A COMPARATIVE ASSESSMENT OF MANAGEMENT PROBLEMS ASSOCIATED WITH THE FREE-ROAMING BISON IN PRINCE ALBERT NATIONAL PARK

by

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Fulfilment of the Requirements for
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- Nursing 0569
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- Pathology 0571
- Pharmacology 0419
- Pharmacy 0572
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- Radiology 0574
- Recreation 0575
- Speech Pathology 0460
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Home Economics 0386

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- Inorganic 0488
- Nuclear 0738
- Organic 0490
- Pharmaceutical 0491
- Physical 0494
- Polymer 0495
- Radiation 0754

Mathematics 0405
Physics
- General 0605
- Acoustics 0986
- Astronomy and Astrophysics 0606
- Atmospheric Science 0608
- Atomic 0748
- Electronics and Electricity 0607
- Elementary Particles and High Energy 0798
- Fluid and Plasma 0759
- Molecular 0609
- Nuclear 0610
- Optics 0752
- Radiation 0756
- Solid State 0611

Statistics 0463

Applied Sciences

Applied Mechanics 0346
Computer Science 0984
Engineering
- General 0537
- Aerospace 0538
- Agricultural 0539
- Automotive 0540
- Biomedical 0541
- Chemical 0542
- Civil 0543
- Electronics and Electrical 0544
- Heat and Thermodynamics 0348
- Hydraulic 0545
- Industrial 0546
- Marine 0547
- Materials Science 0794
- Mechanical 0548
- Metallurgy 0743
- Mining 0551
- Nuclear 0552
- Packaging 0549
- Petroleum 0765
- Sanitary and Municipal 0554
- System Science 0790

Geotechnology 0428
Operations Research 0796
Plastics Technology 0795
Textile Technology 0994

PSYCHOLOGY

General 0621
Behavioral 0384
Clinical 0622
Developmental 0620
Experimental 0623
Industrial 0624
Personality 0625
Physiological 0989
Psychobiology 0349
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Social 0451

A COMPARATIVE ASSESSMENT OF MANAGEMENT PROBLEMS ASSOCIATED WITH THE FREE-ROAMING BISON IN PRINCE ALBERT NATIONAL PARK

A practicum submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of Master of Natural Resources Management.

By

Mr. Douglas Bergeson

ABSTRACT

Plains bison (Bison bison) have once again become part of the Prince Albert National Park (PANP) regional ecosystem. Bison were released north of PANP in 1969 by the Saskatchewan Department of Natural Resources (SDNR) with the purpose of establishing a free-roaming herd in the area. However the bison migrated south and a few animals found there way into the southwest corner of PANP. These animals formed the nucleus for the present herd of approximately 70 animals. This herd is unique in that it is the only free-roaming plains bison herd in a Canadian National Park and only one of three in all of Canada. While the bison have filled a missing link in the ecosystem they have also added to the resource management problem of depredation on adjacent agricultural lands. As the herd size increases so does the number of bison that migrate out of the park and onto adjacent landowner's properties.

Landowners adjacent to PANP along the west boundary were distributed a questionnaire and interviewed to determine their concerns with the bison herd. Most of the landowners experienced bison on their property, however, only 36% of the landowners experience bison on their property nearly every year. It is these landowners who feel there may need to be some future active management to reduce bison occurrences on their properties. Types of damage caused by the bison while

on landowner's properties included; crop and hayfield damage from bison trampling, grazing and wallowing. However landowners considered the most serious form of damage was to their fences. Overall the landowners had a positive attitude toward the bison herd.

Past and present management programs of Wood Buffalo National Park, the Mackenzie Bison Sanctuary and Yellowstone National Park were reviewed to gain an understanding of management problems associated with free-roaming bison.

Ecological management considerations examined were: historical evidence of bison in the PANP region; mortalities; rate of herd growth; age and sex structure of the herd; preferred bison habitat within PANP; interspecific competition and general herd behavior.

Attempts to minimize bison conflicts with adjacent landowners included herding bison off their properties and constructing short fences at known crossing areas. The bison were easily herded into the park but the fences only resulted in the bison crossing elsewhere.

It was recommended that the free-roaming bison be allowed to continue to be part of the ecological integrity of the PANP area and that preservation of the herd take precedence in management. It was also recommended that the CPS initiate discussions with the SDNR, local landowners and local native groups to establish common, short and long term goals for the herd within the region.

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CONTENTS

LIST OF TABLES

List of Figures

CHAPTER I

INTRODUCTION

1.1 Background

Prince Albert National Park (PANP)*, established in 1927, is located 65 km north of Prince Albert in central Saskatchewan (Fig. 1). The park covers an area of 3,874 square km and extends 80 km north to south, and 50 km east to west. A significant feature of PANP is its ecological diversity, due to its location in a transitional zone between aspen groveland and boreal forest. Padbury et al. (1978) states that apart from a small section of grassland along the southern edge, the vegetation of PANP is typical of that found in the mixed wood section of a boreal forest. In addition, PANP has a variety of ungulate species such as elk (Cervus elaphus), moose (Alces alces), mule deer (Odocoileus hemionus), white-tailed deer (Odocoileus virginianus), caribou (Rangifer tarandus) and most recently, the plains bison (Bison bison bison).

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* Acronyms used in practicum:

CPS (Canadian Parks Service); DNA (Deoxyribonucleic Acid); EINP (Elk Island National Park); MBS (Mackenzie Bison Sanctuary); MDNR (Manitoba Department of Natural Resources); NWT (Northwest Territories); PANP (Prince Albert National Park); RMNP (Riding Mountain National Park); SDNR (Saskatchewan Department of Natural Resources); SPRR (Saskatchewan Parks and Renewable Resources); SRL (Slave River Lowlands); WBNP (Wood Buffalo National Park); and YNP (Yellowstone National Park).

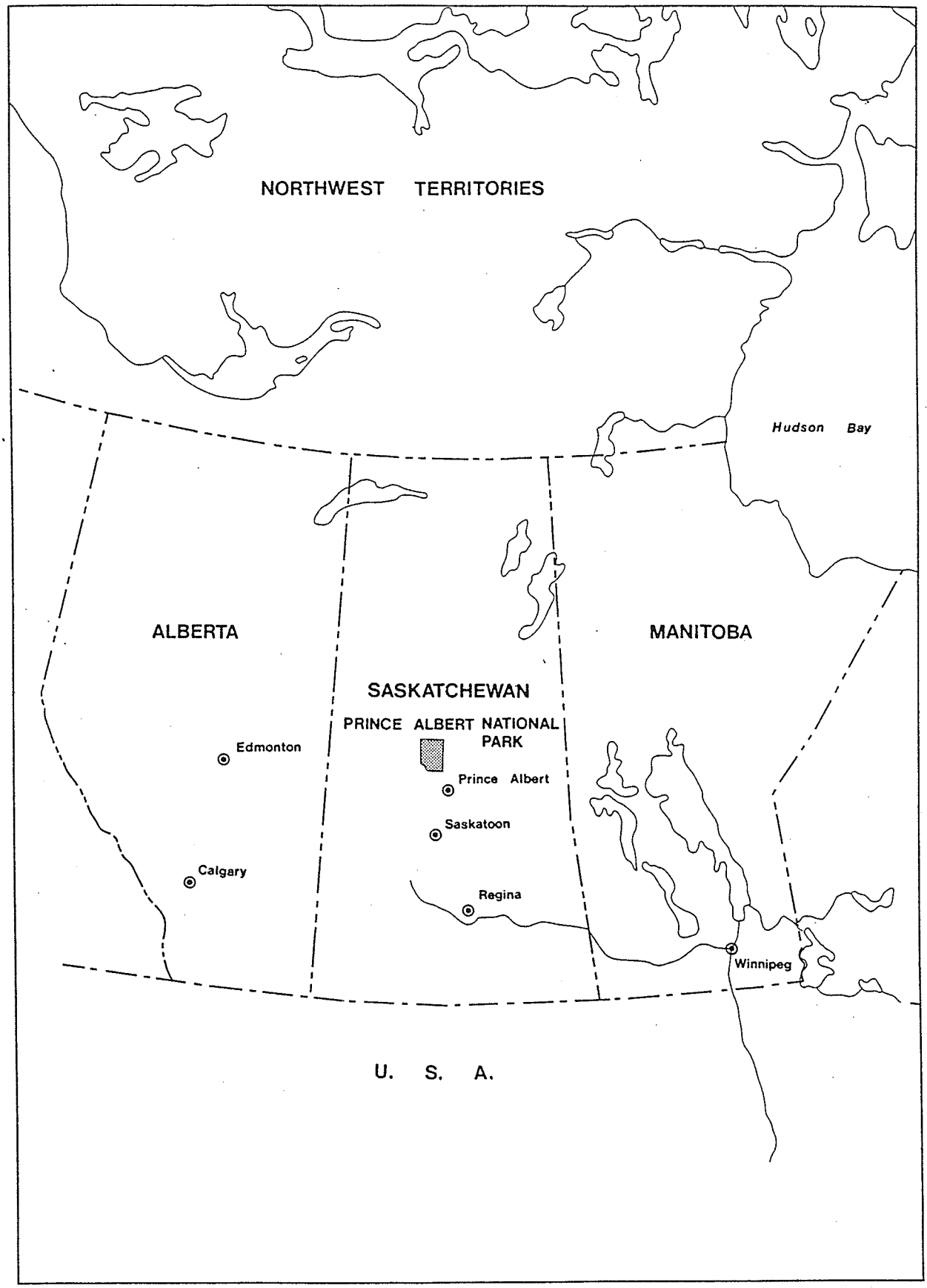


Figure 1: Location of Prince Albert National Park (PANP).

