

# **A LANDSCAPE EVALUATION OF BISON MOVEMENTS AND DISTRIBUTION IN NORTHERN CANADA**

Addendum to the final report dated December 2001

## ***Simulation of bison movements in the Slave River Lowlands and the area between Wood Buffalo National Park and the Mackenzie Bison Range in the Northwest Territories***

February 2003



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## **Executive Summary**

This report forms an addendum to:

Gates, C.C., J. Mitchell, J. Wierzchowski and L. Giles. 2001a. A landscape evaluation of bison movements and distribution in Northern Canada. Axys Environmental Consulting Ltd., Calgary, Alberta. 113 pp. [www.axys.net/library.htm](http://www.axys.net/library.htm)

This work was commissioned by the Government of the Northwest Territories, the Canadian Bison Association and Parks Canada Agency (Wood Buffalo National Park). The mandate of the work was to provide an evaluation of local knowledge of bison movements and distribution and to calculate simulated movement pathways in three study area including the area west of WBNP to Manning Alberta, in the Slave River Lowlands and in the area between Wood Buffalo National Park (WBNP) and the Mackenzie Bison Range. When the final report was submitted in December 2001 geographic data were only available for the Alberta study area and had not yet been provided for the NWT study areas by the Government of the Northwest Territories (GNWT). Although local ecological knowledge was compiled and presented for each area in the final report, simulation of bison movements was completed only for the Alberta/WBNP study area. This addendum completes commitments made to the funding agencies and organizations by providing the results of movement models for the two study areas in the Northwest Territories.

Simulation of bison movement pathways in the area west of WBNP south of the Mackenzie River indicated that the highest density corridors are in the area along the south shore of Great Slave Lake and the mouth of the Mackenzie River. Another major corridor was evident in the area between Buffalo Lake and Highway #5. The currently defined Zone 1 in the Bison Control Area encompasses these corridors. The length of pathways calculated by the model between WBNP and the Mackenzie Bison Range are within observed dispersal distances of bison. In the Slave River Lowlands, movement corridors were more widely distributed, reflecting the assumptions of the model, which were based on known terrain features and crossing areas on the Slave River. Pathway distances were well within the observed dispersal distances of bison. Reports of movements of bison across the Slave River from or to other occupied ranges confirm that the Hook Lake bison range is not isolated by natural barriers in the region. Although there may be an interest in depopulating the Hook Lake Bison Range and reintroducing stock from the captive breeding herd held in Fort Resolution, the new herd would be at extreme risk of becoming infected under current conditions. To achieve the long-term goals of the Hook Lake Wood Bison Recovery Program and to protect healthy wood bison herds from becoming infected will require cooperation between local communities and government and non-government stakeholders at the territorial, regional and national levels. A coordinated, broadly supported regional plan is required for disease eradication and recovery of healthy wild wood bison populations.

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## Introduction

Wood Buffalo National Park (WBNP) and the surrounding area, located in the northeast corner of the province of Alberta and the southern Northwest Territories supports wood bison that are infected with two cattle diseases introduced during the 1920's, resulting from a massive release of infected plains bison imported from east central Alberta. *Mycobacterium bovis* and *Brucella abortus* are the causative agents of the reportable diseases, bovine tuberculosis and bovine brucellosis respectively. Owing to the importance of brucellosis and tuberculosis as zoonoses and reportable diseases, they have been the subject of intensive, long-term eradication programs in livestock populations in Canada and the United States. Bison in the Greater Wood Buffalo National Park area represent the last known reservoir of the diseases in Canada.

The issue of disease management was the subject of a controversial proposal to cull and replace the infected wood bison in the region (EARP 1990). Although the Government of Canada rejected the proposed action, concern about the persistence of the diseases has not diminished. Indeed, the reasons for concern have increased since 1990 in two main areas including the risk to the conservation of recovering disease-free, free-ranging bison and the risk to a rapidly expanding commercial bison industry in the region. There have been no management initiatives undertaken to promote growth or recovery of infected herds since the 1970's. During the past three decades, six wild populations of non-infected bison have been reestablished in northern Canada, which now number approximately 4,700 bison in aggregate. They include one plains bison and five wood bison populations (Gates et al. 2001b).

