Wood Buffalo National Park
Bison Survey

March 2014

Lana Cortese

John McKinnon

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Abstract

The 2014 Wood Buffalo National Park bison population survey was conducted between March 3rd and March 22nd, 2014 and produced a population estimate of 3363 with a 90% confidence interval of ±893. The Slave River Lowlands (SRL) stratum in the Little Buffalo subpopulation was surveyed by the GNWT in 2014. The combined GNWT-Park estimate is 3731, however this number should be used with caution as there is no accompanying estimate of precision, due to differences in the data collection and analysis methodologies used in the two surveys. The Delta sub-population had an estimated 1416 bison with a 90% confidence interval of ±667, the Garden River sub-population was estimated to be 760 with a 90% confidence interval of ±282, the Hay Camp sub-population estimate was 499 with a 90% confidence interval of ±220, the Little Buffalo area sub-population estimate was 362 with a 90% confidence interval of ±419, and the Nyarling area sub-population estimate was 326 bison with a 90% confidence interval of ±301. The number of bison seen during the 2014 survey of the Park (the "minimum" total count) was 2244. Including GNWT's minimum count of 329 for the SRL stratum, the combined minimum count was 2573, 1369 fewer than were seen in the 2009 count (3942), also less than seen in the 2007 (4065), 2005 (4727), 2003 (3743) and 2002 (3870) counts.

The 2014 population estimate is significantly different from 2009 ($t_{0.05,\ 116}$=2.26) when the population was estimated to be 4958, as seen by the non-overlapping confidence intervals in Figure 10. In 2014 the GNWT conducted the survey outside the Park boundary in the Slave River Lowlands using slightly different boundary for the SRL stratum, as well as a different data collection and analysis approach. Differences in the study area, data collection and analysis methodologies between the 2014 survey results and those of previous years may confound comparisons. However, the fact that the 2014 minimum count and population estimate (including SRL), as well as the minimum count and population estimate for the Little Buffalo subpopulation, all show a proportionate decline between 25-35% from 2009 numbers lends support to the declining trend observed in 2014.

Acknowledgements

Cite as:

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Introduction

The numbers of Wood Bison (*Bison bison athabascae*) have fluctuated dramatically since European arrival, primarily due to human intervention. It has been estimated that there were 168,000 wood bison in Canada prior to 1800 (Soper, 1941), with an estimated 6000 in the area that eventually became Wood Buffalo National Park (WBNP) (Carbyn et al. 1993). Heavy hunting pressure and severe winters are thought to be responsible for reducing the population to an estimated 300 wood bison remaining in the area that would become WBNP by 1891 (Carbyn et al.1993). The population is thought to have numbered around 1500 animals when WBNP was established in 1922, providing a refuge for the only remaining herd of wood bison. Diseased Plains Bison (*Bison bison bison*) were introduced from Wainwright Alberta in 1925-1928 bringing brucellosis and tuberculosis to the WBNP wood bison population (Carbyn et al. 1993, Mitchell 1976). The disease anthrax was first documented in WBNP in 1964. In spite of the diseases, WBNP's bison population remained at around 10,000 animals from 1935 to the mid 1960's (Fuller 1952, Novakowski 1961, Oldham 1948). Intensive management through predator control and supplemental feeding of the bison during the winter took place during this time. The Bennett Dam on the Peace River began generating electricity in 1968 and flows on the Peace River in the following years were erratic. An early spring flood in 1974 caused the ice to collapse and resulted in the drowning deaths of many bison when they broke through the ice. The years of intensive management of the herd concluded in the early 1970's, coinciding with a long-term decline of the population. The ecological and agricultural significance of the diseases has led to enduring controversy regarding management of the WBNP wood bison population. The long history of management issues has also led to the collection of a long-term dataset on bison population size.
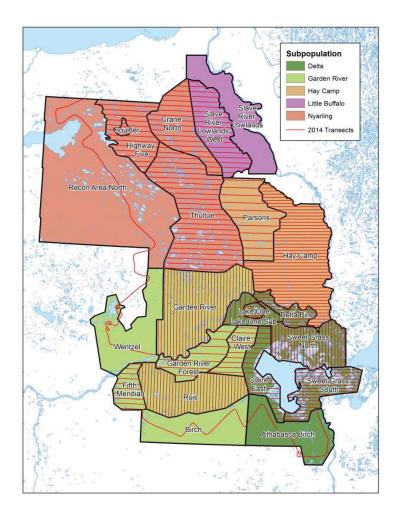
Aerial bison surveys in Wood Buffalo National Park began when Oldham (1948) conducted an aerial strip transect survey in 1948. Fuller (1952) and Novakowski (1961) did aerial strip transect surveys, in the 1940's, 1950's and 1960's. Annual 'total count' surveys started in 1972, but with varying degrees of effort. Permanent transects were established for the total counts in 1991.

In 2002 it was recognized that the 'total counts' were actually more correctly characterised as minimum counts. This was because some bison were certainly missed by the survey crews and not all areas were searched in each year. It was also recognized that standardizing the entire survey would lead to more reliable results. Since 2002, strip transect surveys have allowed for both minimum counts and a population estimate with accompanying estimates of precision. From 2003 to 2009, surveys to estimate population size occurred at two year intervals. After the 2009 survey it was decided to increase the interval between surveys to five years.

Methods

Study Area & Stratification
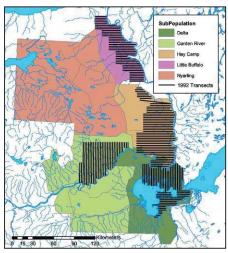
The 2014 bison survey study area is based on the subpopulation boundaries outlined in Joly and Messier (2001), and is thought to include the entire ranges of the Delta, Garden River, Hay Camp and Nyarling subpopulations, as well as about half the range of the Little Buffalo subpopulation (Figure 1). In 2014, the study area and boundaries in the Little Buffalo subpopulation differed slightly from previous surveys, with the GNWT taking over responsibility for conducting the survey in the Slave River Lowlands (SRL) stratum. The boundaries for the two strata in the Little Buffalo subpopulation were redrawn to reflect this new management arrangement. The west boundary of the SLR stratum and the east boundary SLR West stratum were redrawn so that they follow the Park boundary along the Little Buffalo River. This change resulted in a reallocation of part of the SRL stratum to the SRL West stratum. Additionally, the GNWT used distance sampling approach to survey the SLR stratum, a different method than the strip transect survey methodology that continues to be used within the Park.

Figure 1. Subpopulation areas, strata and transects
for the 2014 bison survey. Strata names are labeled.

Annual bison surveys have been ongoing in WBNP since 1972, but prior to 1991, survey area, effort and flight lines changed often. Starting in 1991, GPS and GIS technology was

used to establish permanent transects in what was historically known as the 'primary range' (Figure 2). The 'secondary range' (i.e. the entire Nyarling subpopulation range, plus parts of the Garden River, Little Buffalo, Hay Camp, and Delta subpopulation ranges) was covered by reconnaissance flights commensurate with funding left over after the primary range survey. The reconnaissance flight lines were not recorded, except in 2001 (Figure 3).