There are few areas south of the boreal forest that remain suitable range for reintroductions of free-roaming bison. Some areas that are available are not feasible due to conflicting land uses, namely agricultural production. Depredation by wildlife on agricultural land began when early settlers transformed wildlife habitat into cultivated fields. Settlers decided governments would be responsible for wildlife management (Purdy 1987) thus creating the paradox of private land and public wildlife. This is a unique situation in which private land supports wildlife, yet wildlife is considered a public resource. Landowners benefit from transforming wildlife habitat into agricultural production at the expense of the wildlife resource owned by society. However, landowners must also absorb most of the costs and in many cases, raise wildlife for the benefit of society (Colpitts 1974).

Plains bison, once the dominant herbivore on the Great Plains of North America, were reduced to near extinction by the turn of the century (Roe 1970). It was mainly through the initiative of the Canadian Government that steps were taken to re-introduce the plains bison onto Canadian public lands (Ogilvie 1979). In 1988 there were just over 1100 plains bison (Reynolds 1991) on government-owned lands in Canada. To date, plains bison have not been considered by the Committee on the Status of Endangered Wildlife in Canada (Shoesmith pers. comm. 1992). Novakowski (1989) states the reason plains

bison have not been considered and classified as threatened, is due to the fact that a large number of plains bison currently exist on private ranches throughout western Canada and the United States.

Free-roaming plains bison in Canada occur in three separate herds and number approximately 700 (Reynolds 1989). The largest herd estimated at 600 (Gates pers. comm. 1990), is located on provincially-owned land in the Pink Mountain area of northern British Columbia (Fig. 2).

The Pink Mountain herd originated in 1971 when a rancher purchased 47 plains bison from Elk Island National Park (EINP). The bison subsequently escaped confinement and dispersed onto provincially owned crown lands. The Pink Mountain herd now occupies an area which falls within the historic range of the wood bison (Bison bison athabascae) (van Zyll de Jong 1989) and is considered by some to be a hinderance to transplants of wood bison in northern British Columbia and Alberta (van Zyll de Jong 1989). This herd may disperse northward as it increases in size. Eventually the herd may come into contact with wood bison from the Nahanni transplant (Fig. 2) (Reynolds 1982). Consequently the Pink Mountain herd's future is somewhat uncertain (van Zyll de Jong 1989). Reynolds (1989) also states that the Pink Mountain herd's future is not secure and therefore should not be included in a future plains bison conservation strategy for Canada until its continued existence becomes certain.

The remaining two free-roaming plains bison herds are located in Saskatchewan and are remnants of a transplant that took place in 1969. In 1968 a request for 50 surplus plains bison was made by the Saskatchewan Department of Natural Resources (SDNR) to EINP. The main purpose of this request was to establish a free-roaming herd of bison which would provide local native bands with an additional meat source. The request was granted and in January of 1969, 50 plains bison were released approximately 60 km north of PANP (Novakowski 1989) (Fig. 3). The release labelled Project Bison received a great deal of local attention and more than 300 people from the surrounding communities came to observe this historic event (Barrie 1969). The provincial Minister of Natural Resources declared that this bison release would be a great milestone for native people in the Montreal Lake area and people in attendance will always remember this day (Barrie 1969). However, the hope of viewing free-roaming wild bison near the release site quickly vanished as it soon became apparent the bison would not remain in the area, as they dispersed southward (Saskatchewan Department of Natural Resources 1969). By June of 1969, bison were observed north of the forks of the Saskatchewan Rivers, near the town of Big River and within PANP. The bison near Big River quickly became a nuisance to local landowners and villagers so in June of 1969, 17 bison were rounded up into the holding corrals at the Big River Community Pasture (Panter pers. comm. 1990).

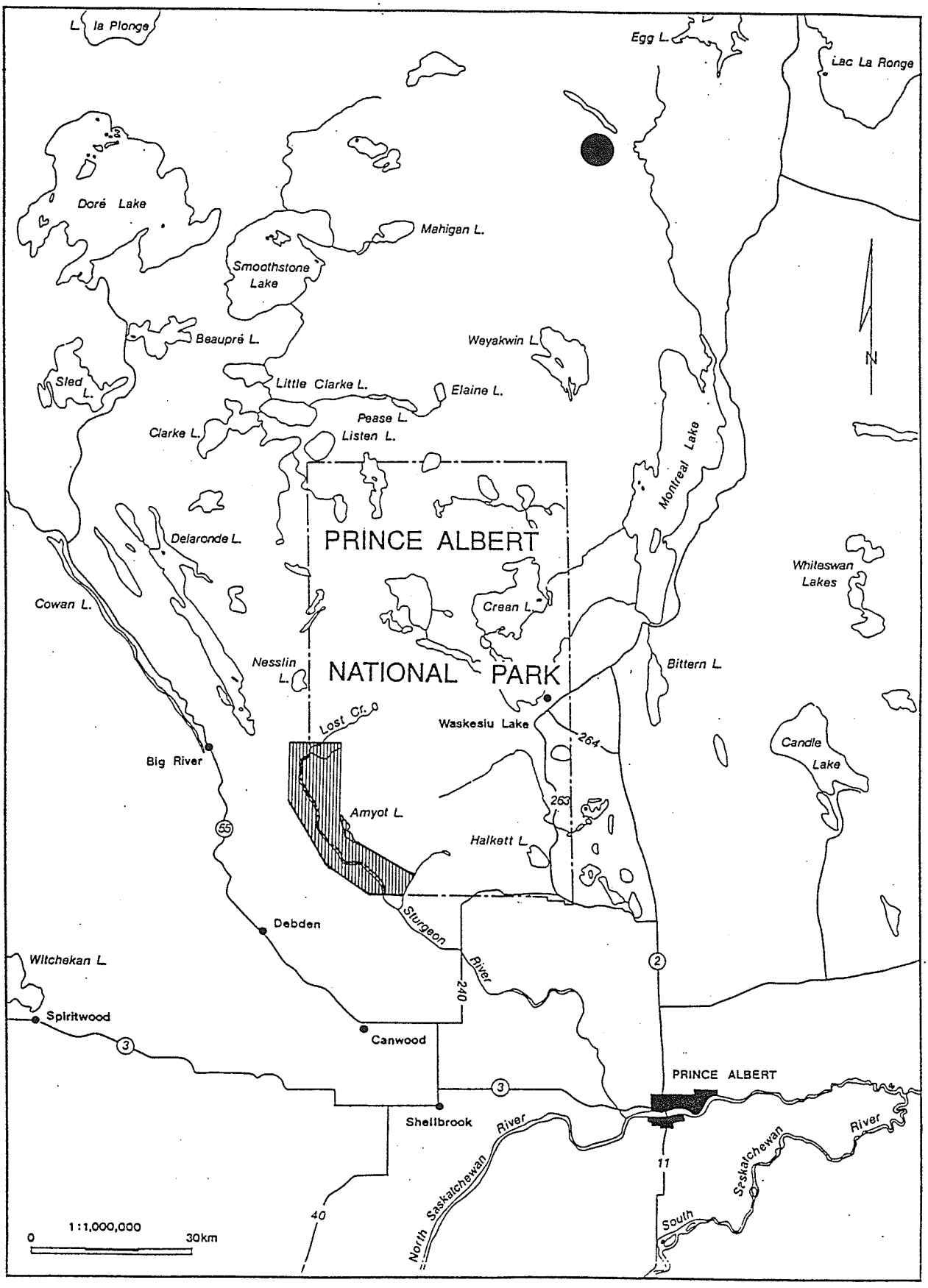


Figure 3: Study area. Location of 1969 release.