The risk of infection of healthy bison herds is a chronic management problem (Fuller 1991, Gates et al. 1992, Fuller 2002). The issue was reviewed by a Bison Disease Task Force in 1988, a Federal Environmental Assessment and Review Process (EARP 1990) and the Northern Buffalo Management Board in 1992-93. In 1987, the Government of the Northwest Territories implemented a program to manage the risk of contact between infected and disease-free bison (Nishi 2002). The program entailed defining an area from which bison are excluded through active management. The Bison Control Area (BCA) originally included lands south of the Mackenzie River, and north of the Mackenzie Highway between Mills Lake (near Fort Providence) and Hay River. The BCA was expanded in 1990 to encompass all lands north of the NWT border and south of the Mackenzie River, lying between the Trout River in the west and the Buffalo River and western boundary of WBNP in the east. The BCA encompasses 3,936,339 ha. Bison in the BCA are designated as nuisance wildlife under section 61 of the NWT Wildlife Regulations. This regulation stipulates that any bison sighted in the BCA may be shot by an eligible NWT hunter. Since 1993, the bison control program has been jointly funded by the Department of Resources, Wildlife & Economic Development and by Parks Canada Agency. The objectives of the Northwest Territories bison control program are to detect and remove bison in the BCA, and to prevent the establishment of bison herds or individuals in this area. These objectives serve the goal of lowering the risk of contact between bison in non-infected and infected bison herds.

The Hook Lake herd, located in the Slave River Lowlands near Wood Buffalo National Park, once numbered 1700 (Van Camp 1989). It declined rapidly during the 1970's and 1980's to about 200 bison and remained low near this level. Poor calf production, tuberculosis and brucellosis, wolf predation and hunting were factors contributing to the decline and to the low number of bison in the resident population (van Camp 1989). In 2000, 283 bison were counted east of the Slave River (J. Nishi pers. comm).

In 1991, Deninu Kue' First Nation published a plan for recovery of the Hook Lake herd that proposed to regenerate a healthy herd of wood bison. The plan was implemented in 1992 in cooperation with the Government of the Northwest Territories Department of Resources, Wildlife and Economic Development (formerly the Department of Renewable Resources). Financial support for planning and implementation was provided by the Government of the NWT, the Government of Canada (Arctic Environmental Strategy), and the Canadian Wildlife Federation. The plan detailed the following goals:

- To restore a healthy herd of wood bison to the Hook Lake area that is free of the diseases bovine tuberculosis and brucellosis
- To preserve the genetic integrity of the Hook Lake Wood Bison herd
- To salvage healthy bison from the Hook Lake area
- To preserve and enhance the Hook Lake ecosystem
- To develop economic opportunities from the Hook Lake bison herd.

The first management action for the Hook Lake herd was undertaken in 1992 when prescribed burning was applied to reverse the loss of meadow habitat caused by shrub and forest succession and possibly by a reduction in grazing related to the low number of bison in the system (Chowns et al. 1998). The Hook Lake Wood Bison Recovery Project was implemented to salvage genetic resources from a diseased population in the Slave River Lowlands and to establish a captive breeding herd that can be used to re-establish a disease free free-ranging population in the SRL (Gates et al. 1998, Nishi et al. 2000). This is a community-based collaborative project run by the Deninu Kue' First Nation, the Fort Resolution Aboriginal Wildlife Harvesters' Committee and the Government of the Northwest Territories. The captive herd was founded from 62 neonatal bison calves captured from the Hook Lake population in the SRL. The long-term goal of the project is to reestablish a disease-free population in the Hook Lake area, while conserving the existing genetic diversity of the current diseased population. The presence of diseased bison in the SRL and WBNP presents the most significant limitation to the long term goal of the project.

The purpose of this addendum to the 2001 report (Gates et al. 2001a) is to provide results of simulations of bison movement pathways and corridors between WBNP and the Mackenzie bison population and between bison ranges in the western and eastern Slave River Lowlands. The products of this work provide information that is useful for evaluating the surveillance program in the Bison Control Area and for considering the nature of movements of bison across the Slave River as a consideration in planning long term actions to reestablish a disease free herd in the Hook Lake bison range.

## Study Areas

Two study areas were defined in consultation with the Government of the Northwest Territories. The western study area was located between WBNP and the Mackenzie Bison Range. The northern part of this area has been subject to intensive surveillance and a bison control program to detect and remove any bison found there. The eastern study area was located in the Slave River Lowlands where Deninu Kue First Nation and the Government of the NWT are interested in creating conditions for reestablishing a reintroduced wood bison population that is free of tuberculosis and brucellosis. Movements of bison across the Slave River are of particular interest in this area.

