SURVEILLANCE ACTIVITIES UNDER THE NORTHWEST TERRITORIES BISON CONTROL AREA PROGRAM (1987-2000)

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ABSTRACT

In 1987, the Bison Control Area (BCA) program was established to reduce the risk of contact between healthy free-ranging bison *(Bison bison)* herds in the Northwest Territories and those bison in and around Wood Buffalo National Park (WBNP) which are infected with bovine tuberculosis (*Mycobacterium bovis)* and brucellosis *(Brucella abortus)*. In this paper, I summarize the main results of this surveillance program since its inception. I also review recent data on health status of the Mackenzie wood bison herd and then outline issues and considerations for the future of the BCA program. Since diseased bison in and around WBNP represent a continued threat of disease exposure to healthy bison in the Mackenzie and Nahanni herds, my principle recommendation is to continue the BCA and maintain surveillance in the buffer zone.

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INTRODUCTION

In this report my intent is to provide an overview of the Northwest Territories Bison Control Area (BCA) program since its inception in 1987, summarize the history and development of the program, review important events and findings, and provide recommendations for the future. This overview is necessarily broad and the reader is referred to previous reports and publications for specific background information, detailed results of surveillance activities, survey details, sightings and removals of bison, and observations of other large mammals (Gates and Gray 1992, Gates *et al*., 1992b, Williamson *et al*. 1995, Antoniak and Gates 1995, Antoniak and Gates 1996, Bohnet and Gates 1997, *Boulanger et* al. 1999, Boulanger *et al*. 2002, Tanguay *et al*. in prep).

Background

Free-ranging bison (*Bison bison*) in and around Wood Buffalo National Park (WBNP) and the Slave River Lowlands are infected with bovine tuberculosis (*Mycobacterium bovis*) and brucellosis (*Brucella abortus*) (Tessaro *et al*. 1990, Joly and Messier 2001). These bovine diseases were likely introduced to the park bison between 1925 to 1928 when 6,673 diseased plains bison were moved from Wainwright National Buffalo Park to WBNP. The diseased bison have since presented a difficult and unresolved management problem (Federal Environmental Assessment Review Office 1990, Wobeser 1992). From a perspective on the risk of disease transmission, diseased bison in and around

WBNP threaten the health status of the disease-free* Mackenzie wood bison herd (Tessaro *et al*. 1993), the Hay-Zama herd located in northwest Alberta, and potentially the Nahanni herd located near the Mackenzie Mountains (Gates *et al*. 1992a, Canadian Food Inspection Agency 1999) (Figure 1). As well, the existence of diseased free-roaming herds is perceived to be a continued threat (see CFIA 1999) to the disease-free status of commercial bison (Matthews 2000, 2001) and cattle ranch operations. Diseased bison in the greater WBNP Ecoregion are also considered to present the single greatest factor limiting range availability for reestablishment of other healthy free-roaming herds in the region and for the potential of further recovery of wood bison in Canada (Gates *et al*. 2001).

Wild herds at risk

Mackenzie wood bison herd

Following the discovery of what was considered to be an isolated herd of pure wood bison in the northwest region of WBNP (Banfield and Novakowski 1960), 77 animals were captured in winter of 1963 from the Needle Lake area. Subsequent to disease tests for bovine tuberculosis and brucellosis, 19 of those wood bison were transported to a holding corral near Fort Smith, NT, to establish a captive-breeding herd (Gates *et al*. 2001). After an outbreak of anthrax in bison in the Grand Detour area in summer 1963, 18 bison were re-tested for bovine

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* "Disease-free" is used here to describe wild bison herds that are not infected with either bovine tuberculosis and/or brucellosis. Conversely, I use the term "diseased" to describe wild bison herds that are considered enzootic for bovine tuberculosis and brucellosis.