These bison were transported north to an area near Vermette Lake just north of Primrose Air Weapons Range (Runge pers. comm. 1991). Another herd of 14 bison were rounded up east of the city of Prince Albert and relocated to the Cumberland Delta (Saskatchewan Department of Natural Resources 1969). Six bison found near Melfort were relocated to the Carrot River area. A bull and cow were reported to have been shot not far from Fort a la Corne (Minton and Schmidt 1984). The following August, one bull was discovered to have travelled the entire 600 km back to EINP. Attempts to capture the animal were unsuccessful and the bull was destroyed. Observation of the carcass, indicated the bull had previously been shot and its neck was raw from going through barbed wire fences (Novakowski 1989). The fate of the remaining ten original transplant bison is unknown.

There have been suggestions offered to explain why the bison did not remain near the original release site. One argument put forward by the SDNR (1969) was that the bison were young (all under four years) and lacked older bison to act as herd leaders, so the entire herd dispersed in small groups and in several directions. Novakowski (1989) suggested the terrain near the release site was not suitable for bison and they dispersed southward in search of better habitat. Two herds survived the original transplant; one is located in the Primrose Air Weapons Range and the other is located in PANP (Fig. 2).

In 1988, an aerial survey of the Primrose site revealed 17 bulls in the area (Runge pers. comm. 1991). Based on survey results and knowledge of the area, Runge estimated 25 cows to be in the vicinity resulting in a possible total of 42 bison. Nevertheless, he concluded that due to marginal bison habitat and the presence of hunting, the chance for long term survival of this herd is not favourable.

In 1969, approximately four bison took up residence in the southwest corner of PANP. Since that time the herd has slowly increased to the present-day estimate of 70 bison (personal observations). The free-roaming bison herd in PANP is the only free-roaming plains bison herd in a Canadian National Park. Wild plains bison have ecological, cultural and spiritual importance to Canadians and are an integral part of the Canadian identity. Plains bison being a major herbivore represent a missing link in PANP's regional ecosystem.

While the free-roaming bison have been a welcome addition to PANP, they have added to the resource management problems of the park, through conflicts with adjacent landowners, namely, depredation to landowner's crops and hay fields as well as causing damage to their fences.

1.2 Problem Statement

The main objective for PANP within the National Parks system is to offer protection for its wilderness area which is

representative of the Southern Boreal Plains and Plateau Region of Canada, and to allow present and future generations to understand and appreciate the park's resources (Canadian Parks Service 1987a). This includes protection of the habitat of the significant wildlife species located within the park, (including pelicans Pelecanus erythrorhynchos), caribou and bison), as well as protection of the representative species of the boreal forest (Canadian Parks Service 1987a).

Prince Albert National Parks's Conservation Plan (1987) states that the resource management objective for the free-roaming bison is "to preserve free-roaming plains bison in a natural state, within PANP, so as to minimize bison/human/agriculture conflicts" (Canadian Parks Service 1987b). The management problem associated with the free-roaming bison is not complex, as the herd increases so do the number of bison which migrate onto adjacent agricultural lands, resulting in damage to crops and fences.

1.3 Study Objectives

The purpose of this study was to provide detailed information on the management problems associated with the free-roaming bison herd located in PANP. Recommendations were made to aid resource managers in decision making.

Specific study objectives included:

1) identify landowner concerns and describe the existing conflicts with regard to the presence of a free-roaming

bison herd adjacent to agricultural lands;

2) identify and describe various ecological management considerations of the PANP free-roaming bison herd; and

3) make recommendations for future management of the free-roaming bison herd.

1.4 Study Limitations

This study was confined to a relatively small area and results will only be applicable within this area. This study was species specific, and problem wildlife situations which involve other species may yield quite different results. Specific limitations include:

1) bison observations were predominantly confined to well-used trails and roadways, hence habitat utilization in these areas is over-represented. In addition field work for this study was solely conducted during the summer months therefore identification and descriptions of winter habitat and range was not attempted;

2) a linear regression model was used to predict herd growth. However, the number of bison on any given year will affect the number of bison in the following year thus a basic rule of the model was violated, the rule of independence. As a result confidence intervals were not used. In addition the regression model does not take into account external factors such as predation, hunting, poaching, accidents, or fire, all of which may have an

impact on future herd numbers. Therefore the predictions of future population numbers based on the regression model are at best, an educated guess and should be used by resource managers as a general guide.

1.5 Summary of Relevant Acts, Policies, and Directives

1.5.1 Canadian Parks Service

The National Park's Act (Canadian Parks Service 1990a) states that the maintenance of ecological integrity through the protection of natural resources shall be given utmost priority. Within the Act bison fall into (Part II of Schedule II) and are classified as protected. Anyone found guilty of poaching or in possession of a bison, or parts of, within a National Park or outside of a National Park that was found to have been killed within a National Park faces a maximum penalty of $10,000, six months in jail or both (Canadian Parks Service 1990a).

Ideally, within a National Park, attainment of resource management goals would not involve manipulative management. However, as stated in Canadian Parks Service (CPS) policy there are certain conditions when manipulation of resources may be required, such as:

> "1) the existence of the potential for adverse effects on neighbouring lands and/or existing infrastructure;
> 2) to maintain or perpetuate rare and endangered species, critical wildlife habitats or features of special interest;
> 3) public safety and enforcement concerns" (Canadian Parks Service 1987a).

Maintaining positive relations with adjacent landowners is also part of the CPS's policy which states:

> "Parks Canada will seek to integrate elements with surrounding regions so as to have a positive social,physical and economic impact... and will accomplish this by acting in a manner which is sensitive to local concerns and with other government agencies. Local communities and local citizens cannot be asked to bear a disproportionate share of the cost of preserving and protecting the national heritage of all Canadians" (Parks Canada 1980a).

Natural resource management within National Parks involves specific activities that result in the understanding and maintenance of ecological integrity or the modification of biotic or abiotic resources to achieve approved objectives (Canadian Parks Service 1990b). The Natural Resource Management Process is a framework for information collection, setting of objectives, problem identification, establishing management strategies necessary to manage natural resources and maintaining ecological integrity within National Parks (Canadian Parks Service 1990b). The Natural Resource Management Process consists of a number of interrelated steps (Fig. 4). This resource management study is a specific, finite project designed to provide detailed information necessary to solve a resource concern and meet a stated objective of the Park Conservation Plan (Canadian Parks Service 1990b).

While the CPS does not have a specific policy or management directive which relates to accidental reintroductions, there is a directive that deals with the