## Methods

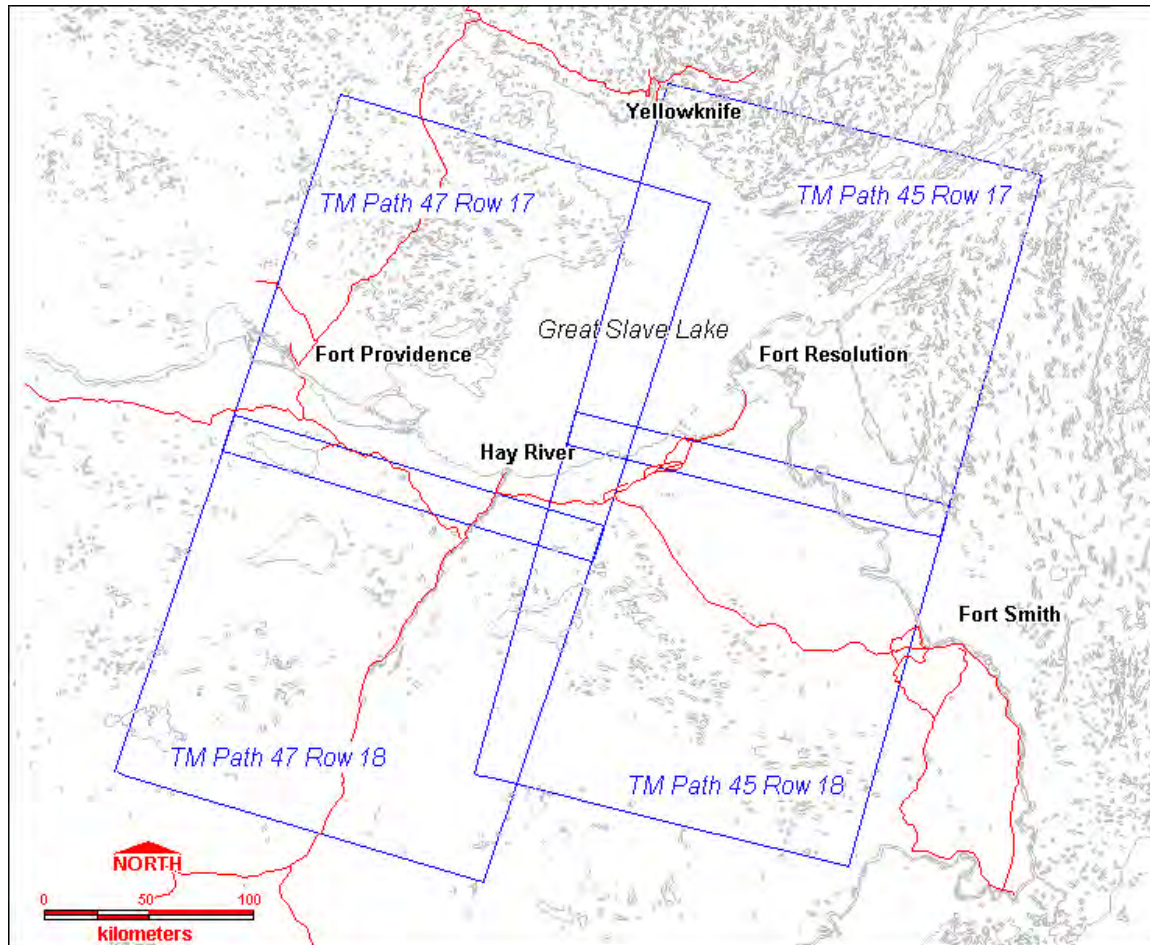
We simulated the movements of bison in two areas south of Great Slave Lake in the North West Territories using the same methods developed for the northern Alberta study area reported previously in detail in Gates et al. (2001a). Briefly, the affinity of bison for specific habitat variables was quantitatively defined from data for the Lake Claire area in Wood Buffalo National Park for which Parks Canada provided Landsat 7 data. A data set of the locations of radio collared bison obtained during a recent study of bison movements in WBNP (Joly and Messier 2001) was provided by the University of Saskatchewan. A resource selection model (logistic regression) was calculated for which the dependent variable was the probability of summer habitat use by bison. We were unable to validate its adequacy in the NWT study area owing to the lack of data. Variables included in the resource selection model were 'greenness' and distance to water.

We based the bison movement corridor model on the "least cost" principle, which states that wildlife movement is most likely to follow a path of least resistance along a vector defined by the juxtaposition of relatively high quality habitat patches weighted by distance. The effect of steep slopes on bison movements was included in the movement pathway model. The geographic analysis and image processing software IDRISI32 (Clark Labs 2001) provides an example of a program that calculates the route of least cost distance between one or more points. This model was applied in the two NWT study areas to calculate movement corridors.

We used four Landsat 7 scenes provided by NWT Center for Remote Sensing (Figure 1). A fifth scene (Path 49 Row 17) was not used due to excessive high cloud cover around Kiska Lake. All scenes were taken between early July and early September and represented a similar phenological stage of vegetation. We used 1:250,000 scale NTDB databases for mapping bison habitat and producing final maps. We augmented the poor quality digital hydrology data with information extracted from Landsat 7 spectral data. We used the digital elevation model (DEM) and Landsat 7 panchromatic and spectral data to map barriers to movement along the Hay River. We treated all significant rocky outcrops along the river and all escarpments exceeding 15% in slope as absolute barriers.



**Figure 1.** Landsat 7 scenes selected for use in developing a habitat (greenness) data set for the two study area south of Great Slave Lake in the Northwest Territories.