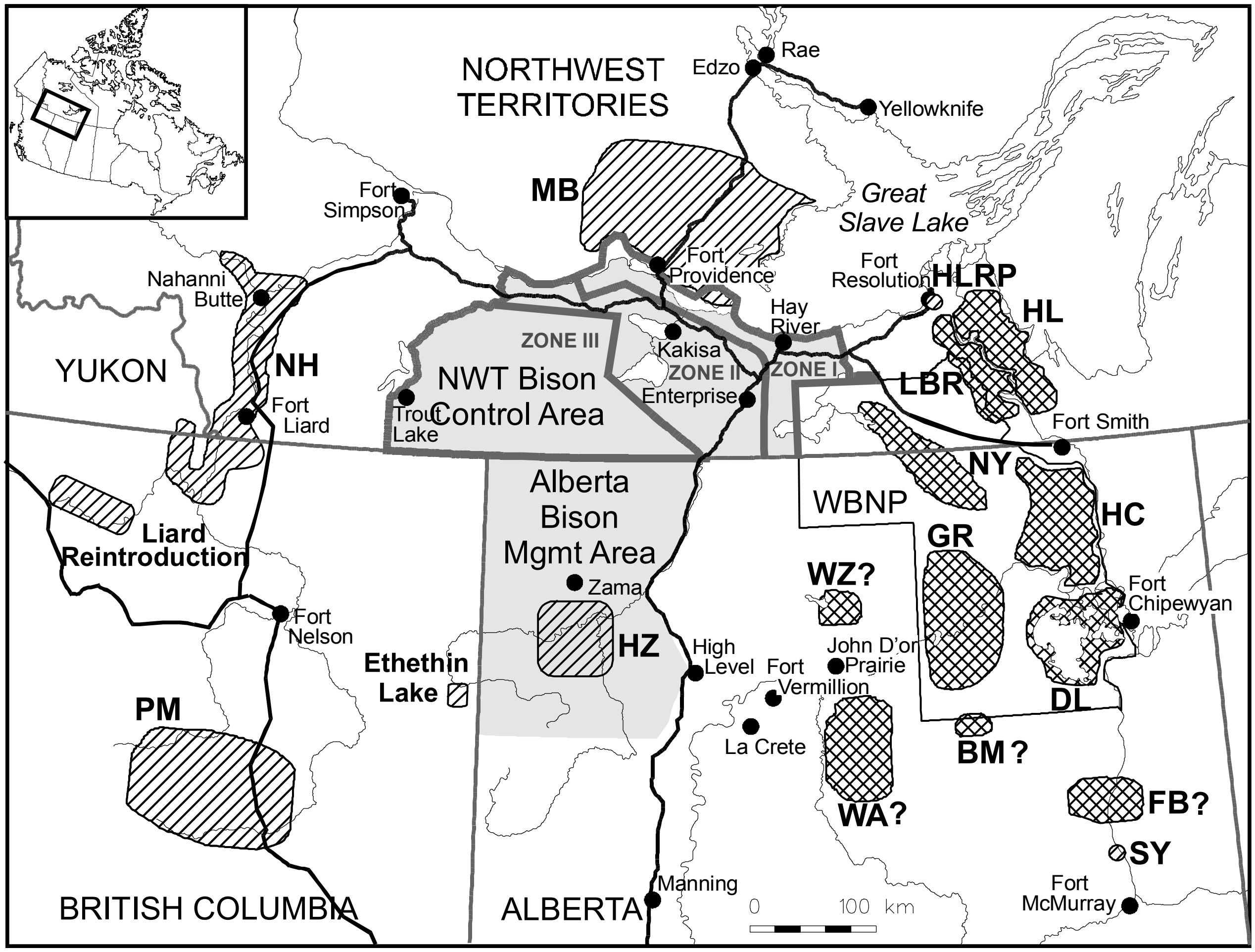

Figure 1. Distribution of bison herds in northern Canada and location of the Northwest Territories Bison Control Area (BCA) and Wood Buffalo National Park (WBNP). BCA zones highlighted by dark grey borders. Bison herds considered to be infected with bovine tuberculosis and brucellosis are shown by crossed hatching: HL = Hook Lake, LBR = Little Buffalo River, NY = Nyarling, HC = Hay Camp, GR = Garden River, DL = Delta, FB = Firebag, WZ = Wentzel, WA = Wabasca, BM = Birch Mountains. Bison herds considered to be disease-free are shown by single line hatching: MB = Mackenzie, NH = Nahanni, PM = Pink Mountain, HZ = Hay Zama, SY = Syncrude/Fort McKay. HLRP represents the Hook Lake Wood Bison Recovery Project.

disease and then translocated to the Mackenzie Bison Sanctuary near Fort Providence to establish a free-ranging herd. The herd has increased in number to become the largest wood bison herd (see Larter *et al.* 2000) that is free of bovine tuberculosis and brucellosis (Tessaro *et al.* 1993). An aerial survey of the Mackenzie herd in March 2000 resulted in a population estimate of 1,998 $\pm$ 163 (SE) bison (J. Nishi and T. Ellsworth unpublished data). There is an annual hunting quota of 47 assigned to the Mackenzie bison population.

Hay-Zama wood bison herd

In 1984, 29 wood bison from Elk Island National Park were transferred to a 300 ha enclosure located along the Hay River east of Hay-Zama lakes in northwestern Alberta. The release of bison to the fenced enclosure was part of a co-operative program with the Dene Tha First Nation to reintroduce wood bison to northwestern Alberta. Flooding and sever winter conditions initially resulted in poor calf production and survival during the first three years of the project, which was subsequently improved through supplemental feeding. In 1993, portions of the fence collapsed allowing the herd of 49 to become free ranging. In winter 1994, the population consisted of 58 animals while in winter 1999/2000 the population was estimated at 130 (Gates *et al.* 2001). In May 2001, aerial surveys by the Natural Resources Service, Alberta Environment, provided a minimum count of 185 bison for the Hay-Zama bison herd (Morton 2001).

Nahanni wood bison herd

In June 1980, through a national recovery program for wood bison, 28 bison from Elk Island National Park were transported to the Liard-Nahanni River Valley and released on the north bank of the South Nahanni River near Nahanni Butte (see Gates *et al.* 2001). This population was augmented in March 1989 with another 12 animals from Elk Island National Park. Herd size was most recently estimated in June 1997 when 102 bison were counted during timber harvest surveys. The herd was augmented again in March 1998, when 61 wood bison were transported from Elk Island National Park to Fort Liard, NT. The bison were being held in a 2.5 ha fenced enclosure 15 km north of Fort Liard, and escaped prematurely in April 1998. The current guess on size of the Nahanni herd is between 150 – 200 animals (aerial survey planned for winter 2001). Bison are found throughout the Liard River Valley in the Northwest Territories and have expanded their range into British Columbia and the Yukon. The current annual quota for the Nahanni herd is two.

History of the Bison Control Area (BCA) program

In 1987, the Government of the Northwest Territories (GNWT) implemented a program to reduce the risk of contact between infected bison in and around WBNP and disease-free bison in the Mackenzie and Nahanni herds by establishing a Bison Free Management Area (BFMA) (Gates and Gray 1992; Gates *et al.* 1992b). The BFMA originally included lands south of the Mackenzie River, and north of the Mackenzie Highway between Mills Lake (near Fort Providence) and Hay River.

In 1990, the BFMA was expanded to encompass the area between the Alberta - Northwest Territories border and southern shoreline of the Mackenzie River. Trout River delineated the western boundary whereas the eastern boundary was outlined by the Buffalo River and western boundary of WBNP (Figure 1). Current size is *ca.* 39,000 km^2.

In 1992, the GNWT established the Nuisance Bison Control Regulations under Section 61 of the Northwest Territories Wildlife Regulations Act (Government of the Northwest Territories 1992). This regulation designated the BFMA as the Bison Control Area (BCA) and permitted eligible big game hunters to legally shoot any bison sighted in the BCA.

Since the 1992/93 winter surveillance season, Parks Canada had contributed funding to the BCA program through a Memorandum of Understanding with the GNWT. Since 1995, Parks Canada has co-funded the BCA program through its Bison Research and Containment Program (BRCP) (Chisholm *et al.* 1998, Huff and Chisholm 1999).