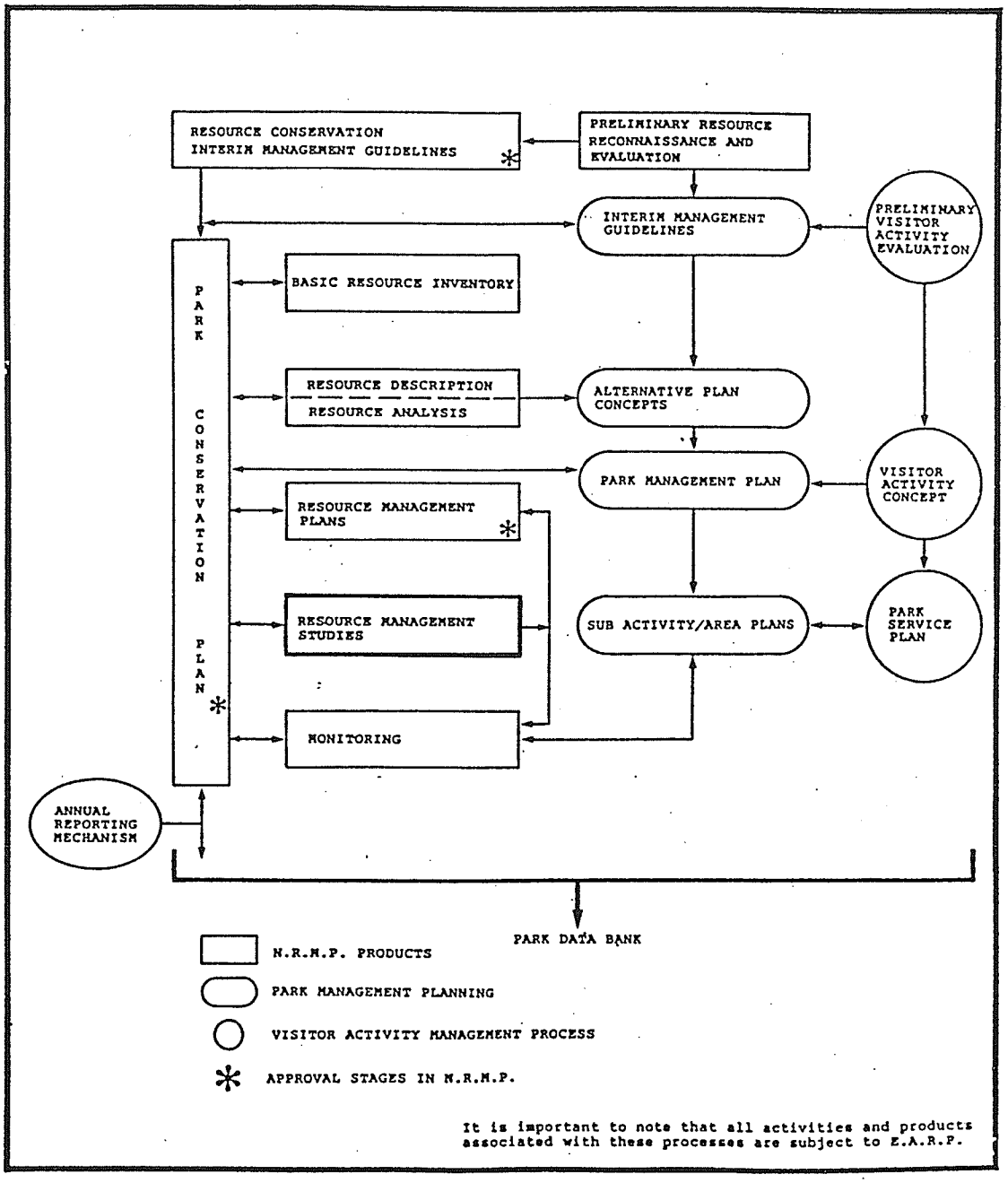


Figure 4: Natural resource planning process for National Parks (from Canadian Parks Service 1990b).

reintroduction of native species into a National Park (Parks Canada 1971). The directive states that a native species is one which is considered to be indigenous to the area, and reintroduction is defined as a release of native wildlife for the purpose of establishing a viable population. The conditions which must be considered prior to any reintroduction include: the effects of the introduced species on other plants and wildlife; is reintroduction compatible with park objectives; and does reintroduction pose a serious threat for adjacent land uses. In addition, any introduced species must be thoroughly inspected for disease prior to release (Parks Canada 1971). If the free-roaming bison in PANP were part of a reintroduction program the above criteria would have been satisfied except for potential adverse effects on adjacent land uses.

Canadian National Parks have a system of zoning whereby land use within a National Park is organized in accordance to its ability to support certain types of activities (Parks Canada 1980a). The Management Plan for PANP (Parks Canada 1980b) identifies five zones ranging from special preservation zones which require a maximum amount of protection, to service zones where development attempts to meet the basic needs of visitors (Parks Canada 1980b).

All management activities, plans, or developments within a National Park are subject to the Environmental Assessment Review Process to ensure that environmental concerns are taken

into consideration early in the decision-making process (Parks Canada 1980a). Environmental assessments occur on all projects which may have an adverse effect on the environment prior to the making of any financial commitments or irrevocable decisions. The CPS will conduct environmental screening reports on projects and those projects with significant effects are submitted to the Federal Environmental Assessment Review Office to undertake formal review.

1.5.2 Saskatchewan Department of Natural Resources

In Saskatchewan, bison are classified as both domestic and big game. In addition free-roaming bison have been placed in the category of threatened wildlife. Which means any management, enforcement or research which will directly protect or increase populations will be given priority (Saskatchewan Parks and Renewable Resources 1987). Currently no open hunting season exists for bison in Saskatchewan (Saskatchewan Tourism and Renewable Resources 1981). However, treaty natives can legally hunt bison on unoccupied crown land or on private land with the permission of the landowner (Kowal pers. comm. 1991).

1.6 Study Area

The study area includes the summer range of the bison herd located in PANP as well as adjacent private lands and provincial crown land which border on the Sturgeon River along the southwest corner of the park (Fig. 3). The entire study

area comprises approximately 150 square km within the mixed-wood section typical of the boreal forest region. The upland areas are dominated by white spruce (Picea glauca), trembling aspen (Populus tremuloides), jack pine (Pinus banksiana), with lesser amounts of white birch (Betula papryfiera), balsam poplar (Populus balsamifera), black spruce (Picea mariana) and balsam fir (Abies balsamea). The lowlands and depressional areas support tamarack (Larix laracina), black spruce, and various shrub, grass and sedge communities (Padbury et al. 1978).

Lands adjacent to the Sturgeon River within the study area are primarily under some type of agricultural production. Lands to the southeast include a Wildlife Management Unit and a community pasture. The area to the northwest of the study area encompasses the southern portion of the Northern Provincial Forest. This area adjacent to the park is presently under forestry production. The study area falls within the physiographic division called the Saskatchewan River Plain. Within the Saskatchewan River Plain there is a subsection labelled the Debden Plain. The Debden Plain consists of an almost level to gentle-sloping glacial till plain which parallels the Sturgeon River in the southwest corner of the park. The slope varies between 0.05% and 9.0% and is drained primarily by the Sturgeon River which flows into the North Saskatchewan River. Average annual rainfall for the area ranges from 400-500 mm, with approximately 60% of

this occurring as rain during the summer (Padbury et al. 1978).

The study area within the park occurs in three park management zones. The south-east portion of the study area falls within zone one, classified as special preservation area due to the remnant fescue grassland. Park policy describes zone one areas as deserving special attention because they contain unique, rare or endangered features, or are the best examples of a park's representative natural features. Access to these areas is tightly controlled and may be prohibited altogether. Motorized access or person-made facilities are not permitted.

The largest section of the study area falls into zone two, wilderness areas. These zones are typified by large areas representing the natural history themes of the park and are to be maintained in a wilderness state. Only activities which necessitate primitive facilities for visitors which are appropriate to a wilderness experience are permitted. There are limits placed on the number of users in this zone, and motorized access is prohibited. Management actions in these areas are to be developed to ensure visitors are dispersed as these areas contain the wilderness resources which are fundamental to the park's character and its management.

Dissecting the study area within the park is a travel corridor known as the West Side Road on which public use is presently prohibited. The road falls into zone three, natural

environment. This zone is to be maintained as a natural environment which can sustain a minimum of impairment with a suitable range of low density outdoor activities and related facilities. Non-motorized access is preferred, but access by public transit may be permitted. The intent of this zone is to provide appreciation and enjoyment of park resources through participation in appropriate outdoor recreational opportunities, while maintaining the individual character of the park (Canadian Parks Service 1987a).

CHAPTER II

METHODS

2.1 Landowners

Landowner concerns and types of bison conflict were identified through:

1) a written questionnaire mailed to each landowner in the study area;

2) personal interviews with each of the landowners;

3) discussions with local and regional Saskatchewan Parks and Renewable Resources (SPRR) personnel as well as with past and present CPS personnel;

4) a review of Warden Service Occurrence Reports; and

5) personal observations.

The questionnaire (Appendix 1) was an open-ended design, which encouraged individuals to give their thoughts or opinions rather than answer questions by selecting one of several specific alternatives (Reber 1985). The issues addressed in the questionnaire were formulated through discussions with practicum committee members. A complete list of landowners adjacent to the Sturgeon River along PANP's southwest boundary was attained and landowners with properties adjacent to the park or who were known to have bison on their land, were selected.

The questions asked during each interview (Appendix 2) were designed to promote discussion with landowners. This

allowed the author to gain a greater sense of landowner's concerns and an overall impression of his/her attitude toward the bison. Upon completion of the interview, questionnaires were collected and landowners were given a small information package on bison which included a PANP bison lapel pin as a token of appreciation. Landowners were also mailed thank-you cards for participating in the study.