Due to the low resolution (1:250,000 scale) of the DEM this relatively low slope angle was the minimum slope value useful for defining escarpments along the Hay River. We considered all large water bodies (Slave Lake, Buffalo Lake, Slave River, and Mackenzie River) as barriers to movement except where local knowledge indicated that crossing occurs. We treated all human developments as being permeable to movement, except for highly developed residential and commercial areas in the Town of High River.

We used Entry/Exit points provided by John Nishi (Bison Biologist, Government of the NWT) for movement simulations (Figure 2). We simulated movements interchangeably using the entry and exit points; e.g. in the western study area we simulated movements from Entry 1 to Exit 5 to 12 as well as the movements from Entry 5 to 12 to Exit 1. A total of 320 pathways were calculated for the western part of the study area (red entry/exit points), and 300 pathways for the eastern section (blue entry/exit points). We tested the movement model for the Slave River Lowlands by looking at spatial correlations between the simulated movement routes and known bison water crossings on Little Buffalo River. This information was presented to us in the form of point locations and vectors representing zones of most frequent river crossings (Gates et al. 2001a). To facilitate the analysis we converted the latter to a set of points along the vectors at 500 meter intervals.

## Results

Greenness intensity maps are provided in this report for the interest of the supporting agencies (Figures 3 and 4). Greenness was one variable used in a logistic regression representing summer habitat selection by bison in WBNP. Habitat use probability was subsequently used as a variable in the movement pathway models. Results of the models are presented separately for the two study areas.

### *Slave River Lowlands*

300 movement pathways were simulated for the Slave River Lowlands between 5 evenly spaced points located on either side of the Slave River (Figure 5). Bidirectional pathways were calculated between pairs of points. Simulations indicated that the most significant movement corridors for bison across the Slave River were at the south end of Point Ennuyeuse, north of Point Brule, and at Grand Detour (Figure 5). Distances between pairs of points ranged between 59.5 km and 122.0 km (Table 1).

We tested the correspondence between water crossing locations provided from local knowledge interviews for the Little Buffalo River (Gates et al. 2001a) and crossing locations simulated using the movement model. Local knowledge was mapped as point locations on the Little Buffalo River and vectors representing areas of frequent river crossings. We converted the vectors to a set of points set at 500 meter intervals along the vectors. The median distance between the nearest movement pathway and known water crossings and vector points was 300 meters (mean = 525 meters), indicating a strong association between the two (Figure 6).

**Figure 2.** Entry and exit points used for bison movement simulations (provided by John Nishi, Resources, Wildlife and Economic Development, Government of the NWT). Points used for the western and eastern study areas are indicated in red and blue respectively.

