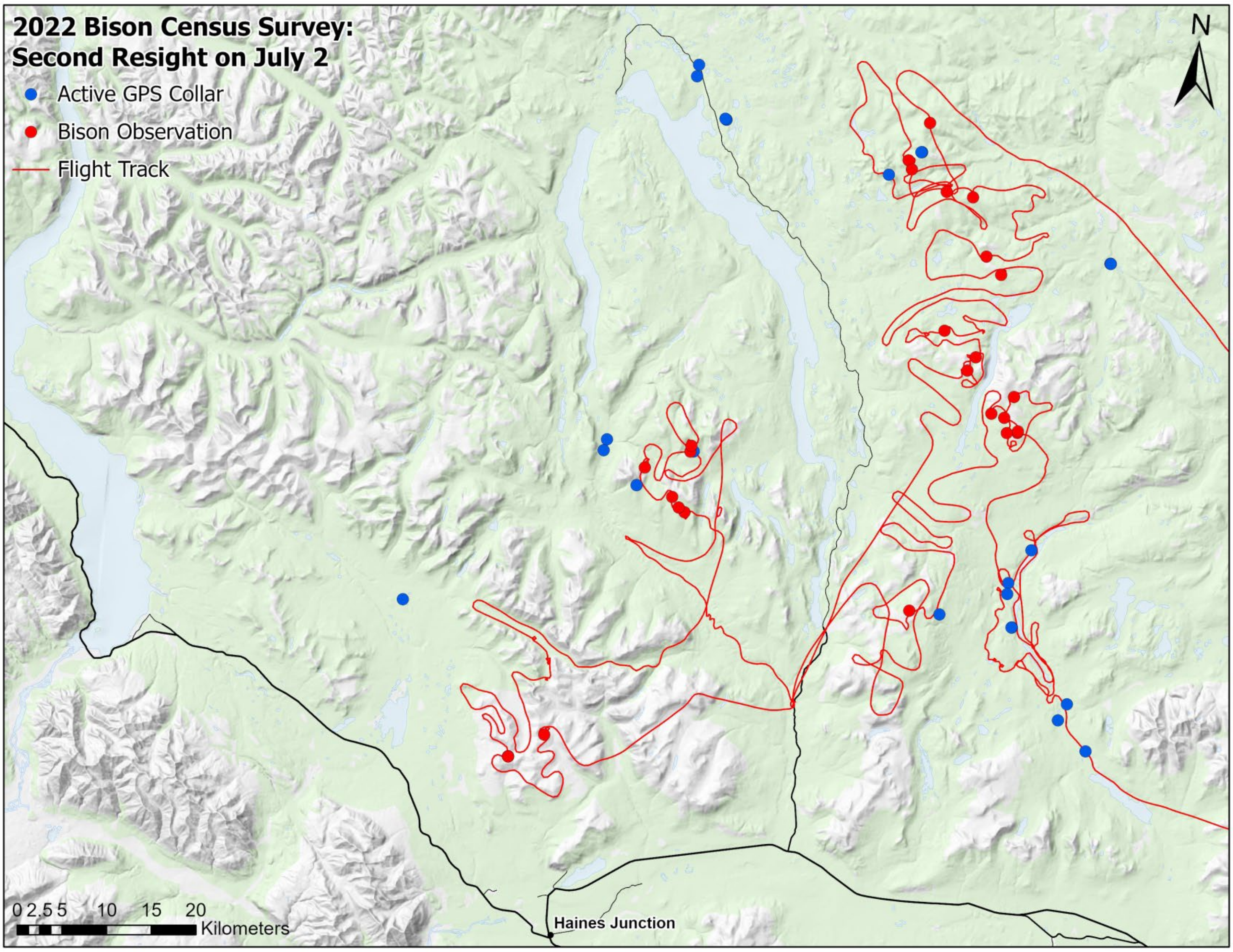

Figure 4. Locations of GPS-collared bison (blue dots) and bison observed (red dots) during the second resighting survey on 2 July 2022. The red line is the path flown during the resighting flight.