2.2 Ecological Management Considerations

Various ecological management concerns were identified through:

1) a literature review, focusing on free-roaming bison in Wood Buffalo National Park (WBNP), the Mackenzie Bison Sanctuary (MBS), and Yellowstone National Park (YNP);

2) discussion with resource managers of the above bison herds;

3) visitation to WBNP, and YNP; and

4) personal observation of the PANP free-roaming bison herd over three summers (1989-1991), including random aerial surveys over known bison range, and a review of historical data on the herd.

Through discussion with practicum committee members, ecological factors deemed important were: 1) historical evidence of bison within the study area; 2) mortalities; 3) growth rate of the herd and growth predictions using regression analysis; 4) herd structure, interspecific

competition and general herd behavior; 5) preferred bison habitat within PANP and distribution throughout the park; and 6) summer range of the herd.

2.2.1 Historical Evidence

Three bison skulls were collected from adjacent landowners who had unearthed them during plowing. These skulls were subsequently forwarded to Dr. van Zyll de Jong at the Canadian Museum of Nature to be measured and evaluated for their sub-species designation.

2.2.2 Mortality

Mortality was determined through examination of bison carcasses, as well as site investigation of the area where the carcasses were found. One calf carcass was located as well as skeletal remains of a yearling-juvenile and an adult. The calf carcass and a femur bone of the yearling-juvenile bison were collected and shipped to the College of Veterinary Medicine in Saskatoon to determine cause of death and health status prior to death. The carcass was also tested for disease. The age of the adult, and the yearling-juvenile was determined through cementum analysis of their primary incisors conducted by Matson's Laboratory in Montana.

2.2.3 Rate of Growth

The annual rate of population growth was determined through total observed counts from random aerial surveys using an Aerospatiale Astar helicopter. The survey procedure included searching meadows and grasslands which bison were

known to inhabit. Flights occurred throughout the summer months. The average finite rate of growth (e^r) was found by dividing successive total counts from the three years and then averaging them. This was expressed as a percentage. Exponential rate of increase (r) was calculated by converting the average finite rate of increase using the formula ($\log_e e^r = r$).

Regression analysis was calculated using Kwikstat Statistical Package (Texas Mission Software Technologies 1989). Actual observed values of herd growth from 1970-1991 were compared with values of a natural log (ln) regression equation which correlated bison abundance and time. In addition, predictions for estimation of herd growth (1992-2001) were calculated using the values of the regression equation.

2.2.4 Structure, Interspecific Competition, and Behavior

Herd structure, interspecific competition, and behavior were determined through visual observations on the ground, from the air, and photographs. Bison were classified into age classes based on animal size, color, and horn growth.

2.2.5 Habitat

Preferred bison habitat type, within PANP, was determined through visual observations of foraging bison. Habitat distribution was determined through analysis of PANP's biophysical inventory (Padbury et al. 1978).

Padbury et al. (1978) defined a plant community as an

assemblage of plants having similar structure and composition, and classified PANP plant communities into four categories; forest, shrub, grass/sedge and miscellaneous areas. Padbury et al. (1978) also classified plant communities with regard to how abundant the plant community was in a given area. This study concentrated on dominant plant communities. Dominant plant communities were considered to occupy 40% or more of an area. For the purposes of this study only plant communities the author thought were utilized in the bison's diet were selected: the sedge community (Carex), the grass communities (Elymus,Agropyron) and (Festuca,Stipa), and one shrub community the willow-sedge (Salix/Carex). The author categorized the plant communities into two divisions, primary and secondary bison habitat. Primary habitat was classified as those plant communities made up of sedges and grasses namely (Carex), (Elymus,Agropyron) and (Festuca,Stipa) communities. While secondary habitat was classified as plant communities that contain willow and sedge namely (Salix/Carex). Outside the park, habitat was determined from discussions with landowners, and from provincial government personnel forestry branch, and PANP's Resource Description and Analysis.

2.2.6 Range

Summer range was determined by plotting both ground and aerial observations onto topographic maps. Figures were then produced indicating the main herd's summer range as well as

areas where lone bulls were observed exclusively.

2.3 Migratory Deterrents

In an attempt to reduce the number of occasions and severity of conflicts which occurred when bison migrated from the park the following passive and active measures were taken by the author. Passive measures included: placement of a pole with reflective tape across the Texas Gate; attachment of reflective tape on a neighbouring barbed wire fence; and the erection of two short fences (2m high and 3-5m long) strategically placed along the Sturgeon River at known bison crossings. Active measures included gaining permission to access adjacent lands and herding bison off the landowners property across the Sturgeon River and into the park. Bison were primarily herded on foot, by vehicle siren and crackershells.

CHAPTER III

RELATED LITERATURE

3.1 Problem Wildlife Management

Positive values of wildlife are well known, including consumptive and non-consumptive uses. However, the negative values of wildlife actions are often avoided by wildlife managers and not fully understood by the general public. Wildlife have the potential to cause problems such as elk destroying hay bales, bears destroying beehives, beavers flooding hay and cropland, wolves and coyotes preying on livestock and waterfowl depredating crops.

According to Dorrance (1983) problem wildlife management occurs when there are conflicts between agriculture and wildlife and states there are several components involved in problem wildlife management: 1) damage prevention includes the use of habitat manipulation, enhancement of natural predator populations, or construction of barriers to deter wildlife. Dorrance (1983) adds that whatever measure chosen, considerable time and effort should be made to ensure only the target species is deterred; 2) controlling wildlife may occur when preventative measures have not been totally effective. Rarely if ever is wildlife depredation completely eliminated from an area. Removal of problem wildlife is sometimes the most effective, economical, and biologically sound method of reducing wildlife depredation. On private land, animal removal should be the responsibility of the landowner and the

government. Hunting and trapping by landowners should be encouraged as a method of wildlife damage control and should sometimes be used to achieve predetermined wildlife population levels in areas of serious and chronic depredation; and 3) compensation may be required when the above two methods are not effective. Compensation is justifiable to landowners because the welfare of wildlife on private land is largely dependant on the landowner. However, Dorrance (1983) points out that losses should be compensated at less than market value to encourage the use of preventative and control techniques. The following may dictate when compensation is appropriate: 1) damage caused by a wildlife species protected by law; 2) damages are considerable and constitute a significant loss of income to the landowner; 3) preventative and control measures have been ineffective; 4) damage caused by a wildlife species where animal removal is not socially acceptable (ie. damage by endangered species); and 5) damage that is not normally covered by insurance (Dorrance 1983).

3.2 Historic Evidence of Bison

Bison fossils found throughout northeastern Asia, Alaska, and central North America indicate that a wide variation in body size, conformation and horn growth occurred within historic populations (Reynolds et al. 1982). Definitive research on the evolution of bison has been completed by Flerov and Zablotski (1961), Geist and Karsten (1977), Guthrie

(1970, 1980), Harington (1980), Hillerud (1980) and Wilson (1980). It was during the late Pleistocene era when bison emigrated to North America (McDonald 1981, Reynolds et al. 1982, Meagher 1986).

Historically bison were distributed throughout most of North America from Mexico to Great Slave Lake (van Zyll de Jong 1986). The division between the historic range of the wood and plains bison was roughly parallel with the ecotone boundary between grasslands and boreal forest (van Zyll de Jong 1986).

The following historical accounts of bison in the area of PANP were found in Roe (1970). In 1772, Matthew Cocking wrote that there were plenty of bison in the winter just west of the forks of the Saskatchewan Rivers. Duncan McGillvery in 1794 found bison plentiful near the present day city of Prince Albert. Harmon in 1805 wrote, they were almost starving for a month before they found bison within a days walk south of the present day city of Prince Albert.

Historically there appears little doubt there were bison in the vicinity of PANP. However, uncertainty does exist as to whether the bison in the area were plains or wood subspecies (Gates pers. comm. 1990). According to van Zyll de Jong (1986) the area northwest of PANP is thought to be the northern limit of the historic range of the plains bison. Bison disappeared from the PANP region sometime between 1875 and 1883 (Soper 1951).

3.3 Extirpation of Free-Roaming Bison Throughout Most of North America

Upon arrival of the Europeans there were an estimated 30,000,000 (McHugh 1972) to 75,000,000 (Dary 1974) plains bison and approximately 168,000 wood bison (Soper 1941) in North America. While the Plains Indian tribes already relied on bison for part of their subsistence, the re-introduction of the horse to North America by Europeans caused this reliance to quickly grow (Dary 1974). Dary (1974) states that no other animal in the world has ever matched the buffalo in providing so many commodities of importance to one people. The number of non-food uses of bison by native people was as high as 87.