Figure 2. Subpopulation areas and transects for bison surveys from 1991 to 1999, reconnaissance flight lines not recorded.

Figure 3. Transects and reconnaissance flight lines for the 2001 survey.
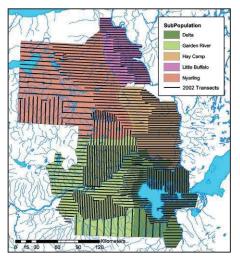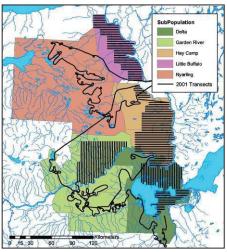
Figure 4. Transects for the 2002 survey.
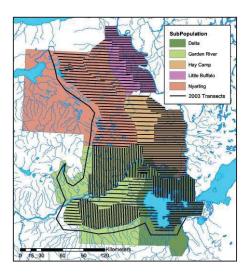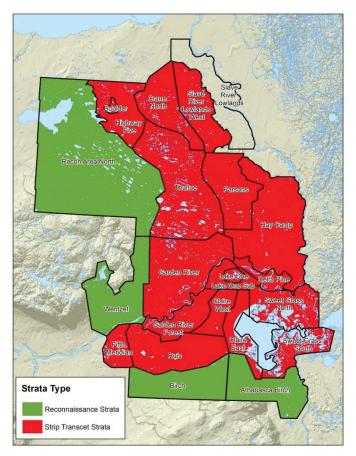
Figure 5. Transects and strata boundaries for the 2003, 2005, 2007, 2009 surveys.

There was no survey in 2000. In 2002, strata and transects were designed for the entire study area (Figure 4). For the 2003 survey, some of the 2002 strata were amalgamated and strata with few or no bison in 2002 were covered by reconnaissance flights rather than transects (Figure 5).

The 2014 survey was based on the strata and reconnaissance flight lines used in 2003, 2005, 2007 and 2009, except for the Little Buffalo subpopulation. The new strata boundaries and management arrangement for the Little Buffalo subpopulation are shown in Figure 1.

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Survey Strata

The 2014 bison survey is a strip-transect survey with transects of 1km in width. Two types of strata were used in the 2014 survey: strip transect (red) and reconnaissance (green) (Figure 6). For strip transect strata an estimate and an accompanying estimate of precision were calculated. The reconnaissance strata were initially classified in the 2002 survey, and were those that contained few or no bison. For reconnaissance strata, observations provided a total count with no estimate of precision. Reconnaissance strata are flown as a single fixed wing flight, rather than transects.

Total counts for reconnaissance strata were added to counts of bison seen on and off transect, for strip transect strata, to generate a minimum count for each subpopulation and the population as a whole. This number represents all bison seen during the survey, including those recorded outside the sample area that were determined not to have been counted during subsequent survey efforts. For example, when turning between the finish of one transect line and the start of another, bison seen on adjacent strata were recorded as "outside sample". If it was determined that these animals were not counted when the adjacent strata were surveyed, then these numbers were retained in the "Outside Sample" category for the purposes of the minimum count only (not included in calculation of the population estimate).

Figure 6: Survey strata types for the 2014 survey, strip transect strata are shown in red and reconnaissance strata are shown in green.

In previous years (2002-2009) the survey was conducted as a strip transect survey combined with areas of 100% coverage. The 100% coverage refers to areas of WBNP where there is high visibility due to sparse ground cover or no canopy. In these years the surveyed area of the park was classified into 4 types of strata: strip transect (red), 100% coverage (yellow), a combination of strip transect and 100% coverage (brown) and reconnaissance (green) (Figure 7). For these years observations recorded in the 100% coverage and reconnaissance strata provided a total count, so the number of bison seen became the estimate for the area, with no accompanying estimate of precision. For "combination", strata transects were flown across the entire strata, but part of the strata was considered 100% and part was considered strip transect. Using GPS and GIS technologies, the navigators recorded bison positions and designated bison groups as being on transect off transect or in a 100% coverage area. Both an estimate and an accompanying estimate of precision were calculated for the combination strata.

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Figure 7: Survey strata types for the 2009 survey.

Modifications to Survey Methodology in 2014

Prior to the 2014 survey, an analysis was conducted to examine the value of conducting the survey using 100% coverage and combination strata, as had been done in previous years. In order to evaluate the utility of the 100% areas, the 2007 survey results were re-analysed as if the survey had been done without use of 100% coverage areas. The estimate without 100% areas was lower by 80 animals (or 1.7%) than the estimate using 100% areas. Given the cost and effort required to revise the 100% areas (on a continuing basis), and the minimal impact on the estimate, a decision was made to modify the survey design to include strip transect and reconnaissance strata only (Appendix B).

Consultation

Local aboriginal community groups in Fort Chipewyan and Fort Smith were contacted about the survey and were requested to provide contract observers. Observers from the Mikisew Cree First Nation, Salt River First Nation, Smith's Landing First Nation and the Fort Smith Metis Council were contracted for the survey.

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Survey Flight Protocol

Survey altitude was 250m, and survey speed was about 190 kph in open habitat and as slow as possible (usually about 160 kph) over forested habitat. Survey aircraft was a Cessna 210. When herds of bison are seen the protocol is to gain altitude to avoid stampeding the bison.

Transect sight lines were set at 500m on each side of the aircraft, for a total transect width of 1km. Observer sight lines from the aircraft were pre-set at the airport by placing markers on the ground 500m from the centre line of the runway, then flying over the runway at survey altitude. Green Painters Tape (¼") was used on the windows to indicate where the observer's line of sight intersected the ground at 500 metres.

Three GPS units were used during the survey, two for navigation purposes and one for recording the location of the observations.

The two GPS units used for navigation were the aircraft's Garmin GPSMap196 (for the pilot) and a handheld Garmin GPSMap 60CSx (for the data recorder/navigator). Prior to the survey, Garmin GPS Routes were created using waypoint data of the transect endpoints. Routes are pre-defined paths created from a group of GPS waypoints in the sequence that you want to navigate them. The transect waypoint data and the route data where uploaded to both GPS units.

The survey crew consisted of the pilot, the data recorder/navigator and two observers. The data recorder/navigator sat in the co-pilot's seat, and the two observers sat in the back seats. The data recorder was responsible for ensuring that the pilot stayed at survey altitude and on transect. The data recorder used a Garmin GPSMap 60CSx to record the location of the observations and paper datasheets to record information about each observation. The observers were responsible for spotting and counting bison, for categorizing observations as either 'on' or 'off' transect, and photographing the herds.

Herds of bison that were larger than 25 animals were photographed with a digital camera. Group sizes were double checked using the photographs once back at the office.