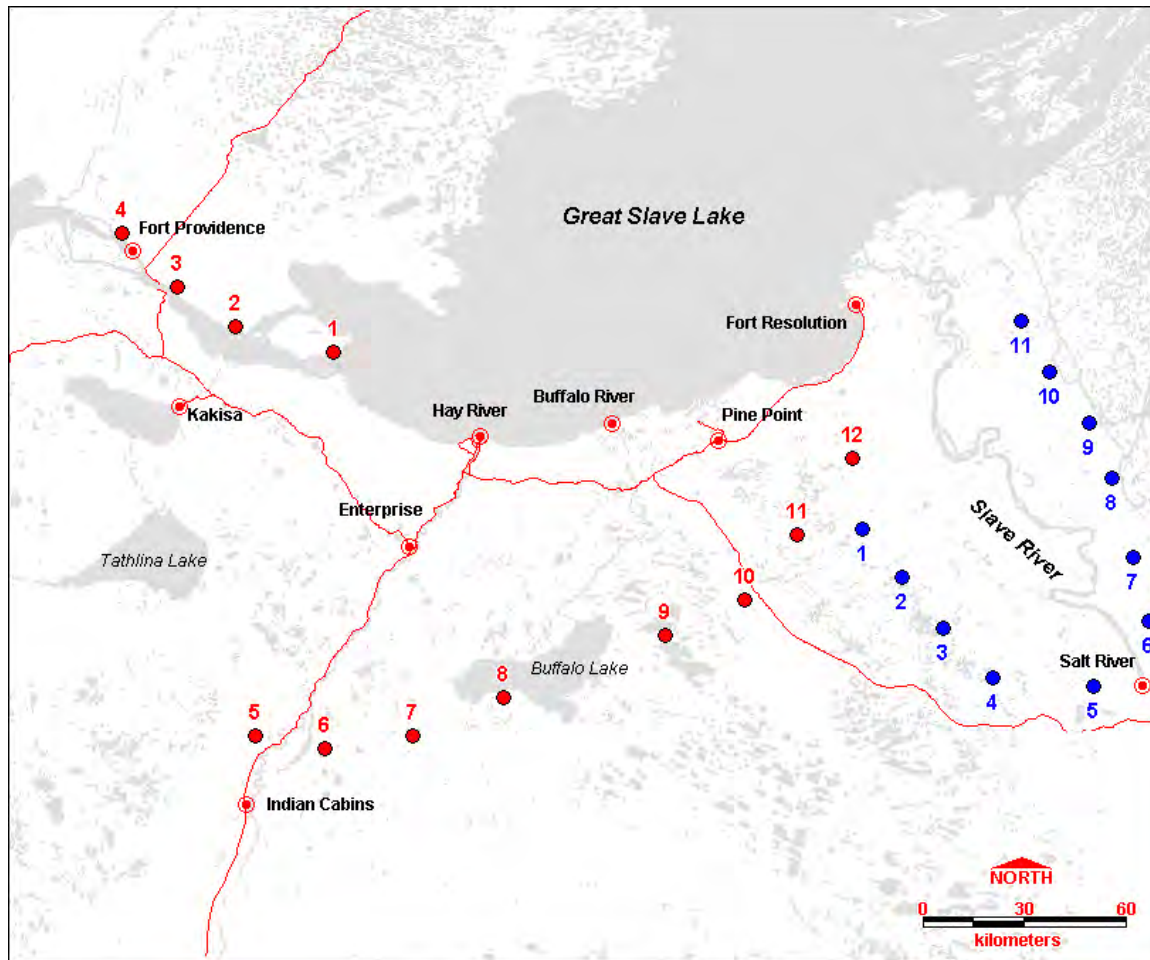




Figure 3. Map of the Slave River Lowlands illustrating 'greenness' of the landscape.



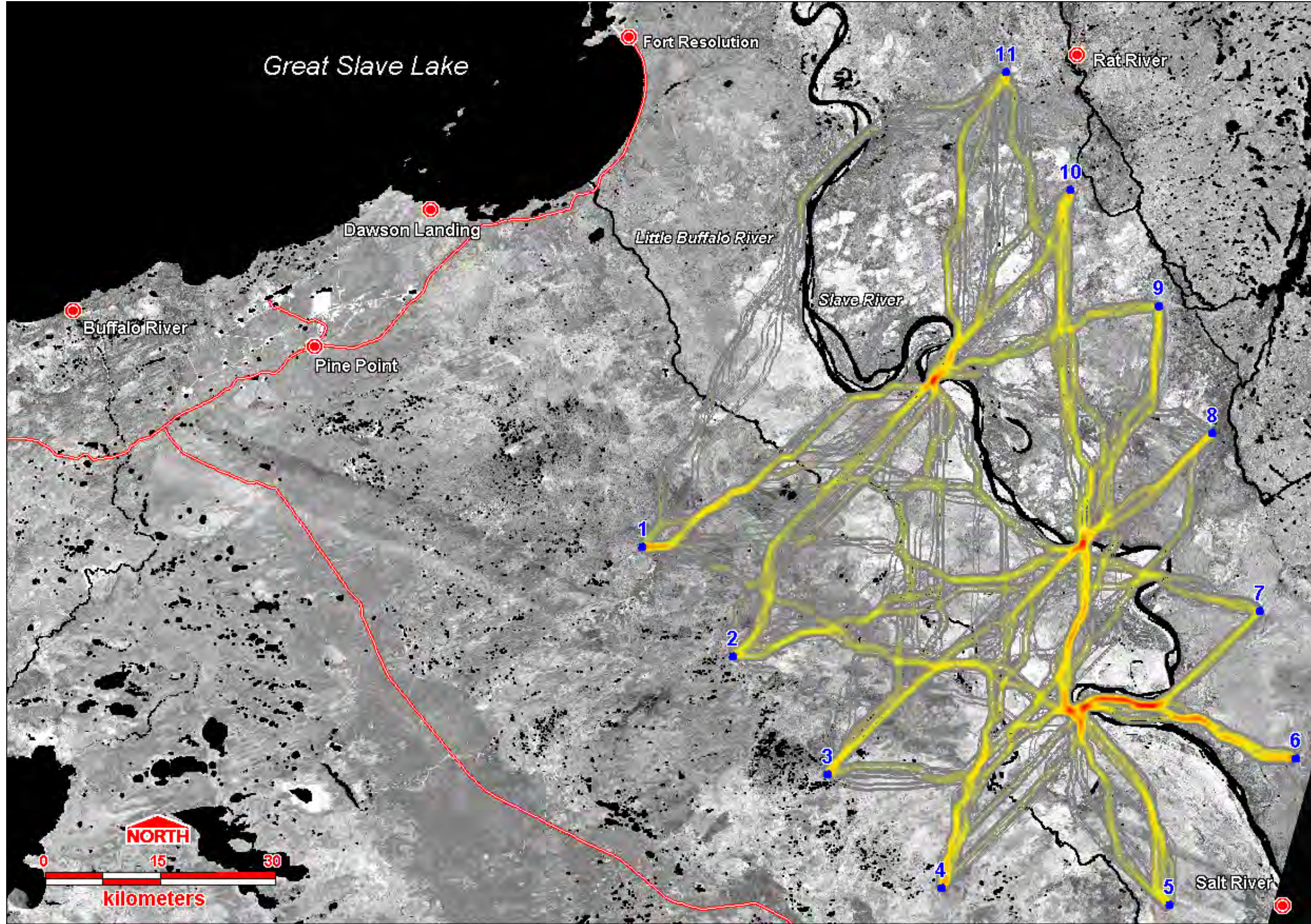


**Figure 4.** Map of the area between WBNP and the Mackenzie bison range illustrating ‘greenness’ of the landscape.





Figure 5. Simulated movement pathways in the Slave River Lowlands.