The slaughtering of large numbers of bison began in the 1820's as the fur trade grew and settlers moved west (Dary 1974). The demand for bison meat, tongues, and robes soon grew along the eastern seaboard of the United States. The large southern herds on the Great Plains of the United States were all but wiped out. The northern herds on the Canadian prairies were reduced to near extinction by 1883 (Hornaday 1889, Haines 1970, Roe 1970, McHugh 1972, Dary 1974, Ogilvie 1979, Lothian 1981). At the turn of the century the plains bison population in North America had fallen to a low of 300 (Thompson 1962). Except for a small free-roaming herd in YNP and a few scattered animals in private herds and zoos, bison were completely eliminated from the plains. The northern wood

bison herds were also close to extinction as Soper (1941) estimated only about 250 wood bison remained during the period of 1896 to 1900.

3.4 Protection and Conservation of Bison in North America

The first official regulations to protect the last remnant herds of Canadian bison were for wood bison located in northern Alberta and the Northwest Territories (NWT), enacted in 1877 (Wood Bison Recovery Team 1987). In 1893 legislation was passed by the Government of Canada to protect the wood bison herd in the Mackenzie District of northern Canada (Soper 1941). However, it was not until the North West Mounted Police took over administration of bison protection legislation in 1897, that active protection of the wood bison took place. It was also around this time that preservation of plains bison in Canada finally began.

In 1898, 13 plains bison were given to Rocky Mountain Park (present day Banff National Park) by Lord Strathcona of Winnipeg (Ogilvie 1979). This was the first plains bison herd in a Canadian National Park. In the early 1900's, the Canadian government took the initiative to negotiate the purchase of a plains bison herd from Michel Pablo of Montana. This herd was the largest existing herd of plains bison left in North America (Coder 1975).

The founding stock of Pablo's herd came from a Pend d'Oreille Indian named Walking Coyote who captured four calves

near Milk River, Alberta in 1873 for a peace offering to another tribe (Corner and Connell 1958). Two ranchers, Pablo and Allard, subsequently bought ten bison from Walking Coyote. By the end of the 19th century Pablo and Allard's original ten bison had grown into a herd which made up 80% of the plains bison left in North America. In 1896, Charles Allard died and his share of the Pablo/Allard herd which numbered 150 bison were sold by his family to dealers all over the United States. Many of these bison became the founding stock for several populations, including the herd which eventually re-populated YNP (Ogilvie 1979). By the turn of the century, Pablo found he could no longer properly manage his large herd of bison. In 1904 the United States government informed Pablo that the Flathead Reservation on which he ranched was going to be opened for settlement. Pablo requested a grant of grazing land for his bison but was refused. He then offered the bison to the United States government but their offer was so low Pablo felt betrayed. Pablo then turned to the Canadian Department of the Interior. The Commissioner of the Dominion Parks, Howard Douglas, made an immediate offer of $200 per head to purchase Pablo's bison (Ogilvie 1979) and in 1907 the first shipment of 149 bison was transferred to EINP. The bison were held in EINP for the interim until construction of the fence was completed at the new Buffalo Park at Wainwright in 1909 (Blythe and Hudson 1987). In total, 716 plains bison were transported from Montana to Canada at a cost of nearly

$200,000 dollars (Ogilvie 1979). In 1909 all of the bison except 48 which could not be rounded up, were transferred to Wainwright. The remaining bison in EINP became the founding stock for their present-day herd (Corner and Connell 1958). By 1913, upon completion of the transfer, Canada had three protected herds on public land: 1,188 at Wainwright; 71 at EINP; and 28 at Banff for a total of 1,287 plains bison (Lothian 1981).

Beyond the boundaries of Buffalo Park in Wainwright, domestic cattle were heavily infected with tuberculosis and brucellosis. In an attempt to distance the bison from contact with cattle, park administration erected a second fence around the park. However, at this time the government was also experimenting cross-breeding domestic cattle with bison, and these cattle were permitted to range with bison. By 1917 at least one bison had died of tuberculosis and the disease was quickly spreading in the close confines of the fenced park. The Wainwright bison population, free from natural predators and winter food shortages, increased rapidly and by 1917 numbered close to 2400 bison. By 1921 there were eight to nine thousand bison in the park. As their preferred habitat, the prairie grasses and meadows, became decimated, the bison reverted to browsing on small twigs. To alleviate some of the pressure, park officials began a slaughtering program and by 1925, 2,000 bison were slaughtered annually. But this was still not effective in keeping the population under control.

The range was overgrazed, the herd was diseased something had to be done. A proposal to slaughter the entire herd was met with great public outcry. Another option was to ship the Wainwright bison somewhere else. Wood Buffalo Park was selected as it had just been created, it was large, well-equipped for bison protection, and with only 1500 wood bison, appeared to be half-empty (Ogilvie 1979). The proposal brought protests by mammalogists, conservationists and bison authorities throughout the country, who were concerned the purity of both sub-species and the health of the wood bison would be endangered (Harper 1925, Howell 1925, Saunders 1925, Rowan 1929, McHugh 1972, and Ogilvie 1979). The Canadian Government argued the site where the Wainwright bison were to be released was isolated from the northern range of the wood bison herd and with regard to the diseases, the Department of the Interior downplayed the high rate of infection theorizing that because only young bison would be relocated, the risk of disease would be minimal (Ogilvie 1979). Hoyes Lloyd, the Park's Supervisor of Wildlife Protection at the time, in a memorandum to the Commissioner of Parks in 1924 warned,

> "It is thought to be very bad epidemiology to ship buffalo from a herd known to be diseased and place them in contact with buffalo at Wood Buffalo Park, which are not known to be diseased as far as I am aware" (Stott 1990).

This caution was ignored and between 1925 and 1928, 6,673 plains bison were transferred from Wainwright to Wood Buffalo Park (4,826 yearlings, 1,515 two-year olds and 332 three-year olds) (Carbyn et al. 1989). The remaining Wainwright herd was

destroyed (Wood Bison Recovery Team 1987).

As predicted, the diseases spread and inter-breeding between the original wood bison population and the introduced plains bison was observed the first year (Fuller 1966). The transfer of plains bison to WBNP has been described as one of the most tragic examples of bureaucratic stupidity (McHugh 1972), as well as the greatest act of stupidity ever to occur in Canadian wildlife management (Tessaro 1990).

3.5 Taxonomy

Recently, bison taxonomy has been an issue of debate. However, it has generally been accepted that there are two subspecies of the North American bison; plains and wood. Rhoads (1897) was one of the first to scientifically describe wood bison and classify them as a separate subspecies. Others that have agreed with Rhoads, include Soper (1941), Skinner and Kaisen (1947), and Geist and Karsten (1977). van Zyll de Jong (1986) conducted a multivariate morphometric study and found a definite phenotypic discontinuity in body size parameters between plains and wood bison. As a result, van Zyll de Jong (1986) felt this justified the subspecies classification. However, at the genotype level a significant difference remains to be established. Graham (1923), Seibert (1925) and Garretson (1927) attributed the larger size and darker color of the wood bison to environmental factors and not genetics. Peden and Kraay (1979) compared blood

characteristics between plains bison, wood bison and their hybrids, and found that within Canadian herds all were relatively similar. In fact, differences among the separate plains bison herds were found to be greater than the differences between the two subspecies and their hybrids. Bork et al. (1991) found a lack of genetic difference between wood and plains bison, but also stated that all possible deoxyribonucleic acid (DNA) combinations have not been tested. Strobeck (1991) studied the differences in mitochondrial DNA and also found the differences between wood and plains bison to be approximately the same or less than differences within plains bison from different areas.

3.6 Habitat

Habitat selection by bison seems to be controlled by high energy requirements and strong preference for graminoids. Primarily grazers, bison rely heavily on grasses and sedges for most of their diet. In some areas, browse can be seasonally important (Soper 1941, McHugh 1958, Holsworth 1959, Fuller 1966, Meagher 1973, Peden et al. 1974, Van Camp 1975, Cairns 1976, Cairns and Telfer 1980, Reynolds et al. 1982, Meagher 1986). Several studies have proven bison will actively search for open grassland and low-lying sedge swales (Meagher 1973, Cairns 1976, Reynolds et al. 1978, Cairns and Telfer 1980, Norland 1984). It is apparent when grasses and sedges are available they are selectively grazed by bison, and

when they are sparse browse may be substituted (Reynolds et al. 1982). When available, bison also favour areas relatively close to forest cover for protection from storms, and sun (Soper 1941, McHugh 1958, Fuller 1966, Meagher 1973, Reynolds et al. 1982, Meagher 1986).