During transect surveys, the geographic position of the bison is not actually known, as the plane is rarely, if ever, exactly over the bison when position is recorded. To estimate the degree of error when recording position, the data recorder estimated direction and distance from the plane to the bison when the GPS location was taken. Compass directions (N, E, S, W, NE, SE, SW, NW) and four classes of distances (Exact, 0 - 500m, 500m – 1km, and >1km) were used. After the survey, the GPS points were moved according to the directions and distances estimated by the data recorder, using GIS software (0m, 250m, 750m or 1500m).

Movement of animals between transects, strata, or a study area is always a problem with aerial surveys. To minimize this bias, transects were kept short (median transect length was 26 km), and the crews kept watch for fresh tracks and groups of similar size on adjacent transects. Data were examined post-flight using GIS software to detect groups of similar size on adjacent transects.

Population Estimate

The subpopulation estimate and measures of precision (90% confidence interval and coefficient of variation) were calculated using Jolly's method II (Jolly, 1969) for transects of unequal length. Degrees of freedom were calculated as per Gasaway et al. (1986).

Buffering of 2002- 2014 Datapoints

The historical dataset is plagued by inconsistent survey effort. Prior to 1991, effort changed almost every year. From 1991 to 1999 consistent transects were flown over part of the study area, but unrecorded reconnaissance flights covered the remainder. There was no survey in 2000, but in 2001 all flightlines were recorded. To determine how many bison would have been seen in 2002 - 2014 with a 1990's level of effort, the 2001 survey's flight lines were buffered - i.e. the flightlines were assigned widths and transformed into polygons. All bison observation falling within the buffered polygons counted as being 'seen'. In the primary range and the secondary range north of the Peace River, flight lines were given a 2 km buffer. In the secondary range south of the Peace River, flight lines were given a 4 km buffer because of higher survey altitudes. The 2002, 2003, 2005, 2007, 2009 and 2014 bison observation data were compared with the buffered 2001 flightlines. The buffers are wider than the transect widths, because we were also looking for bison that would be 'off transect'.

Weather Data

Temperature and wind were recorded from the aircraft's instruments at the beginning of each flight.

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Results

The survey was conducted between March 3rd and March 22nd, 2014.

Bison Observations

The distribution of bison observed during the 2014 survey is shown by subpopulation in Figure 8. Distributions by strata within each subpopulation are shown in Appendix A.
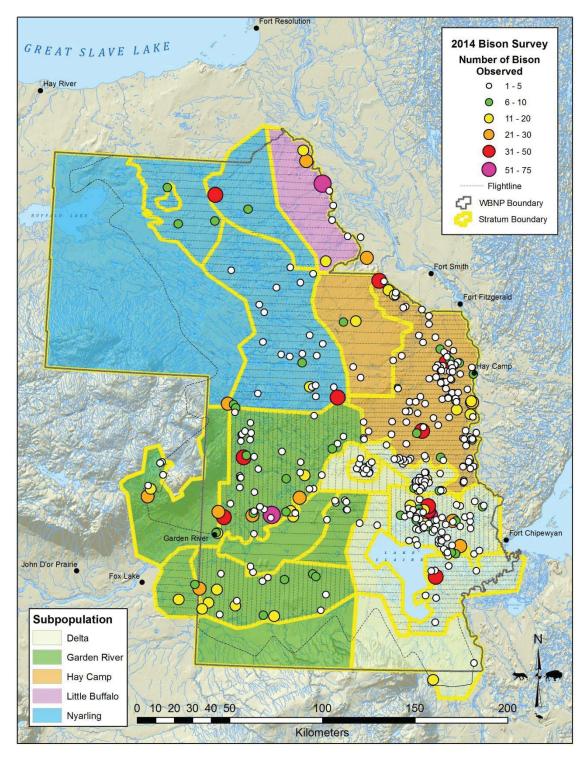
Figure 8. Bison observations for the 2014 bison survey.

2014 Minimum Count

The minimum count for 2014 was 2573 (Table 1), including the 329 observed in the GNWT survey of the SRL stratum (Armstrong, 2014). The minimum count for the Park only (excluding GNWT's survey) was 2244.

Additional data for each subpopulation is presented in Appendix A.

Table 1. Minimum count by subpopulation, 2014.

Sub Population	Total
Delta	756
Garden River	636
Hay Camp	512
Little Buffalo	128+329*
Nyarling	212
Grand Total	**2573**

*329 is the GNWT minimum count for the SRL stratum.

2014 Population Estimate

The 2014 population estimate for WBNP is 3363 with a 90% confidence interval (C.I.) of ±893 (Table 2). The GNWT estimate for the SRL stratum was 368 with a 95% confidence interval of 185-731 (Armstrong, 2014). The SRL stratum surveyed by GNWT in 2014 was part of the Park survey in 2009, so to compare 2009 and 2014 estimates, the GNWT estimate and the Park estimate would need to be combined. However, different data collection and analysis methods were used for the two surveys, therefore a combined estimate of precision was not calculated and the combined GNWT-Park population estimate (3731) should be used cautiously. Observations, estimates and sampling intensities for each subpopulation (and strata) are presented in Appendix A.

Table 2. Summary of total and subpopulation estimates for the Park, 2014.
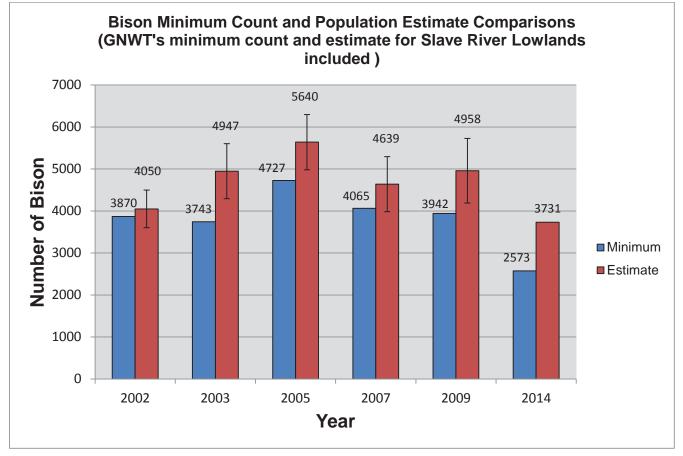
Subpopulation	Estimates	90% C.I.	90% C.I. as % of Estimate	CV
Delta	1416	667	47	28
Garden River	760	282	37	22
Hay Camp	499	220	44	26
Little Buffalo	362	419	116	67
Nyarling	326	301	92	17
Park Total	**3363**	**893**	**27**	**16**
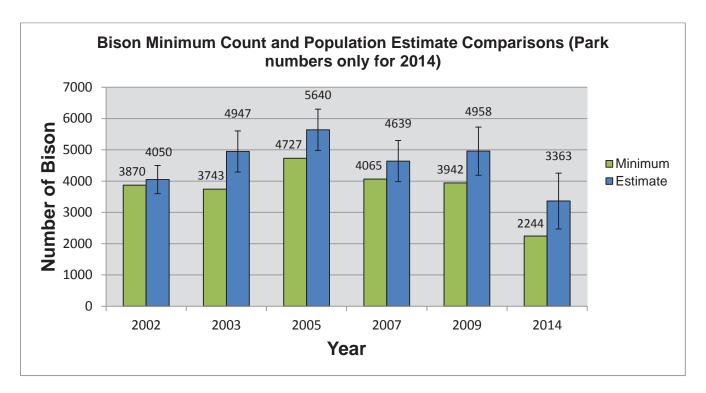
Comparing 2014 results with 2009, 2007, 2005, 2003 and 2002 surveys

Including the GNWT minimum count for SRL, there were 1369 fewer bison seen (minimum count) during the 2014 survey than there were in 2009 (Figure 9). Minimum counts for subpopulations changed by: Delta -208, Garden River -45, Hay Camp –495, Little Buffalo (including GNWT SRL min count) -206 and Nyarling -415.