Program Objectives

The overall goal of the Bison Control Area Program in the Northwest Territories is to reduce the risk of infection of the Mackenzie and Nahanni-Liard herds with tuberculosis and brucellosis by lowering the risk of contact with infected bison from WBNP. The objectives of the program are to detect and remove any bison in the BCA, and to prevent establishment of bison herds or individuals in this area. Specific management objectives are:

1) to continue aerial surveillance of the Bison Control Area during winter months;
2) to maintain the Bison Control Area free of bison and prevent establishment of any herds within its boundaries;

3) to increase public awareness of the Bison Control Program; and

4) to confirm disease status of any bison found and shot in the BCA. A related issue that I report on here is ongoing health monitoring of the Mackenzie herd.

METHODS

Surveillance of the BCA

Fixed-wing aircraft are used to conduct regular aerial surveillance of the Bison Control Area during the winter months (December to April) when complete snow cover provides optimal tracking conditions. Snow cover in winter also provides good background contrast while absence of foliage on deciduous shrubs and trees improves sightability of large mammals.

During a winter surveillance season, survey effort is allocated spatially and temporally according to the likelihood of bison moving in to an area. The Bison Control Area is stratified into three discrete zones based on proximity to the southern distribution of the Mackenzie bison herd and the northwest boundary of WBNP (BCA Zones 1, 2, and 3 in Figure 1). The current survey design includes weekly patrols of the southern shoreline of the Mackenzie River between Axe Point and Point Desmarais. A semi-comprehensive flight of Zone I is conducted monthly, while an annual comprehensive survey of Zones I and II is flown once during a winter surveillance season. Zone III of the BCA is not regularly surveyed due to logistical constraints.

Shoreline patrols were usually flown in a Cessna 150 while all other surveillance flights were conducted in a Cessna 185. A community representative from Fort Providence was the observer during shoreline patrols. Whereas a Bison Control Area Technician conducted the monthly surveillance flights of Zone I and the annual comprehensive survey of Zones I and II with assistance of community representatives. Survey aircraft were flown at approximately 250 to

300 metres above ground level at a speed of 140 - 160 km/hr. All wildlife observations were recorded on 1:250,000 National Topographic Series maps or entered in to a Global Positioning System and downloaded in to an electronic database. (Specific details of survey methodology are described in Gates and Gray 1992, Gates *et al.* 1992b, Williamson *et al.* 1995, Antoniak and Gates 1995, Antoniak and Gates 1996, Bohnet and Gates 1997, Boulanger *et al.* 1998, Boulanger *et al.* 2002, and Tanguay *et al.* in prep.).

Health Monitoring

Tessaro *et al*. (1993) describe methods used during their initial studies on health status of the Mackenzie bison herd. To test for presence of tuberculosis and brucellosis they conducted comprehensive post-mortem examinations on killed bison, which included collection of lymph nodes for histological evaluation and bacterial culture. They screened blood sera for the presence of *Brucella* antibodies using the buffered plate antigen test (BPAT), standard tube aggluntination test (STAT), and the direct complement fixation test (CFT) as described by Forbes (1980).

Since 1990, collection of blood sera from the Mackenzie herd has largely been a result of the co-operation of hunters - licensed bison hunters are required to assist in a *Brucella* monitoring program by collecting blood sera in the field from legally harvested animals. Blood sera were screened for the presence of *Brucella* antibodies using the BPAT, STAT, CFT, Florescent Polymerization Assay (FPA) (Gall *et al.* 2000), and the competitive Enzyme-Linked Immunosorbent Assay (ELISA) (Gall and Nielsen 1994).

Data Analyses

Bison sightings during aerial surveillance were only recorded during shoreline patrols. Because of potential problems with poor comparability with data from earlier years, I restricted analyses of those data to the most recent five years (1995/96 – 1999/00) as the flight paths for those shoreline patrols generally followed a consistent route. In order to improve comparability of bison sightings during shoreline patrols, I used ArcView GIS 3.2 (Environmental Systems Research Institute 1999) to restrict the dataset to include only those bison sightings that occurred within 5 km of the high water mark of the Mackenzie River as indicated on digital 1:250,000 scale NTS maps. I also delineated three sub-zones within the shoreline patrol areas based on observed clumping of bison sightings over the five-year period (Figure 2).

Data from shoreline patrols were not normally distributed and because the flights were flown at varying intervals, the data were affected by varying degrees of temporal autocorrelation. Consequently, I analysed shoreline patrol data using non-parametric statistical methods (*i.e.,* One-way ANOVA on ranks) in Sigma Stat for Windows 2.0 (Jandel Corporation 1995).