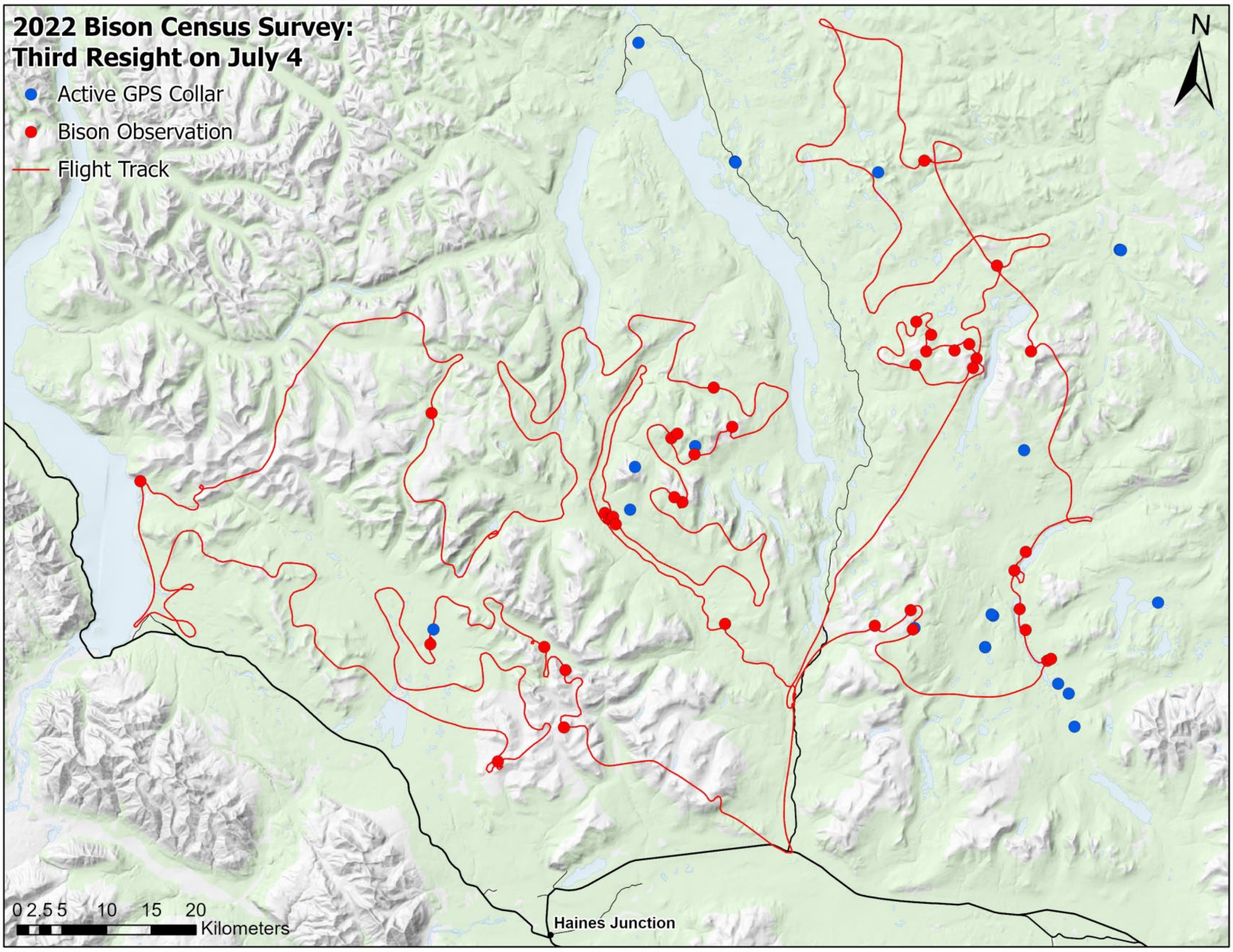

Figure 5. Locations of GPS-collared bison (blue dots) and bison observed (red dots) during the third resighting survey on 4 July 2022. The red line is the path flown during the resighting flight.

Recommended Next Steps

While the Aishihik bison population continues to grow and is larger than it was at the last estimate in 2016, there is some uncertainty as to how large that growth has been and the current population size. Two next steps are recommended to provide further resolution to these core questions: First, it would be prudent to conduct another mark-resight survey in 2023 or 2024 to assess the accuracy of our 2022 survey. Second, we recommend using all available information on the population ecology of the herd (e.g., adult survival, calf composition, harvest numbers, and age-at-harvest) to develop an integrated population model (e.g., Arnold et al. 2018, Riecke et al. 2019, Severud et al. 2022). An integrated population model would better estimate long-term trends in population size and demography, including forecasts into the future under different hypothetical scenarios.

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