The 2014 total population estimate of 3363 is significantly different ($t_{0.05(116)}$ =2.26) from 2009 when the population was estimated to be 4958. There is also a significant difference when the 2014 estimate is compared to 2007 ($t_{0.05(132)}$ =1.92) when the estimate was 4639, as well as 2005 ($t_{0.05(129)}$ =3.43), when the estimate was 5640 and 2003 ($t_{0.05(124)}$ =2.48), when the estimate was 4947. The 2014 estimate is not significantly different from the 2002 estimate ($t_{0.05(104)}$ =1.14), when the estimate was 4050 (Figure 10).
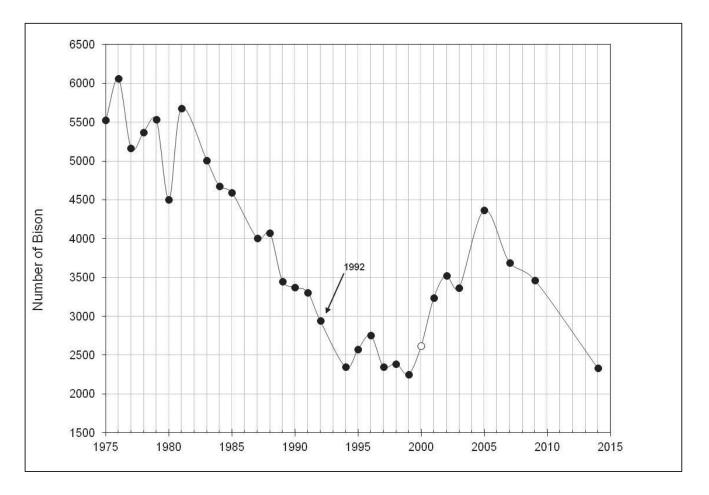
Figure 9. Comparison of the 2002, 2003, 2005, 2007, 2009 and 2014 bison population estimates and minimum counts for WBNP including 2014 survey results from the GNWT for the Slave River Lowlands stratum.
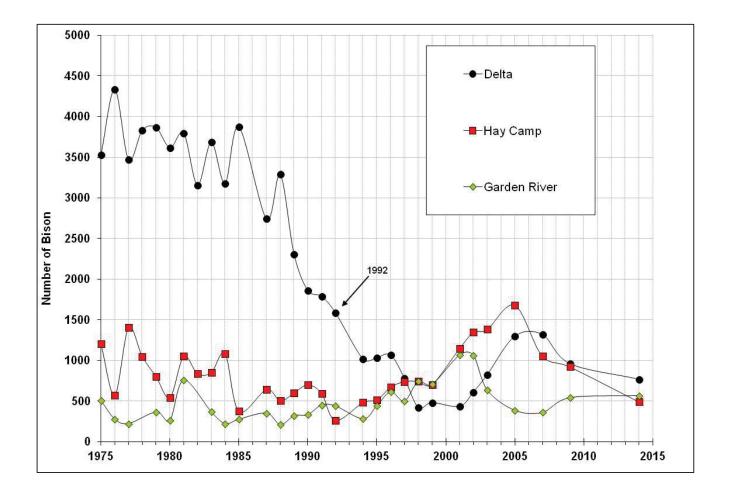
Figure 10. Comparison of the 2002, 2003, 2005, 2007, 2009 and 2014 bison population estimates and minimum counts for WBNP.

Long Term Changes in Population Size

To compare the 2003 data with the long-term dataset, Bradley (2003) buffered points (from the minimum count) to simulate the lower effort prior to 2002. Buffering slightly changes the numbers discussed above for each survey year; 1992 was the start of permanent transects in the 'primary range' (see Methods).

Figure 11. Trend in WBNP bison population (buffered minimum counts), the white circle is number of bison seen during a fall moose survey.

Figure 12. Trend in the Delta, Hay Camp and Garden River subpopulation (buffered minimum counts).
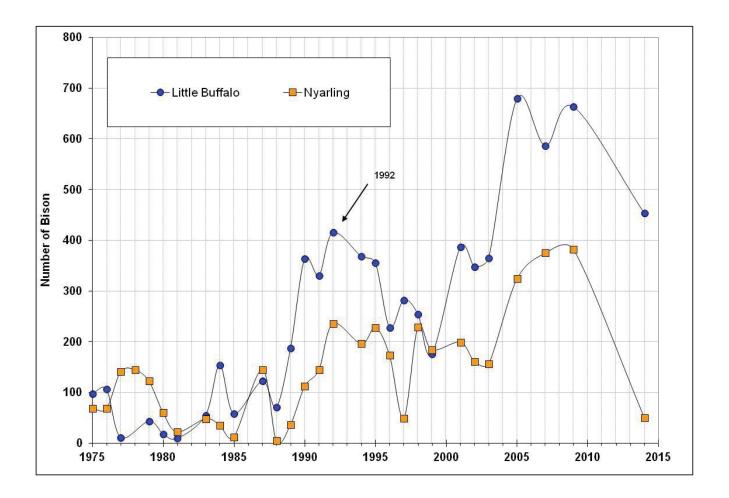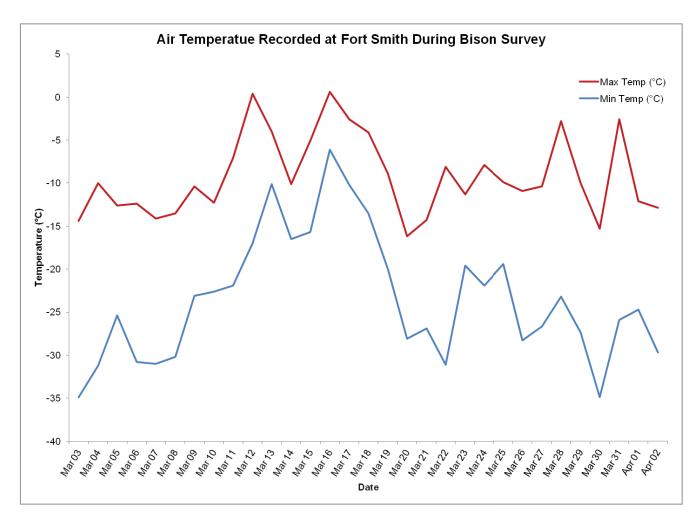
Figure 13. Trend in the Little Buffalo and Nyarling subpopulation (buffered minimum counts).