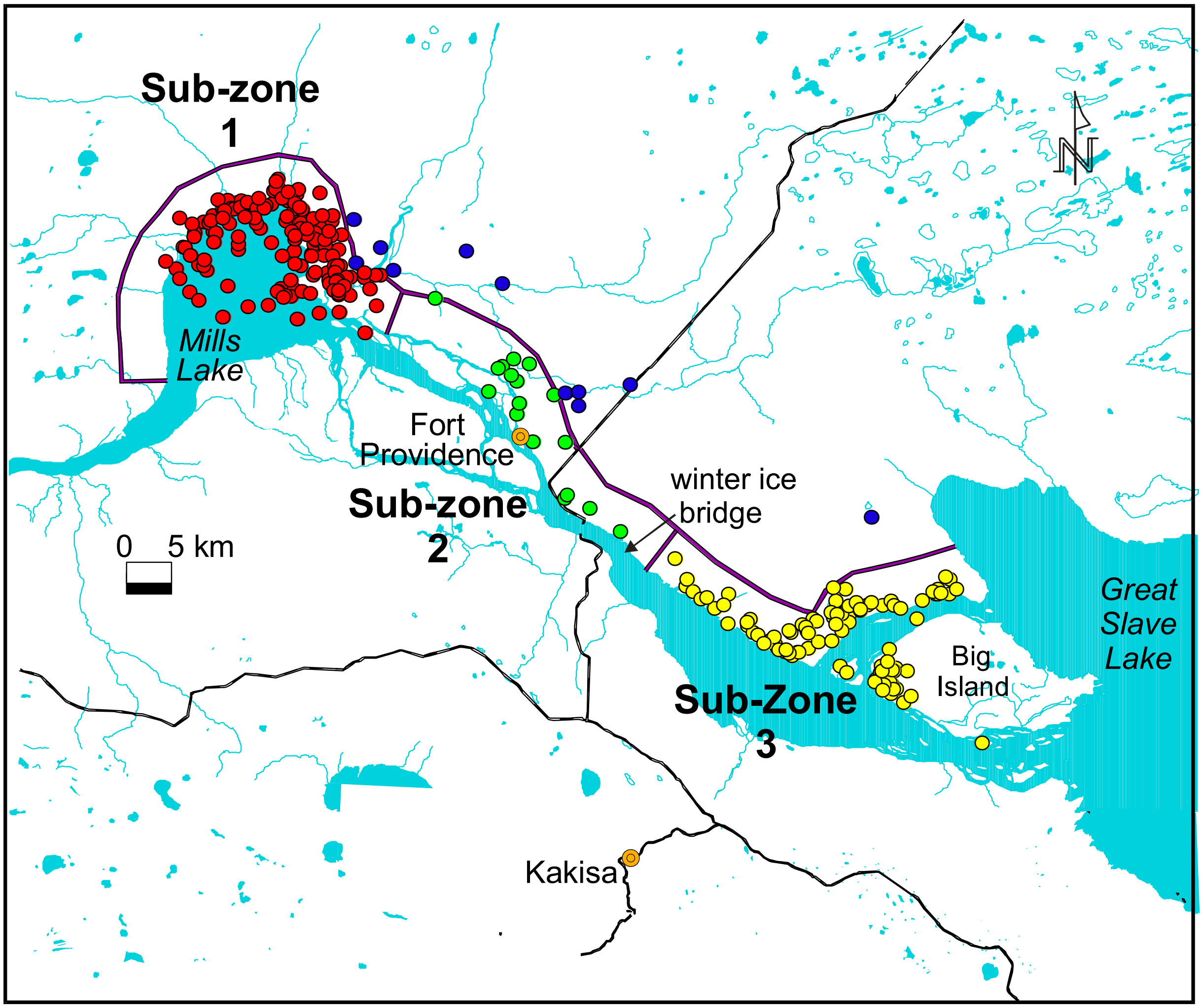

Figure 2. Distribution of all bison observations recorded during shoreline patrols (Bison Control Area program 1995 – 2000). Bison observations located > 5 km of the north shoreline of the Mackenzie River were not included in further analyses. Boundaries for sub-zones 1, 2 and 3 were delineated based on apparent clumping of bison observations.

RESULTS

Surveillance of the BCA

The first aerial surveys of the BCA were conducted in 1988/89 (Table 1) and most closely approximate the shoreline patrols that are currently flown. Surveyed areas expanded following the expansion of the BCA in 1990. From 1991 to 1994 aerial survey coverage and effort varied, and it was not until the 1994/95 surveillance season that effort was allocated more evenly across the BCA (Table 1). Although ground-based snowmobile surveys were conducted in 1993/94 and 1994/95 (Table 1), Antoniak and Gates (1995) suggested that the cost was better allocated to aerial surveys.

There have been a total of 19 semi-comprehensive (*ca.* 291 hours) and 6 comprehensive surveys (*ca.* 260 hours) flown in the BCA between 1994/95 and 1999/00 (Table 1), but no bison were observed in the BCA during those aerial surveys. However since 1976, the general public has reported many sightings of bison and/or their tracks in and around the BCA (Figure 2).

Throughout the duration of the BCA program there have been four separate occurrences where bison were shot and killed within the BCA (Table 1, Figure 3). The first occurrence was on 17 May 1992 whereby a total of 8 bison bulls were destroyed. The second involved one bull and occurred on the 31 May 1992. The third incident was on the 8 March 1995; hunters shot one adult cow. And the fourth occurrence was on 19 March 1996 when three cows were shot on the south side of the Mackenzie River. All of those bison were presumed to be free of brucellosis and tuberculosis based on serology and post mortem results

Table 1. Summary of surveillance activities and removals of bison from the Northwest Territories Bison Control Area program (1988/89 – 1999/00).

Year	Aerial surveillance				Snow-mobile Ground Patrols	Bison Removals
	Shoreline Patrols	Semi-Comprehensive Surveys	Comprehensive Surveys	Total Hours		
1988 / 89	1					
1989 / 90	2					
1990 / 91	2					
1991 / 92		7				
1992 / 93			3			9[a]
1993 / 94	14[b]		1		23	
1994 / 95	10 (26)[c]	6 (94)	1 (34)	153	33	1[d]
1995 / 96	11 (35)	3 (48)	1 (41)	123		3[e]
1996 / 97	21 (62)	3 (45)	1 (46)	153		
1997 / 98	14 (43)	3 (46)	1 (48)	137		
1998 / 99	14 (43)	2 (30)	1 (45)	117		
1999 / 00	14 (42)	2 (28)	1 (46)	115		
2000 / 01	13 (40)	2 (30)	1 (50)	120[f]		

[a] 17 May 1992: 7 bulls and 1 bull shot near Point de Roche
31 May 1992: 1 bull shot near Point de Roche (no lymph nodes collected)
Serological testing for *Brucella* was negative for all 9 bulls, no lesions consistent with tuberculosis observed on gross pathology and histopathology.

[b] Four patrols covered the Hay River area and extended inland to the northwest Park boundary.

[c] Numbers in brackets represent survey hours (rounded off to the nearest hour).

[d] 8 March 1995, 1 cow shot by hunter along south shore of Mackenzie River. Cow had likely been wounded by wolves. Blood serum and retropharyngeal lymph nodes collected.