The amount of forage required per day for bison has been estimated at 7.4 kg of sedge hay or an average daily intake of 1.6% of their body weight in dry matter (Hawley et al. 1981). Quality of feed ingested has been compared to that of domestic cattle. While there is relatively little difference in the digestion efficiency of high quality forages Peden et al. (1974) and Richmond et al. (1977) found that in low quality forages, (low protein and high fibre content), the digestive ability of bison was significantly greater than domestic cattle. Bison also require water or snow on a daily basis and seem to prefer water over snow (McHugh 1958, Jennings and Hebbring 1983).

Impacts bison have on the environment results in compaction of soil from trampling and removal of vegetation through grazing. Other impacts are caused by wallowing, horning, and the establishment and maintenance of trails (Soper 1941, McHugh 1958, Reynolds et al. 1982). Grazing from bison, similar to other ungulates can have a significant impact on maintaining grasslands (Larson 1940). Wallows (depressions in the earth caused by bison rolling, horning and pawing the earth) are subject to wind and water erosion

(McHugh 1958, Meagher 1973). Horning of shrubs, saplings and even mature trees caused by bison rubbing on them can result in completely uprooting shrubs and saplings. Rubbing their horns on the bark of trees often results in bark being torn away which may eventually kill certain trees. Horning is particularly noticeable during the rut (Soper 1941, McHugh 1958, Reynolds et al. 1982). It is also hypothesized that this form of disruption to vegetation may in fact help maintain open meadows by inhibiting forest ingrowth and slow succession (Meagher 1973, Reynolds et al. 1982). Well-used bison paths or trails often leave depressions of bare earth which are subject to wind and water erosion, particularly if located on steep or unstable slopes (Soper 1941). Trampling can keep areas near water bodies or stream crossings almost completely clear of vegetation (Soper 1941).

3.7 Mortality

3.7.1 Predation

Wolves (Canis Lupus) are competent predators of free-roaming bison and in some areas bison comprise a significant portion of their diet (Soper 1941, McHugh 1958, Fuller 1960, Oosenbrug and Carbyn 1985). On occasion, both grizzly (Ursus arctos) (McHugh 1958, Meagher 1973) and black bears (Ursus americanus) (Britton and Graves 1983) have been known to prey on bison calves.

3.7.2 Disease

Tuberculosis is an infectious disease caused by (Mycobacterium bovis) (Tessaro 1987). In bison, the respiratory and alimentary tracts are usual routes for infection (Reynolds et al. 1982). The disease is exhaled in breath vapour or excreted in feces, urine, milk and vaginal discharges. Transmission is usually by inhalation or ingestion of infected milk by calves, contaminated forage or water, or coitus. Tuberculosis is a progressively debilitating disease in bison and may cause pneumonia, encephalitis, and metritis (uterine tuberculosis). It generally makes bison more susceptible to predation, reduces fertility, and can result in weak calves which die shortly after birth (Bison Disease Task Force 1988).

Brucellosis is an infectious disease caused by the bacteria (Brucella abortus) (Tessaro 1987). Brucellosis causes abortion, temporary sterility, metritis and lowers milk production in cattle and bison (Meagher 1973, Choquette et al. 1978, Bison Disease Task Force 1988). The most common mode of brucellosis transmission is oral contact with aborted fetuses and placentas. However, it can also be transmitted by ingestion of infected forage or water or by transfer of milk from an infected cow to her calf (McCorquodale and DiGiacomo 1985).

Anthrax is an infectious, fever-producing disease of warm-blooded animals caused by the bacterium (Bacillus anthracis).

The disease is found in soil-borne spores which can live indefinitely. It is characterized by a rapid infection of the blood and death ensues shortly thereafter (Bison Disease Task Force 1988).

Other diseases and parasites found in bison can include several species of ectoparasites and endoparasites (Kopjar 1989) with the majority of parasites belonging to the class Nematoda (Reynolds et al. 1982). These include stomach worms (Ostertagia ostertagi), lungworms (Dictyocaulus viviparus) and nodular worms (Oesophagostomum radiatum) (Reynolds et al. 1982). In general, free-roaming bison herds have minimal problems with parasites (Meagher 1986), unlike captive herds where ground feeding appears to enhance their occurrence (Reynolds et al. 1982). Depending on the species of parasite, effects can range from minor infestation to death (Reynolds et al. 1982). Pathological conditions found in free-roaming herds include arteriosclerosis, lymphosarcoma and pneumonia (Fuller 1961). Ophthalmia, an enlarged granulated liver disorder, may also be found in free-roaming bison (Garretson 1927).

3.7.3 Winter Severity

Above average snowfall, long periods of low temperatures and mild winter thaws followed by subzero temperatures create conditions detrimental to bison survival. In YNP, Meagher (1973) has described winterkill as the combined effects of climatic stress, reduced forage availability and the

physiological condition of individual bison. Weather alone is not normally a serious cause of bison mortality, but it is an additional physiological stress which, when added to the effects of predation, or disease, can increase the rate of mortality (Fuller 1961). Reynolds et al. (1982) adds that periodic extremes of winter climates are unpredictable and can increase the mortality rate in free-roaming bison populations.

3.7.4 Accidents

Large scale drowning was historically considered to be an important mortality factor of the plains bison (Roe 1970). In one rare year of extensive flooding (1974) in the Peace Athabasca Delta in WBNP, over 3,000 bison drowned (Bison Disease Task Force 1988). Bison have been known to drown in EINP when they travelled too close to beaver (Castor canadensis) houses (Blythe and Hudson 1987). In the spring of 1989 in the MBS 177 bison drowned (Gates et al. 1991). This total included 123 cows resulting in a significant reduction in herd production.

Mortalities due to wildfires in bison ranges, were historically thought to be insignificant (Soper 1941, Fuller 1966). However, Roe (1970) points to historical reports which claim wildfires on the prairies often blinded, badly burned and killed entire herds of bison. One such report was made by Charles Mackenzie in 1804 while he was travelling from Fort Assiniboine (near present day Brandon) to the Missouri and observed several herds of bison with their hair singed, eyes

blinded and several burnt carcasses.

Mortalities from collision with motor vehicles have occurred in northern free-roaming herds in Canada and in YNP (Fuller 1966, Reynolds et al. 1982, Meagher pers. comm. 1990).

3.7.5 Hunting

Outside WBNP, approximately 50-60 bison are legally killed annually by local hunters (Mercredi pers. comm. 1990). From 1988-1990 hunting accounted for approximately 35% of recorded bison mortalities in and around WBNP (Catto 1991). In the Slave River Lowlands (SRL) between 1976-1977 legal hunting accounted for approximately 39% of known bison mortality (Van Camp 1987). In the MBS hunting was permitted by lottery for the first time in 1987 when a quota of 20 bulls was established. This number was subsequently increased to 40 bulls in 1989 (Gates et al. 1991). Outside YNP in Montana, legal hunting has become part of the management practice to try and reduce conflict between ranchers and bison. During the period 1985-1990, a total of 688 bison have been removed in this fashion.

3.8 Herd Characteristics

Although bison are gregarious, there are three types of herd groups which can be observed throughout the year. Matriarchal groups consist of cows, calves, yearlings and occasionally a few older bulls. There are bull groups, and also a combination of matriarchal and bull groups which form

large breeding groups. In the matriarchal group, size and configuration varies little for most of the year (Reynolds et al. 1982). Bull groups rarely consist of more than a few bison. Breeding groups are the largest group and can contain more than 400 bison (McHugh 1958).

Group cohesiveness is generally higher among cows than with bulls (McHugh 1958, Shackleton 1968). Cow groups tend to move as one unit with the initial movement usually instigated by a mature cow (Kopjar 1989). The direction of this group's movement appears to be retained within the breeding group and may be repeated several times (McHugh 1958, Lott 1974).

Bison commonly make daily movements from one forage area to another. Movement in their summer range is influenced by seasonal vegetation changes, size and availability of forage sites, the rut, and the presence of large numbers of biting insects (Meagher 1973). Annual migrations are common and can be either altitudinal or directional (Reynolds et al. 1982). Migration may be in response to availability and nutritional quality of forage, or due to macroclimatic and microclimatic variations, such as the presence of open water, shelter and insect harassment (Reynolds et al. 1982). Bison have been known to migrate as much as 240 km in boreal forest parkland habitat (Soper 1941). In WBNP, bison were observed to be moving toward their winter range by September or October. As streams, sloughs and lake shores freeze, large sedge meadows become accessible to bison. As the migration continues

considerable dispersal and foraging occurs along the route. This pattern is reversed in late March as bison move back to their summer range (Carbyn et al. 1989).