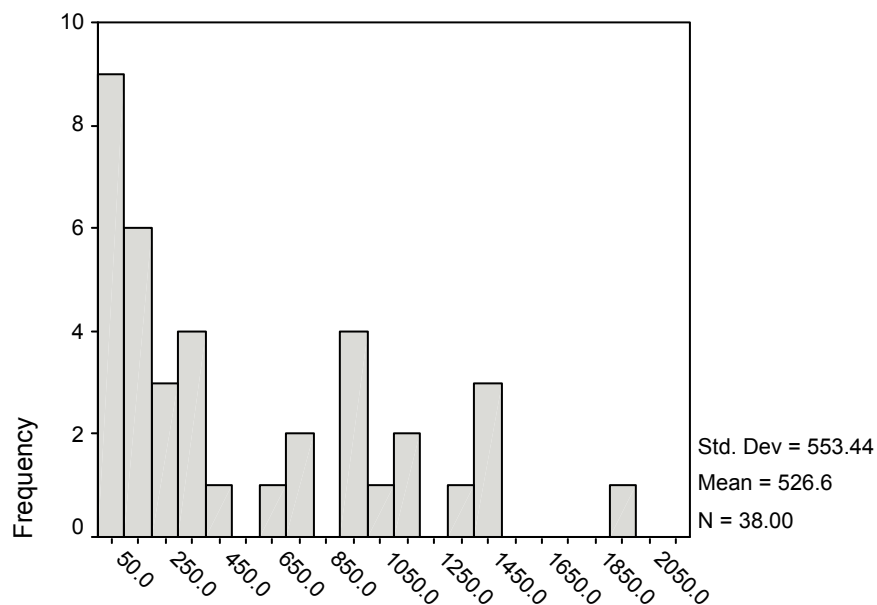
**Table 1** Mean distances along simulated movement pathways between pairs of evenly spaced points located east and west of the Slave River. Refer to Figure 2 for locations of points.

Pathway length (km) between points

Western points	Eastern Points					
	6	7	8	9	10	11
1	97.7	89.6	87.6	80.3	79.0	87.8
2	82.5	76.2	74.8	80.3	79.3	91.7
3	68.7	67.3	69.2	81.3	91.5	104.2
4	62.3	60.0	73.9	87.6	101.1	118.7
5	61.6	59.5	75.5	89.4	103.1	122.0