2014 Weather and Snow Cover

Weather was typical for the season and was not considered to impair visibility of bison (Figure 14). The average daily maximum temperature during the survey was -9.2°C. The average daily minimum temperature was -23.5°C. Snow cover was 100% throughout the survey.

Figure 14. Daily maximum and minimum air temperatures (°C) recorded at the Fort Smith, March 3 to April 2, 2014.

Discussion

There has been a statistically significant change to the park bison population between 2014 and previous survey years up until 2002. The 2009 survey report concluded that there has been an increasing trend in the total population since 1999; however, this trend is not supported by the 2014 minimum count or population estimate. The 2014 minimum count and population estimate (including SRL[1]) indicate a decline of 35% and 25% respectively from 2009 survey results. Although the SRL stratum was surveyed by the GNWT using a different methodology in 2014, the minimum count and estimate for the Little Buffalo subpopulation also showed a respective decline of 31% and 27% from 2009. Differences in the study area, data collection and analysis methodologies between the 2009 and 2014 surveys may confound comparisons between these years. However, the fact that the minimum count and population estimate for the Park as well as the Little Buffalo minimum count and estimate all show a proportionate decline of between 25-35% from 2009 lends support to the declining trend observed in 2014.

In previous years, juvenile survival appeared to be a strong indicator of the population trend. Further examination of the relationship between juvenile survival and bison abundance may provide insight on the causes of the population decline observed in 2014.

Recommendations

Conduct another survey of the Park in 2016 to confirm the direction of the population trend.

Engage GNWT in discussions on how to ensure comparability of data among years and the benefits of harmonising the data collection and analysis methodology for the surveys in and outside the Park. In collaboration with the GNWT, consider additional analyses to examine potential causes of the decline, if the trend is confirmed in 2016.

Consider how to better coordinate the Park survey schedule with future COSEWIC assessments for Wood Bison such that a survey is conducted in the year of, or year prior to the next assessment.

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[1] Although it is outside the Park, the minimum count and estimate for Slave River Lowlands (SRL) stratum are included here for comparison, as SRL was part of the Park survey in 2009.

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Appendix A: Subpopulation counts, estimates and distributions.

Delta Subpopulation

The minimum count for the Delta subpopulation was 756 bison. The calculated population estimate was 1416 (Table A-1). Sampling intensity was 37% (Table A-2). The distribution of bison seen in the area is shown in Figure A-1.

Table A-1. Subpopulation estimate for the 2014 Delta subpopulation.

Stratum	# Bison on Transect	# Bison off Transect	Stratum Estimate	Variance
Athabasca Birch	0	15		
ClaireEast	1	1	4.04	12.28
DeltaPine	36	42	91.28	539.07
Lake 1	37	2	82.19	747.35
Lake 1 Sub	0	0		
SWGN	483	95	1217.53	149903.98
SWGS	8	51	20.55	142.91
Total	**565**	**191**	**1415.60**	

SE: 389

DF: 23

90% CI: 667

CV: 28

Table A-2. Sampling intensity for the 2014 Delta subpopulation survey. Areas are in km^2 and density is bison/km^2 for each stratum estimate. N is the possible number of transects in the stratum, n is the number actually flown.

Stratum	N	n	Stratum area	Area sampled by transects	% Coverage by transects	% Coverage by area	Density
Athabasca Birch	42.06	17	1854.66	790.78	40.42	42.64	
ClaireEast	77.47	19	1086.02	268.64	24.53	24.74	0.004
DeltaPine	34.58	12	586.72	231.40	34.70	39.44	0.156
Lake 1	13.19	6	174.10	78.37	45.50	45.02	0.472
Lake 1 Sub	49.12	12	634.01	157.05	24.43	24.77	
SWGN	60.17	24	1906.91	756.48	40	40	0.638
SWGS	43.93	17	1444.63	562.48	39	39	0.014
Total	**320.51**	**107**	**7687.05**	**2845.20**	**33**	**37**	**0.24**
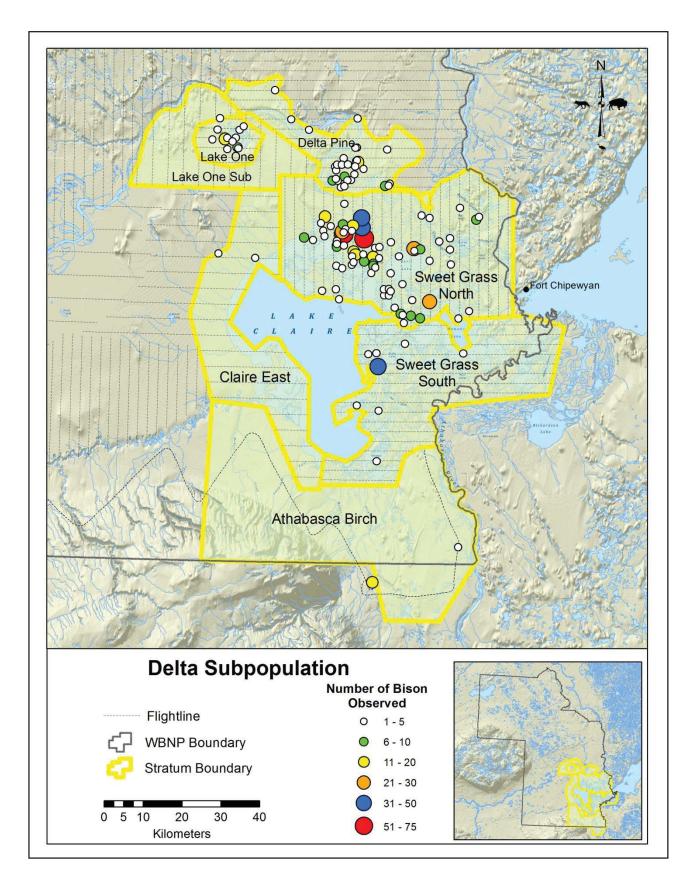
Figure A1. Bison observations for the 2014 Delta subpopulation.

Garden River Subpopulation

The minimum count for the Garden River subpopulation was 636 bison. The calculated population estimate is 760 bison (Table A-3). Sampling intensity was 34% (Table A-4). The distribution of bison seen in the area is shown in Figure A-2.

Table A-3. Subpopulation estimate for the 2014 Garden River subpopulation.