[e] 19 March 1996: 3 cows killed by hunter on south shore of Mackenzie River. Blood serum (n=2) and retropharyngeal lymph nodes (n=3) collected. No serological reactors to *Brucella,* and lymphatic tissue normal on gross examination.

[f] Total hours budgeted for aerial surveys at time of writing.

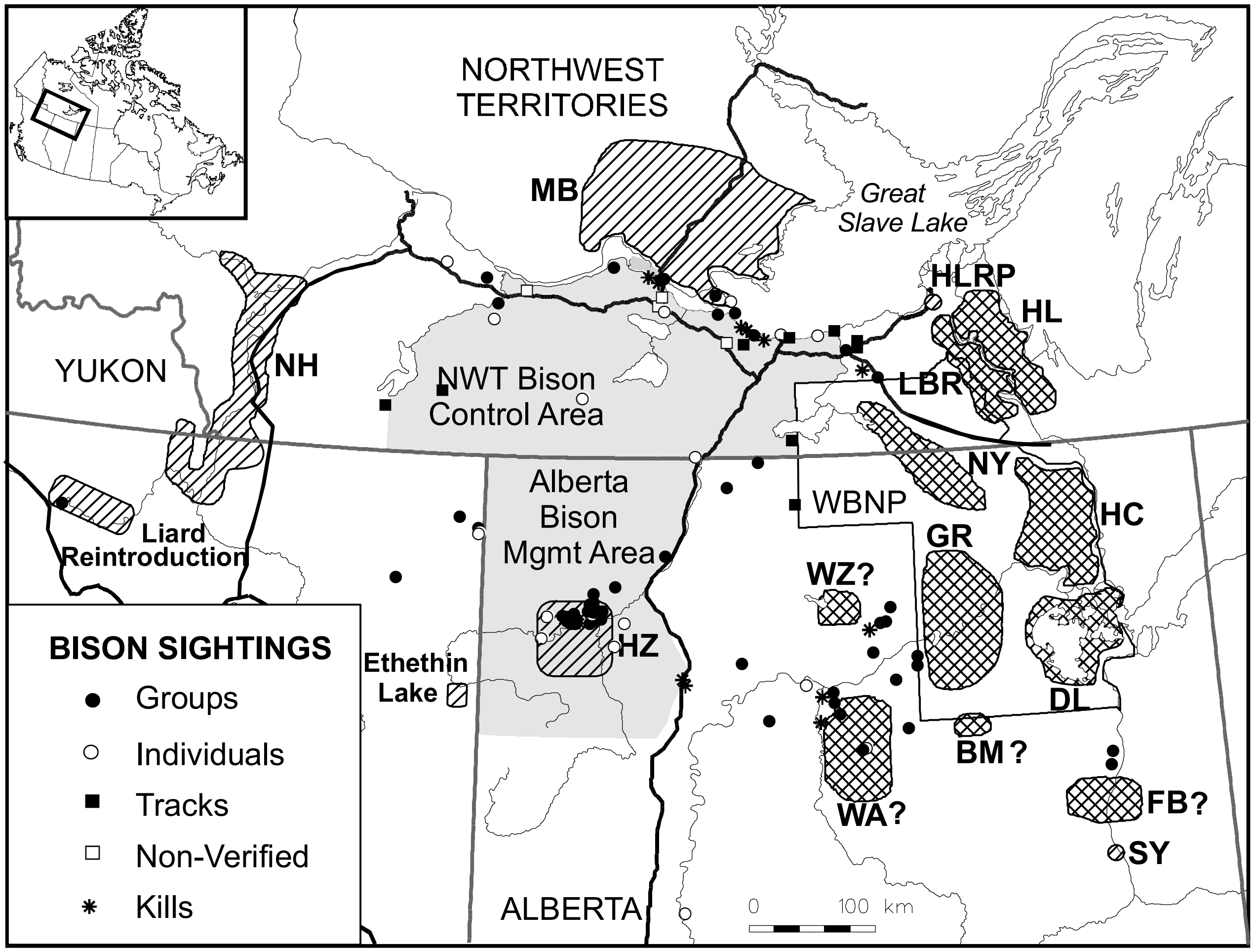

Figure 3. Distribution of bison sightings reported in and near the Bison Control Area in the Northwest Territories, 1976 – 2000 (Bison Control Area program unpublished data). Names of bison herds are on Figure 1.

(Table 1) (Gates *et al.* 1992b, Antoniak and Gates 1995, Antoniak and Gates 1996, Bohnet and Gates 1997).

All bison observed during aerial surveys in the BCA program were seen during shoreline patrols (Figure 2). Mean duration of shoreline patrols from 1995/96 to 1999/00 is 3.3 $\pm$ 0.2 (SE) hours (n = 74). Numbers of bison observed during shoreline patrols are summarized according to sub-zone in Figure 4. There were significant differences in median number of bison observed in sub-zone 1 of the shoreline patrol area among the five years (Figure 4) (H = 26.754, 4 degrees of freedom, P = <0.001). But there were no significant differences between years in median number of bison observed in either sub-zone 2 (H = 2.904, 4 degrees of freedom, P = 0.574) or sub-zone 3 (H = 7.486, 4 degrees of freedom, P = 0.112) (Figure 4).

Variability in the number of bison observed within sub-zone 1 during shoreline patrols was weakly correlated (P = 0.075) with fall water levels in Great Slave Lake (Figure 5). Variability in numbers of bison sighted in sub-zone 1 was higher in years where fall water levels in Great Slave Lake were relatively lower.

Health Monitoring

Tessaro *et al.* (1993) conducted postmortem examinations on 51 Mackenzie bison and found no gross, histological or bacteriological evidence of brucellosis or tuberculosis (Table 2). Antibody titres to *B. abortus* were not found in those 51 animals or an additional 112 bison that were either chemically-immobilized or shot by hunters between 1986 and 1990 (Table 2).