*Hay River Area*

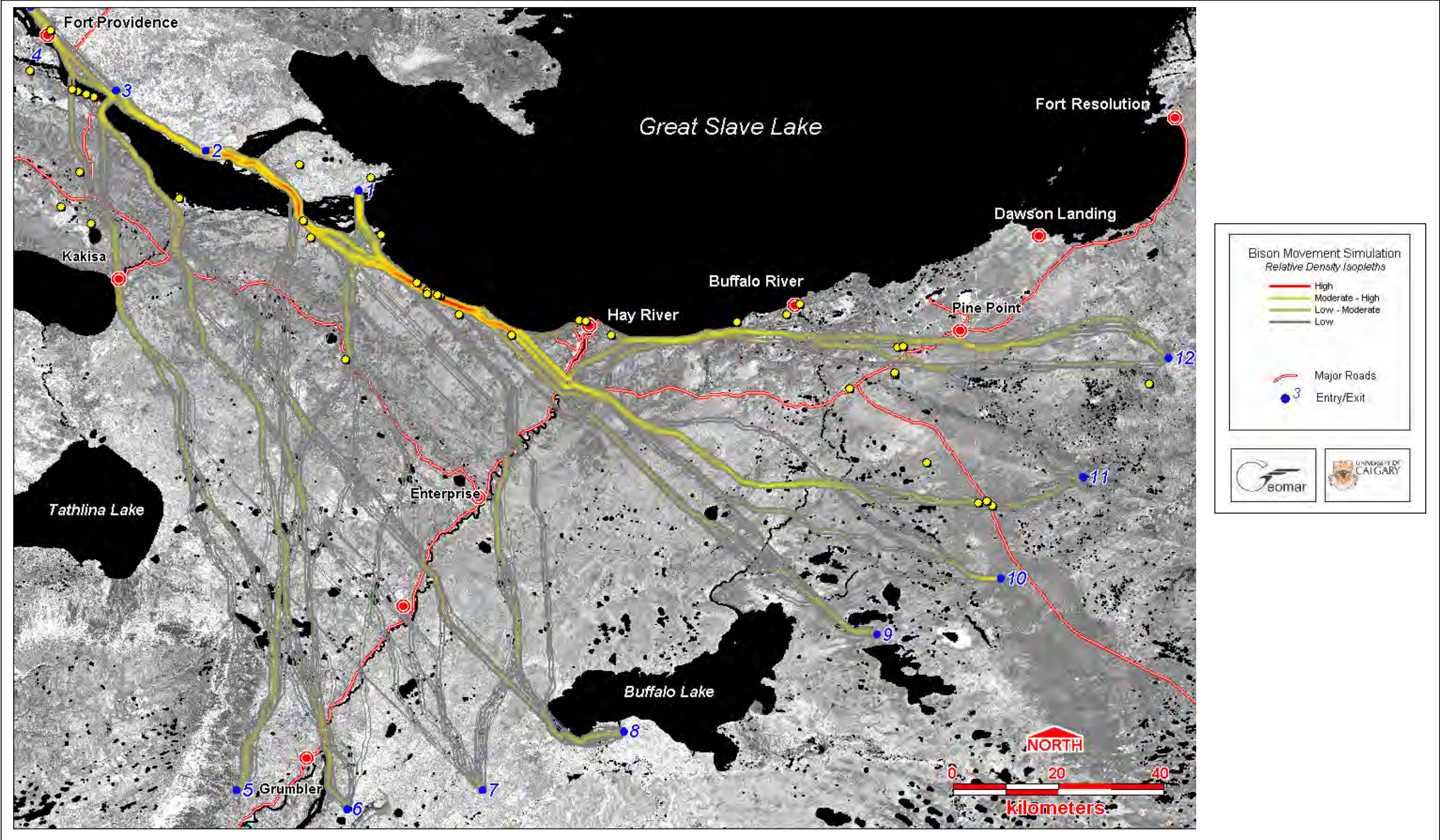
320 movement pathways were calculated between predetermined origin and destination points in the area between WBNP and the Mackenzie Bison Range (Figure 7). The highest density movement corridors were positioned along or near the shoreline of Great Slave Lake, reflecting the strong influence that this water body had on the model. Results of the movement model indicate that the area north and northwest of Buffalo Lake has biophysical features that are more favorable for movement corridors than the area southwest and west of Buffalo Lake. Distances along simulated pathways between pairs of points ranged between 125 km and 259 km (Table 2).



**Figure 6.** Frequency distribution of distances (m) between simulated movement pathways and reported crossing sites on the Little Buffalo River.



Figure 7. Simulated movement pathways in the area between WBNP and the Mackenzie bison range.





**Table 2** Mean distances along simulated movement pathways between pairs of evenly spaced points located in the northeast and southwest quadrants of the Hay River study area. Refer to Figure 2 for locations of points.

**Pathway length (km) between points**

Southwestern points	Northwestern Points			
	1	2	3	4
5	125.1	142.2	151.3	172.9
6	128.0	146.6	158.5	179.8
7	132.7	156.5	165.3	186.4
8	136.5	161.5	175.1	196.7
9	138.8	168.3	190.4	215.0
10	158.4	187.8	210.1	234.6
11	171.2	200.6	222.8	247.4
12	181.5	212.5	234.8	259.3

## Discussion

Managing the risk of transmission of bovine tuberculosis and brucellosis to disease-free recovery populations of wood bison represents one of the most significant challenges for conservation and recovery of this threatened subspecies in Canada (Gates et al. 2001b). The Mackenzie Bison population in the NWT and the Hay-Zama population in Alberta are the closest disease-free herds to known infected populations in and around WBNP and are under the greatest risk of infection. The Nahanni population is also considered to be at risk (Gates et al. 2001b). The Government of the Northwest Territories (supported by Parks Canada since 1992) has maintained an annual surveillance and depopulation program in the area between WBNP and the Mackenzie Bison Range since 1987 (Nishi 2002). The program consists of aerial surveillance during the winter and a public participation component. Public notices in various media request citizens to report any bison sighted in a large Bison Control Area. NWT wildlife regulations allow bison to be shot by eligible big game hunters at any time of year in this area.

The Bison Control Area is stratified into three surveillance zones in which winter aerial surveillance effort is differentially allocated based on empirical observations of bison and expert opinion of how bison could move between WBNP and the Mackenzie Bison Range. The density of bison in northwestern WBNP is low relative to the Mackenzie Bison Range. Since the dispersal of bison is either proportional to population size in the case of adult males, or density dependent in the case of females and juveniles (Gates and Larter 1990), the Mackenzie population represents the most likely source of bison moving into the Bison Control Area. The highest density of bison in the BCA is on the north shore of the Mackenzie River in Surveillance Zone I. The density of bison  $\leq 5$  km from the river in this area varies inversely with the fall water level in Great Slave Lake (Nishi 2002).