Stratum	# Bison on Transect	# Bison off Transect	Strata Estimate	Variance
Birch				
Wentzel		71		
Fifth Meridian	14	17	53.73	1953.15
Claire West	3	5	11.91	56.51
Garden River	228	144	567.96	24032.48
Garden River Forest	0	6		
Ruis	51	97	126.61	2087.98
Total	**296**	**340**	**760.22**	

SE: 168

DF: 40

90% CI: 282

CV: 22

Table A-4. Sampling intensity for the 2014 Garden River subpopulation survey. Areas are in km². Density is bison/km² for each stratum estimate. N is the possible number of transects in the stratum, n is the number actually flown.

| Stratum	N	n	Stratum area	Area sampled by transects	% Coverage by transects	% Coverage area	Density
Fifth Meridian	38.03	10	724.77	188.84	26.29	26.06	0.074
Claire West	41.10	10	771.10	194.25	24.33	25.19	0.015
Garden River	78.49	31	3692.40	1482.26	38.22	40.14	0.154
Garden River Forest	46.10	7	1255.09	199.99	15.19	15.93	0.000
Ruis	89.34	36	2509.38	1010.79	40.29	40.28	0.050
Total	**293.06**	**94**	**8952.74**	**3076.13**	**32.07**	**34.36**	**0.085**
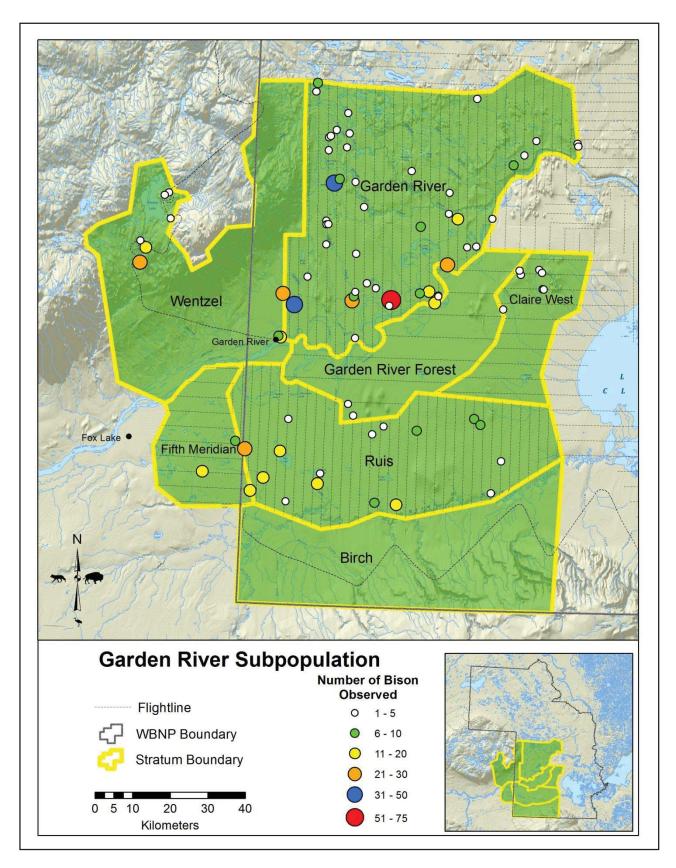
Figure A2. Bison observations for the 2014 Garden River subpopulation.

Hay Camp Subpopulation

The minimum count for the Hay Camp subpopulation was 512 bison. The calculated population estimate is 248 bison. (Table A-5). Sampling intensity was 32% for the sampled areas (Table A-6). The distribution of bison seen in the area is shown in Figure A-3.

Table A-5. Subpopulation estimate for the 2014 Hay Camp subpopulation.

Stratum	# Bison on Transect	# Bison off Transect	Stratum Estimate	Variance
Hay Camp	165	324	415.64	12472.87
Parsons	14	9	83.19	4762.65
Totals	**179**	**333**	**498.83**	

SE: 131
DF: 55
90% C.I.: 220
CV: 26

Table A-6. Sampling intensity for the 2014 Hay Camp subpopulation survey. Areas are in km^2. Density is bison/km^2 for each stratum estimate. N is the possible number of transects in the stratum, n is the number actually flown.

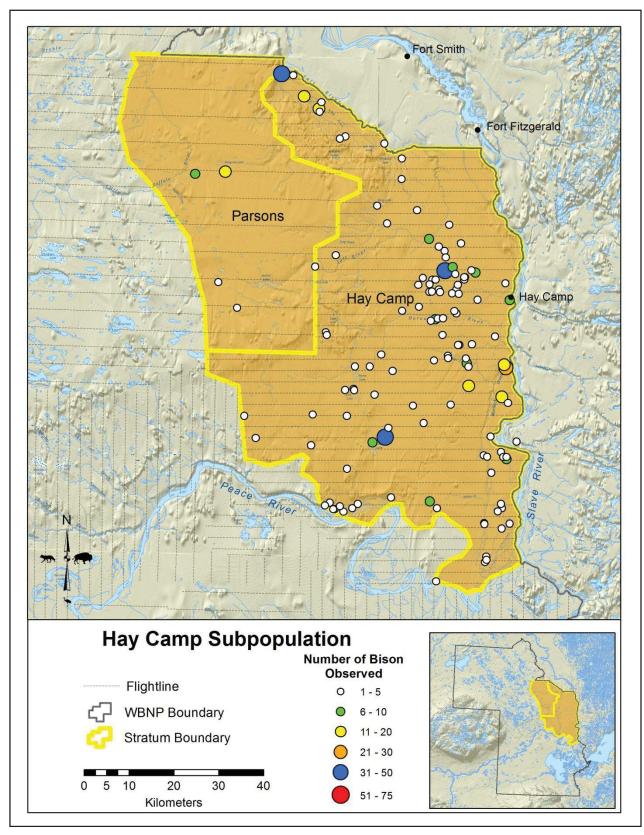| Stratum	N	n	Stratum Area	Area sampled by transects	% Coverage by transects	% Coverage area	Density
Hay Camp	117.5	46	4421.79	1755.37	39.27	39.70	0.037
Parsons	66.84	11	2138.28	359.85	16.46	16.83	0.039
Total	**184.0**	**57**	**6560.07**	**2115.22**	**30.98**	**32.24**	**0.076**

Figure A3. Bison observations for the 2014 Hay Camp subpopulation.

Little Buffalo Subpopulation

The Park-only minimum count for the Little Buffalo subpopulation was 128. The calculated population estimate for the Park was 362 bison (Table A-7). Sampling intensity was 24% for the sampled areas (Table A-8). The distribution of bison seen in the area is shown in Figure A-4.

The combined GNWT-Park minimum count for Little Buffalo was 457. The combined GNWT-Park estimate for Little Buffalo was 730, however this number should be used with caution as no confidence interval was calculated for the combined estimate due to the differences in the data collection and analysis methodologies used for the Park and GNWT survey.

Table A-7. Subpopulation estimate for the Park portion of the 2014 Little Buffalo subpopulation.

Stratum	# Bison on Transect	# Bison off Transect	Stratum Estimate	Variance
SRL West	89	39	362.04	58454.47
Park Total	**89**	**39**	**362.04**	

DF: 18

90% C.I.: 419

CV: 67

Table A-8. Sampling intensity for the 2014 Little Buffalo subpopulation survey. Areas are in km^2. Density is bison/km^2 for each stratum estimate. N is the possible number of transects in the stratum, n is the number actually flown.