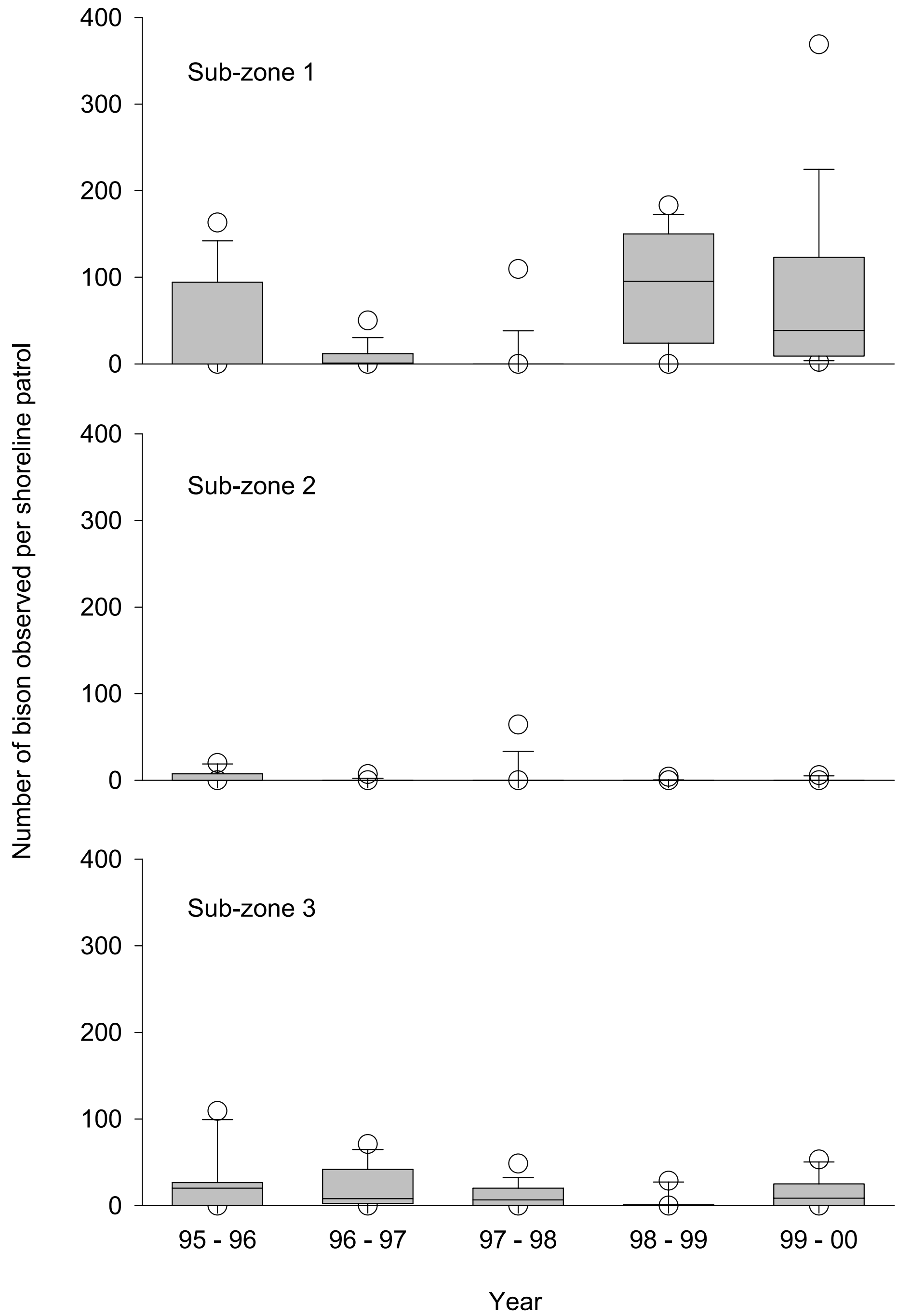

Figure 4. Box plot summaries of numbers of bison observed within sub-zones of shoreline patrols in the Bison Control Area (1995-2000). Median represented by horizontal line; 25th and 75th percentiles presented as grey boxes, 10th and 90th percentiles shown by whiskers, and outliers shown as circles.