Results of the movement corridor analysis (Figure 7) indicate that movements of bison between WBNP and the Mackenzie Bison range are most likely to occur in the northern section of Surveillance Zone I, and that movement pathways in the remainder of the modeling area are more diffuse. Distances between the southeastern edge of the Mackenzie Bison Range at the mouth of the Mackenzie River and northwestern WBNP (136 to 168 km, Table 2) are within the 170 km dispersal range of bison proposed by Gates et al. (2001a). Based on results of the model, we suggest that while aerial surveillance of the shoreline of Great Slave Lake and the Mackenzie River in Zone I is efficient, aerial surveillance would also be wise between Buffalo Lake and Highway #5. Furthermore, given the propensity of bison to use meadows near lakes and rivers (Mitchell and Gates 2002), we suggest that aerial reconnaissance of the northwestern shore of Buffalo Lake would also be expedient. Given the diffuse nature of movement pathways throughout the remainder of the BCA, aerial surveillance at any meaningful intensity would not be an efficient use of control program resources.

In 1996, Deninu Kue First Nation, the Fort Resolution Aboriginal harvesters Association, and the Government of the Northwest Territories implemented a project to evaluate the feasibility of genetic salvage from an infected bison population (Gates et al. 1998). The project has been successful to date in creating a clean captive breeding herd, although a risk assessment is called for to define the probability of a latent infection (Nishi et al. 2002). The long term objective of the project is to make use of captive-born progeny in a reintroduction program for establishing a disease-free herd in the wild in the Slave River Lowlands. The nature of the current movement patterns and location of movement corridors in this area is therefore of interest with respect to this long term objective. There is a significant accumulation of evidence that the Hook Lake Bison Range, located east of the Slave River, is part of a metapopulation that includes sub-populations west of the Slave River, south to Lake Claire in WBNP. Calef and Van Camp (1987) provided evidence that two mature bulls tagged east of the Slave River at Hook Lake crossed over to the west side of the river. Joly and Messier (2001) documented the dispersal of two bulls among 14 radio-collared male bison in WBNP. One of them, a four-year old male that was originally collared west of Hay Camp in March 1999, was found in February of 1999 in the Hook Lake area east of WBNP, approximately 150 km from the capture site. This bull exhibited evidence of infection with bovine diseases at capture. Joly and Messier (2001) also documented the long-range movement of a two-year-old female. It was collared near Murdoch Creek in the Hay Camp region in March 1997 and was relocated alive in February 1999 near Robertson Lake in the northern region of the park, approximately 190 km from the initial capture site. Local knowledge was presented by Gates et al. (2001a, Section 2) describing movement corridors between the Peace Athabasca Delta and the Slave River Lowlands and between the Nyarling area of WBNP and the eastern Slave River Lowlands. The distances along movement pathways calculated for the Slave River Lowlands in this evaluation ranged from 59 to 122 km, and are well within the documented dispersal range of bison in the region. Furthermore, local knowledge documented in Gates et al. (2001a) identified crossing locations on the Slave River in four areas including Grand Detour, Point Brule, south end of Point Ennuyeuse, and another site in the northern reaches of the Slave River. We conclude that the Hook

Lake bison population is not isolated from sub-populations west of the river, including WBNP sub-populations.

Although there may be an interest in depopulating the Hook Lake Bison Range and reintroducing stock from the captive breeding herd, the new herd would be at extreme risk of becoming infected under current conditions. Construction of bison proof fences in low areas and at known crossing sites on the east bank of the Slave River represents a possible means to prevent bison from crossing the river and isolating the Hook Lake area from infected bison. However, the feasibility and cost of isolation fencing would have to be considered relative to more comprehensive regional approaches to disease eradication and larger scale reestablishment of disease free populations. To achieve the long-term goals of the Hook Lake Wood Bison Recovery Program, cooperation will be needed between the local communities and government and non-government stakeholders at the territorial, regional and national levels. A coordinated, broadly supported regional plan is required for disease eradication and recovery of healthy wild wood bison populations.

## **Acknowledgements**

We acknowledge logistic support, data, advice, and information provided by John Nishi and Troy Ellsworth (Wildlife and Fisheries Division) and David Taylor and Helmut Epp (Remote Sensing Division) of The NWT Department of Wildlife, Resources & Economic Development. We would also like to thank our funding partners for supporting this project: the Government of the Northwest Territories Department of Resources Wildlife & Economic Development, Parks Canada Agency (Wood Buffalo National Park), the Canadian Bison Association, the Margaret Gunn Endowment for Animal Research, the University of Calgary Faculty of Environmental Design, the Government of Alberta, Canadian Cattlemen's Association, Alberta Cattle Commission, Peace Country Bison Association, and the Alberta Bison Association.

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