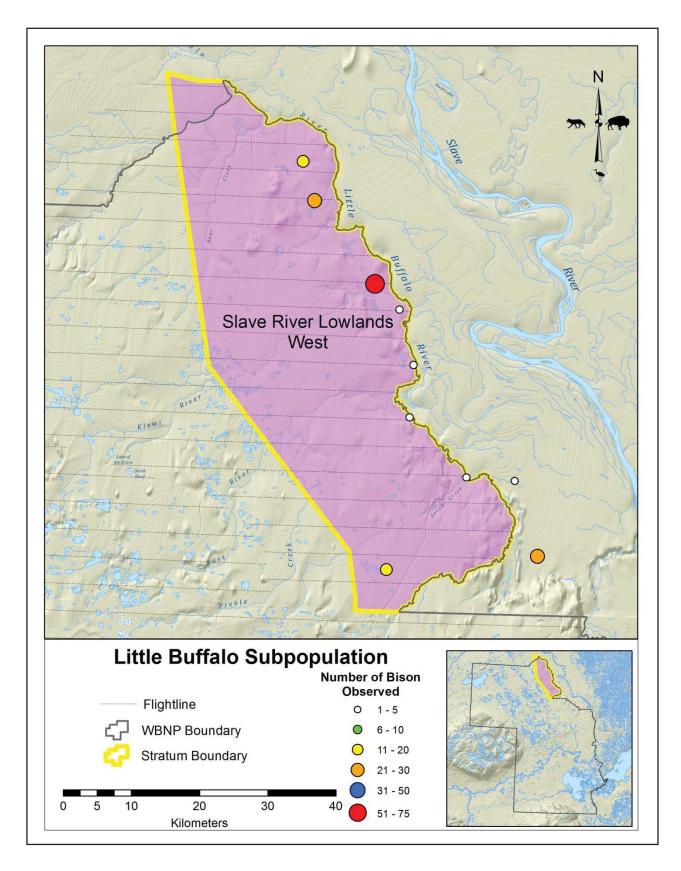| Stratum	N	n	Stratum area	Area sampled by transects	% Coverage by transects	% Coverage area	Density
SRL West	79.11	19	1838.62	451.99	24.02	24.58	0.197

Figure A4. Bison observations for the 2014 Little Buffalo subpopulation.

Nyarling Subpopulation

The minimum count for the Nyarling subpopulation was 212 bison. The calculated population estimate is 326 bison (Table A-9). Sampling intensity was 25% for the sampled areas, 26% if you include the 100% areas (Table A-10). The distribution of bison seen in the area is shown in Figure A-5.

Table A-9. Subpopulation estimate for the 2009 Nyarling subpopulation.

Stratum	# Bison on Transect	# Bison off Transect	Stratum Estimate	Variance
Recon Area North		24		
Boulder	0	0		
Crane North	45	9	181.21	24249.59
Highway Five	7	13	28.73	571.92
Thultue	29	85	116.19	6773.01
Total	**81**	**131**	**326.14**	

SE: 178

DF: 31

90% C.I.: 301

CV: 55

Table A-10. Sampling intensity for the 2014 Nyarling subpopulation survey. Areas are in km^2. Density is bison/km^2 for each stratum estimate. N is the possible number of transects in the stratum, n is the number actually flown.

Strata	N	n	Stratum area	Transect area	% Coverage by transects	% Coverage area	Density
Boulder	14.53	5	98.78	37.85	34.41	38.32	
Crane North	77.52	19	1840.66	457.08	24.51	24.83	0.098
Highway Five	59.13	14	1728.15	421.01	25.37	24.36	0.017
Thultue	104.87	26	4648.21	1160.16	24.79	24.96	0.025
Total	**256.05**	**64**	**8315.79**	**2076.10**	**24.99**	**24.97**	**0.039**
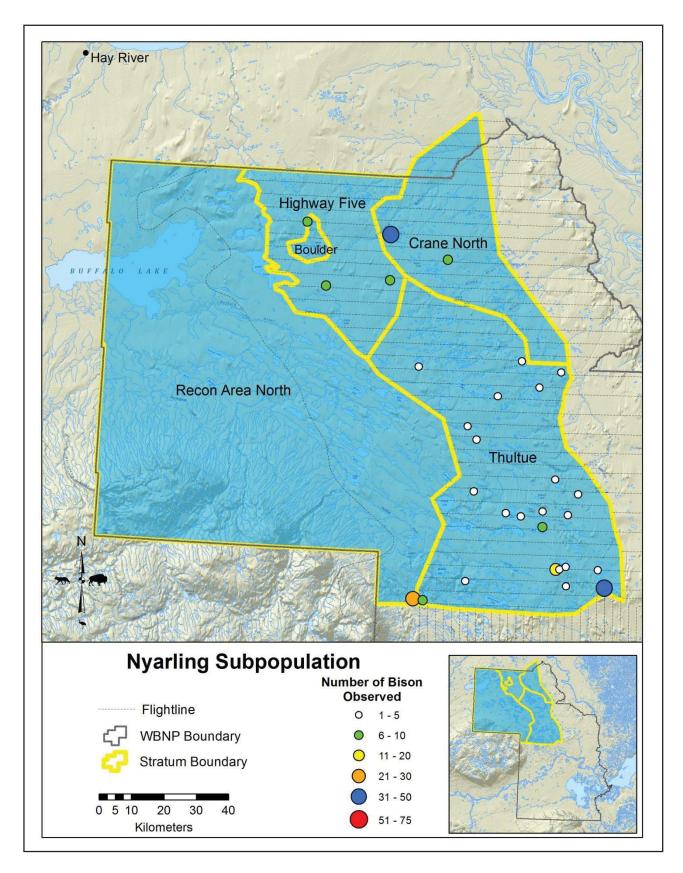
Figure A5. Bison observations for the 2014 Nyarling subpopulation.

Table A-11. Subpopulation results for actual count and population estimate 2002-2014.