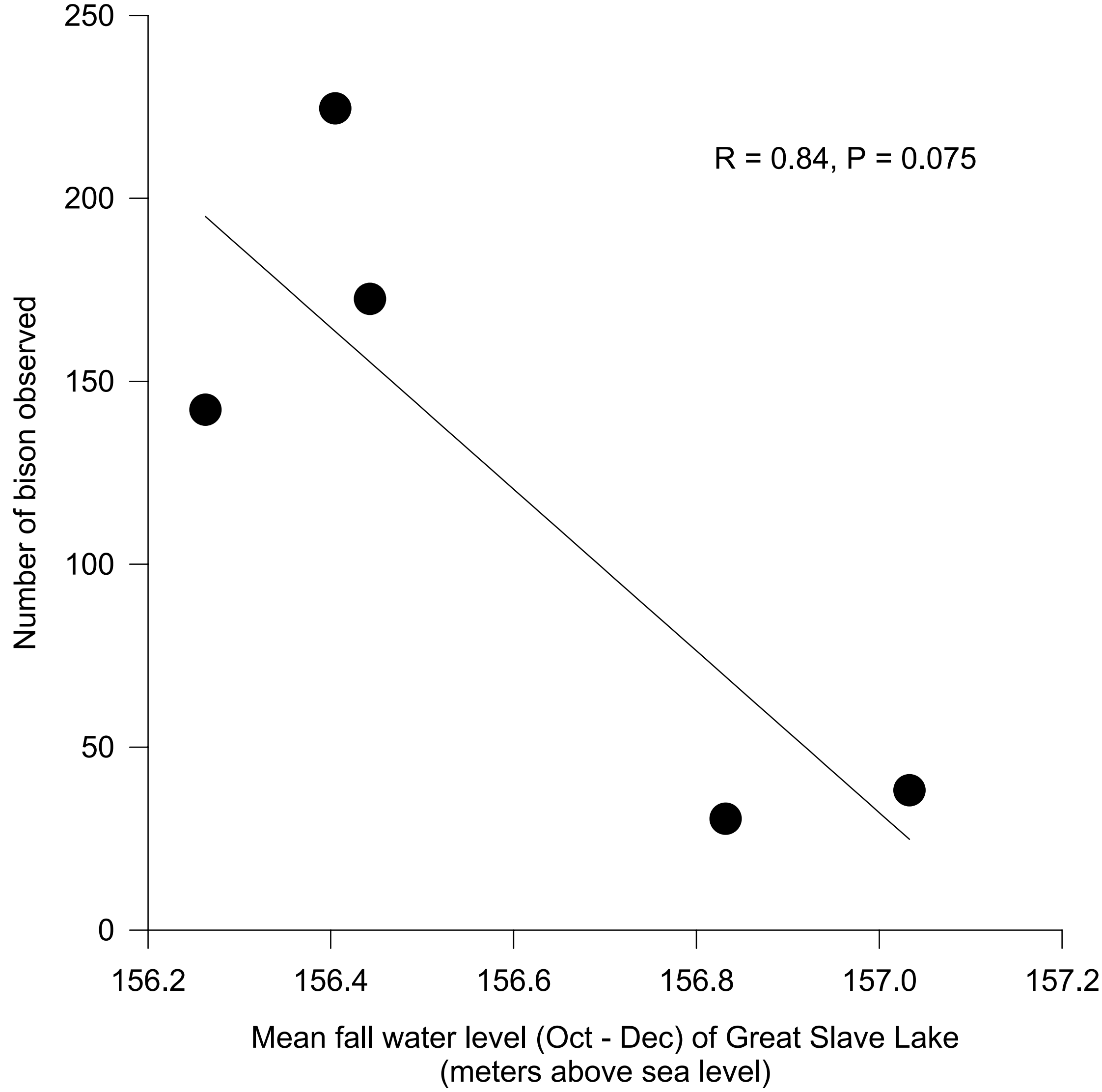

Figure 5. Correlation between variability in number of bison observed in sub-zone 1 of shoreline patrol areas (1995/96 – 1999/00) and mean fall water levels on Great Slave Lake. Values for variability of bison observed are 90th percentiles from data shown in Figure 4. Water level data measured at Hay River and are provided courtesy of Environment Canada.

Table 2. Samples collected from the Mackenzie bison herd (1986 – 1990) to determine whether bovine tuberculosis or brucellosis were present in the population. Data are taken from Tessaro *et al.* 1993.

	Males (57%)			Females (43%)			
	Adult	Sub-adult	Calf	Adult	Sub-adult	Calf	Totals
Mar 86 - Apr 88 (Field collections: post-mortem analyses, blood serum and tissues collected)	3	2	5	28	2	11	51
Mar 86 - Dec 90 (Radio-collaring project: blood sera only)	74		3	20		9	106
Mar 88 & Apr 89 (Hunter-kills: blood sera only)	6						6
	83	2	8	48	2	20	163

More recent results from serological tests of 131 blood sera sampled from hunter-kills and chemically immobilized bison (Table 3) showed that usable samples ranged from 93 – 97% of the total submitted for BPAT, STAT, and CFT, and were all negative for *B. abortus* (Table 4). All 82 samples submitted for the FPA and cELISA were also negative for *Brucella* (Table 4).

Table 3. Description of blood serum samples collected from hunter-killed Mackenzie wood bison to test for presence of antibodies to bovine brucellosis.

	Males (88%)			Females (8%)			Unknown (4%)			
	Adult	Sub-adult	Unknown	Adult	Sub-adult	Unknown	Adult	Sub-adult	Unknown	Total
89/90		1								1
90/91	1									1
93/94	21 *									21
94/95	11	3	2	1						17
95/96	3	6	2							11
96/97	4	4	1	2	3	2				16
97/98	7	5	3							15
98/99	13	15	1				1	2	1	33
99/00	12		1	1	1				1	16
Total	72	34	10	4	4	2	1	2	2	131

* This sample was collected during a field study of anthrax where 21 bulls were chemically-immobilized, radio-collared, and were either vaccinated or served as controls.

Table 4. Results of serological testing of Mackenzie bison sera for antibody titres to *Brucella abortus* using five different diagnostic tests (Buffered Plate Antigen Test, Standard Tube Agglutination Test, Complement Fixation Test, Florescence Polymerization Assay, competitive Enzyme-Linked Immunosorbent Assay).

	BPAT		STAT		CFT			FPA	cELISA
	Neg.[a]	Unfit	Neg.	Unfit	Neg.	Anti-Comp.[b]	Unfit	Neg.	Neg.
89/90	1		1		1			1	1
90/91	1		1		1			1	1
93/94	21		21		21			-	-
94/95	17		17		17			-	-
95/96	11		10	1	11			-	-
96/97	16		15	1	14	2		16	16
97/98	15		15		14	1		15	15
98/99	29	4	28	5	27	2	4	33	33
99/00	16		16		16			16	16
Total	127	4	124	7	122	5	4	82	82

[a] Negative
[b] Anti-complementary

DISCUSSION

Aerial surveys provide a basis for detecting dispersal and the presence of bison in the Bison Control Area. Since this active surveillance was initiated in 1988, there have been no bison observed in the BCA during regular aerial surveys of the BCA program. However, the fact that bison have been found and shot in the BCA, as well as reported bison sightings by the general public, show that small groups and individual bison may occasionally move into the area undetected by winter aerial surveillance (see Figure 3). This passive surveillance (public sightings and reports) of the BCA is complementary to the active surveillance (aerial surveys in winter) and is an integral component of the overall program.

All bison sighted during regular aerial surveys of the BCA have been observed during shoreline patrols and were located along the north shoreline of the Mackenzie River between Mills Lake and Big Island – the southern most distribution of the Mackenzie wood bison herd. Numbers of bison observed along the north shoreline of the Mackenzie River in the Mills Lake area appear to be related to fall water levels prior to freeze-up. I suggest that during years of low water levels, relative forage availability is higher in the Mills Lake area allowing larger total numbers of bison to occupy the area for longer periods in winter. High relative bison densities in the Mills Lake area may subsequently result in higher risk of animals dispersing across the Mackenzie River (depending on ice conditions) and into the Bison Control Area.