Minimum (actual) Count Comparison for Subpopulations 2002-2014						
Year	Delta	Garden River	Hay Camp	Little Buffalo	Nyarling	Total
2002	633	1259	1349	350	279	3870
2003	627	889	1383	365	279	3543
2005	1309	526	1755	687	450	4727
2007	1328	548	1072	588	529	4065
2009	964	681	1007	663	627	3942
2014	756	636	512	128+329	212	2573
Population Estimate for Subpopulations 2002-2014						
Year	Delta	Garden River	Hay Camp	Little Buffalo	Nyarling	Total
2002	635	1363	1465	353	233	4049
2003	1034	1066	1592	602	652	4946
2005	1499	833	1737	1054	518	5641
2007	1542	518	1178	684	717	4639
2009	1197	655	1528	1002	576	4958
2014	1416	760	499	362+368	326	3731

Table A-11 compares subpopulation results from 2002-2014 for the actual count and for the population estimate. Survey methodology was standardized from 2002-2009. In 2014 the strata boundaries for the Little Buffalo subpopulation were modified and the SRL stratum was surveyed using a different method for data collection and analysis by the GNWT.
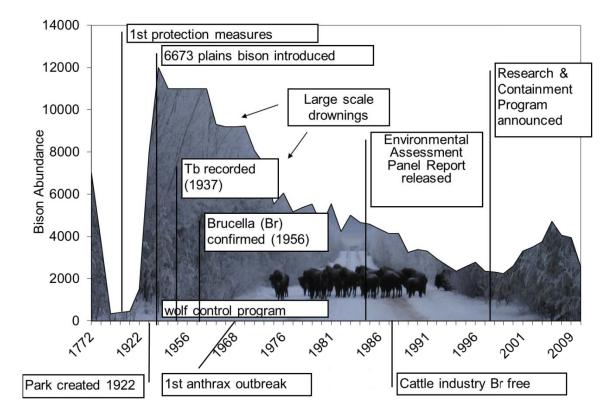

Figure A-6. Wood Buffalo National Park historic bison numbers.

The historic numbers are approximations of the population. The data lines are a best approximation. For example, there was no bison survey in 2006. The value for 2006 is an approximation. Methodology for conducting the count has also changed over time, so values are not directly comparable from survey to survey. Between 2002-2009 the survey format was standardized and the figure shows minimum counts for these years and for 2014. In 2014 the survey format within the Park was the same as 2002-2009, except for slightly different boundaries for the SRL west stratum. The survey format for the SRL stratum of the Little Buffalo subpopulation was different in 2014, as this area was surveyed by GNWT.

Appendix B: Examining the Bison Total Count Survey protocol with respect to 100% Areas
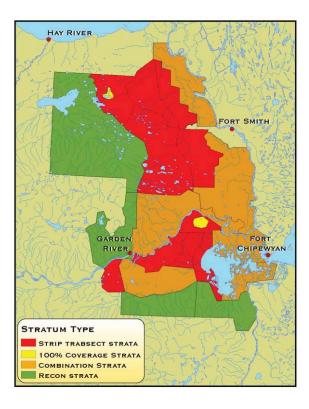
Analysis conducted by D. Andrews, 2008.

The problem:
- 100% areas used in Bison Population Surveys are known to be inaccurate (based on anecdotal reports by the 2005 and 2007 survey crews), leading to questioning of the accuracy of the bison estimates generated from this data.
- Attempts to field truth the 100% areas during the Population Survey survey have been unsuccessful (too many things happening during survey for crews to give it the concentration it requires)
- It is difficult for survey crews to know when they are in what has been designated a 100% area, and to switch their data collection protocols appropriately
- Using the 100% areas adds a lot time and effort to the data processing. This time is wasted if it is not improving the accuracy of the estimate.
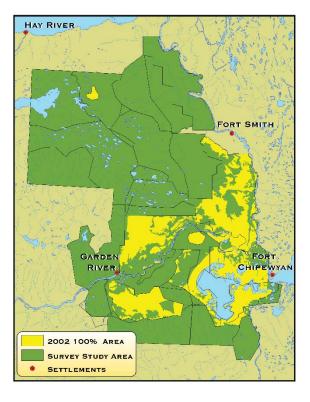
Possible solutions:
- (a) Spend the time, money and effort required to improve the 100% area coverage before the next survey. This would require new satellite imagery for the park, and a field truthing survey. The coverage would also have to be updated periodically to ensure that it always reflects current conditions.
- (b) Omit the 100% areas, performing the survey as strip transect only
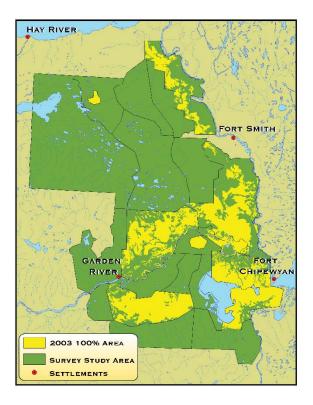- (c) Continue using the 100% areas as is.

Background:
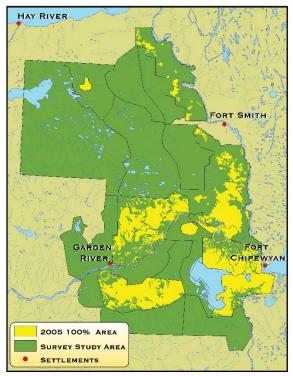
The strata are classified as strip, 100% coverage, combination, and mixed. Combination strata are further classified into strip and 100% areas. Strip strata and the strip portions of combination strata have estimates statistically generated from the "on transect" observations. For 100% areas and recon strata, we use the raw number observed. These two types of estimates are added together to make the final estimate.

In the 2002 survey, 100% areas were determined based on the resource inventory from the 1970's

In 2003 new 100% areas were generated based on classified 2000 Landsat 7 imagery. (Note that the strata also changed this year) During the survey, crews recorded observations on the accuracy of the 100% areas.

The observations made in the 2003 survey were used to remove areas that did not actually have 100% coverage. These revised 100% areas were used in the 2005 and 2007 surveys. During the survey 2007 survey crews again recorded observations on the accuracy of the 100% areas with the hope of again revising the coverage. Unfortunately these observations were only sporadically recorded.

How would performing the survey as strip transect only (solution b) effect the estimate?

In an attempt to answer this question, I re-analyzed the 2007 survey results as if it had been done as strip-transect only (no 100% areas) with the following results:

Population Estimate 2007

Population:	# Bison Seen					Population Estimate	Area	Density
	on	off	100%	Recon	Total			
Delta	689	637	0	0	1326	1761.20	7986	0.22
Garden River	160	376	0	12	548	443.842	13830	0.03
Hay Camp	299	770	0	0	1069	806.759	6560	0.12
Little Buffalo	275	298	0	0	573	683.842	3918	0.17
Nyarling	250	276	0	0	526	862.598	17850	0.05
Grand Total:	1673	2357	0	12	4042	4558	50146	0.091

Compare to the original estimate:

Population Estimate 2007

Population:	# Bison Seen					Population Estimate	Area	Density
	on	off	100%	Recon	Total			
Delta	179	84	1063	0	1326	1541.64	7986	0.19
Garden River	115	239	182	12	548	517.949	13830	0.04
Hay Camp	213	263	593	0	1069	1177.84	6560	0.18
Little Buffalo	274	294	5	0	573	683.506	3918	0.17
Nyarling	156	276	94	0	526	717.408	17850	0.04
Grand Total:	937	1156	1937	12	4042	4638	50146	0.092

The no-hundred areas estimate is slightly lower (by 80 animals or 1.7%) than the estimate using 100% areas.

Recommendation:
Given the cost and effort of revising the 100% areas (on a continuing basis), and the small difference it makes to our estimate, I recommend modifying the survey design to strip transect and recon only.