The risk of contact between healthy free-ranging bison and diseased bison is bi-directional. In fact because of a density dependent component to dispersal in bison (described as “pressure” dispersal in Gates and Larter 1990: 236), the probability of dispersal from the Mackenzie herd is likely higher than the probability of animals dispersing from WBNP. Between the time of introduction in 1963 and through to the late 1980s, the Mackenzie bison herd increased rapidly (mean exponential rate of r = 0.215) (Gates and Larter 1990). Since the 1990s, the population has fluctuated around an estimated size of *ca.* 2,000 (Larter *et al.* 2000). The 13 bison that were found and shot in the BCA had likely dispersed from the Mackenzie bison herd and were considered free of bovine tuberculosis and brucellosis. Conversely, the WBNP bison population has been declining since the 1970s (Carbyn *et al.* 1993), with the population survey in March 1999 providing a total count of 2,137 bison within the park (Bergeson 1999). Although the WBNP bison population has been declining and in all likelihood is not expanding in range, the probability of long-range “innate” dispersal (Gates and Larter 1990) by young adult bulls cannot be discounted (see Joly and Messier 2001), and still represents a mechanism by which bovine diseases may be transmitted to the Mackenzie herd.

The risk assessment completed by the Canadian Food Inspection Agency (CFIA 1999) highlights the continued need for active surveillance of the BCA and continued vigilance for dispersing bison between the ranges of the Mackenzie bison herd and WBNP. Although the risk-assessment is based on a simple two-dimensional diffusion model of bison movements within the landscape, it concluded that the disease-free, free-ranging bison herds are at the greatest risk of disease transmission from the herds in and around WBNP (CFIA 1999):

> *"…one can say with 95% confidence that on average the introduction of infection* [bovine brucellosis] *would occur no more frequently than once every 8 years if populations and distributions remain at 1998 levels;"*
> *"…one can say with 95% confidence that on average the introduction of infection* [bovine tuberculosis] *would occur no more frequently than once every 6 years if populations and distributions remain at 1998 levels;"*

The importance of the CFIA (1999) risk-assessment lies in its evaluation of the relative risk of disease transmission to three at-risk groups (cattle, commercial captive bison, and disease-free, free-ranging bison), and the relative risk of transmission of tuberculosis being greater than the risk of transmission of brucellosis. Shortcomings of the CFIA (1999) risk-assessment lie in its simplistic treatment of bison movements and a conspicuous absence of data on bison distribution and movement corridors within the landscape. A collaborative research project lead by the University of Calgary (Mitchell *et al.* 2001), and partially funded by the GNWT and BRCP should improve the accuracy of the CFIA risk-assessment of disease transmission to disease-free, free ranging bison. That research may also provide practical advice for optimising allocation of survey effort within the BCA.

Based on the absence of serological reactors to brucellosis and the absence of tuberculosis-like lesions reported by hunters, I conclude that the Mackenzie herd is still free from bovine diseases. However, from an annual sampling perspective, the recent data on negative serological reactors to brucellosis from hunter-kills of Mackenzie bison suffers from small sample sizes and hence has relatively low statistical power. For example, in a population of 2,000 animals, a sample size of 57 (with negative test results) is required to conclude at the 95% confidence level that the true prevalence of disease is less than 5% (see Cannon and Roe 1982 for a detailed discussion of sample sizes required to detect varying levels of disease prevalence). Given that the range in annual serum sample sizes from 1993/94 to 1999/00 was between 11 and 33 (Table 3), the minimum detectable prevalence rate on an annual basis would have ranged between 23.8% to 8.6% respectively. If we pool the last four years of results from the FPA test (similar to the four-year sampling period described by Tessaro *et al.* 1993), the total sample size is 80 with an associated minimum detectable prevalence rate of 3.6% in a population of 2,000.

My assertion that bovine diseases are not present in the Mackenzie bison population requires further confirmation through increased sampling effort. Presently, the strength of this assertion is weakened by small annual sample sizes of blood sera collected through hunter-kills and the lack of a specific sampling regime to detect tuberculosis. Confirmation on the presence/absence of tuberculosis may require collections of specific lymph nodes (*i.e.,* retro-pharyngeal) and tissues (*i.e.,* heart and lungs) for histology and bacteriology. This sampling effort will involve continued and improved collaboration and training with all bison hunters in the Northwest Territories. In addition, validation of the FPA for tuberculosis (Lin *et al.* 1996) as a diagnostic test in bison would also improve sampling efforts (see Joly and Messier 2001).

In conclusion, I suggest that maintenance of the current surveillance program of the Bison Control Area is the minimum required surveillance needed to provide any real measure of protection to the health status of the Mackenzie bison herd. The obvious implication is that this collaborative program of surveillance must be maintained until the health threat imposed by diseased bison in and around WBNP is removed. Given the risk-assessment by the CFIA (1999) and the current trends of the Mackenzie and WBNP bison herds, this is unlikely for the foreseeable future. In fact, recent evidence of sporadic bison sightings extending north from Zama to the Northwest Territories along Highway 35 (J. Mitchell pers. com.), suggests that additional surveillance may be required in the southern part of the BCA and in adjacent areas within Alberta.

In addition to maintaining the current surveillance program, I argue for an increased effort on confirming health status of presumed disease-free, free-ranging bison herds. My specific emphasis is on the Mackenzie bison herd, but I also extend it to the Hay-Zama bison herd in Alberta. Indeed health status of all free-ranging bison herds that are either presumed to be disease free or are of unconfirmed status in the Greater Wood Buffalo National Park Ecoregion (*i.e.,* Nahanni, Wentzel, and Wabasca), require a stronger empirical basis to designate their disease status and facilitate informed management decisions. We need to consider directed field sampling programs for those herds.

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