Shaw and Carter (1990) found when bison's winter and annual range was burned the bison would increase the use of their annual range, but showed little response to new areas of winter range created by the burn. They also observed that older cows appeared to be more likely to seek new winter range than younger bison. Shaw and Carter (1990) concluded that to discourage bison movements into new range managers might have to limit the number of older cows in the herd.

3.8.1 Rut

The activity of bison bulls substantially increases during the rut. Bulls investigate cows by sniffing, and licking their vulva or urine, followed by a curling of the lip with the neck fully extended (Reynolds et al. 1982). Bulls will often "tend" a cow and this temporary bond between the two may last from a few seconds to several days (McHugh 1958, Reynolds et al. 1982). During the tending period a bull will attempt to separate the cow from other individuals in the herd. This is accomplished through displays of aggression and threat postures in the form of elevating their tail, broadside posturing, pawing, wallowing, nodding their head, aggressive lunging and occasional butting of heads with other bulls (McHugh 1958, Lott 1974). Submissive gestures include turning, running away and sudden resumption of grazing

(Reynolds et al. 1982). Sounds made during the rut include soft to loud grunts, bleats, roars, snorts, foot stamping and tooth grinding (McHugh 1958, Fuller 1960).

3.8.2 Calving

Immediately prior to parturition, cows become restless and excitable and will often move away from the herd for one or more days (McHugh 1958, Egerton 1962). Cow-calf pairs remain in close proximity for the first couple of weeks and are less approachable when calves are present (Soper 1941, McHugh 1958, Engelhard 1970, Reynolds et al. 1982). It is in these first few weeks that calves are most vulnerable to predation, and as a result, bison have adopted defence mechanisms to protect their calves (Carbyn and Trottier 1987). These methods include: calves running to the cow; to a nearby bull; or to the center of the herd. When in danger, adult bison will attempt to separate the calf from the predator. If the herd is fleeing from a pack of wolves, the calves are usually located in the center so that the greatest possible distance from the wolves is achieved. Bison, like other ungulates, will also run through water bodies to deter predators (Carbyn and Trottier 1987).

3.9 Management of Free-Roaming Bison

Past and present management programs from PANP, WBNP, the MBS and YNP, were reviewed to gain a better understanding of bison management and are included below.

3.9.1 Prince Albert National Park

Management of the free-roaming bison in PANP has generally consisted of monitoring herd numbers, distribution and activity by park wardens while patrolling the park. From 1969-1978 the free-roaming bison herd was monitored through incidental observations by park wardens. Between 1979-1983 park wardens closely monitored the following: 1) total numbers; 2) age and sex composition; 3) general habitat usage and distribution; 4) activity on adjacent lands; and 5) general herd behavior. These were determined through ground and aerial observations. Status reports for the bison herd were produced by Collingwood (1980a, 1980b), Minton (1983) and by Minton and Schmidt (1984). From 1985 to 1988 monitoring involved wardens recording incidental observations. Active management has occurred in the past when bison were located outside of the park boundaries and involved herding the bison into the park.

3.9.2 Wood Buffalo National Park

Wood Buffalo National Park was created in 1922, with one of its primary objectives being the preservation of the last remaining wild herd of wood bison (Fuller 1966). A reconnaissance of the bison ranges between 1920 and 1922 revealed the area surrounded by the Little Buffalo, the Salt, the Slave and the Jackfish rivers, contained approximately 1,500 wood bison (Ogilvie 1979). The introduction of the plains bison in 1925 marked the most significant event in the

management of the park's bison (Carbyn et al. 1989). One of the first management problems created by the newly acquired plains bison was that a large number of them dispersed southwest from Hay Camp across the Peace River, migrated out of the park and into the lush meadows of the Peace Athabasca Delta (Ogilvie 1979). To maintain protection for bison, the park was enlarged in 1926 from 26,800 square km to its present size of 44,800 square km, to include most of the delta.

Between 1925-1965 there were four main management programs initiated within WBNP. The first was the slaughter of bison for local consumption and aid for the Roman Catholic missions and needy people around the park. Beginning in 1929, small scale slaughters took place in the field, with the meat being distributed by the Catholic Missions (Carbyn et al. 1989). The total number of bison slaughtered and the efficiency with which this was accomplished increased in the early 1950's when portable abattoirs were first used (Mitchell 1976). The demand for bison meat grew, and with standards established by the Department of Agriculture, inspection of meat became mandatory. This resulted in the building of a permanent abattoir at Hay Camp (Stelfox 1976). Wing fences and corrals were also built to aid in the herding of bison, adding to the efficiency of the slaughter. At this time 500-1000 bison were being killed annually for meat. In 1957 an additional abattoir was erected at Sweetgrass. By the 1960's bison meat was sold in southern markets. Slaughtering for commercial

purposes ended with the last shipment of meat to Expo 67 in Montreal (Stelfox 1976). The last slaughter for local use took place in 1974. Between 1950 and 1974 approximately 8,200 bison were slaughtered for meat of which a large percentage were cows and calves, thus effectively reducing the productivity of the population (Bison Disease Task Force 1988).

The second management program in this period dealt with the disease issue. The first occurrence of tuberculosis in park bison was reported in 1937 (Bison Disease Task Force 1988), while brucellosis was not confirmed until 1956 (Fuller 1966). By the early 1950's veterinarians and biologists who inspected the meat found high rates of tuberculosis in the slaughtered bison (Carbyn et al. 1989). In 1954 a management plan was established with the following goals: 1) to reduce the incidence of disease in the bison herd; 2) to maintain the park bison population within the carrying capacity of the range; and 3) to slaughter only the diseased bison (Stelfox 1977). This management program was in effect from 1954 to 1962. While the main objective of the program was to test for tuberculosis, much of the culling which took place was to provide meat for local communities, with little or no selective killing of diseased bison. In many cases testing for disease did not actually occur, despite the opportunity (Bison Disease Task Force 1988).

In 1962, an outbreak of anthrax occurred east of the park

near Hook Lake and it became the new focus of disease control (Novakowski and Choquette 1961). By 1964 the disease had spread to the park despite efforts to depopulate the area between the Little Buffalo and Slave Rivers (Bison Disease Task Force 1988). Anthrax prevention programs began in 1965 and included searching for and destroying cadavers, as well as vaccinating as many bison as possible (Carbyn et al. 1989).

The third major bison management program in WBNP during this period was the predator control program. By the late 1900's wolves were becoming more numerous within the park and playing a larger role in bison mortality (Soper 1945). A wolf control program was recommended to make more bison available for human consumption (Soper 1945). Buffalo rangers began poisoning wolves in 1935 (Mitchell 1976). During the winter of 1953-54, one trapper poisoned 80 wolves in the Sweetgrass area. On average it is estimated that 20 to 100 wolves were poisoned annually between 1940 and the mid-1960's, when the program ended (Carbyn et al. 1987). While the exact number of wolves killed is unknown, it was probably significant enough to reduce the predation pressure on the bison (Carbyn et al. 1989).

The fourth major bison program initiated prior to 1965 was the Wood Bison Recovery Program. In 1957, Novakowski observed an isolated bison herd in the northwest portion of the park near the Nyarling River and Buffalo Lake area (Wood Bison Recovery Team 1987). This discovery supported earlier

speculation by Soper (1941) that a herd of wood bison had remained isolated from the southern hybrids. In 1959, five specimens were collected from the herd of approximately 200 and sent to the Museum of Natural Sciences in Ottawa for subspecies designation. Pelage characteristics, cranial measurements and size compared favourably with wood bison specimens (Banfield and Novakowski 1960). As a result, the Nyarling River herd was classified as morphologically representative of wood bison (Wood Bison Recovery Program 1987). In February of 1963, 77 bison were captured in this area with the purpose of establishing a herd of wood bison in another location to eventually form a breeding population (Wood Bison Recovery Team 1987). At the capture site, 61 bison were tested for disease. The tests indicated one animal had tuberculosis and over half were infected with brucellosis. Of the disease-free bison, 18 were transported to an area north of Fort Providence and released. These bison were the founders of the present day MBS Herd (Novakowski 1963). In 1965 a second roundup took place. This time 40 bison were captured and tested for disease, 24 were subsequently transported to EINP to establish a herd which would eventually be used for future wood bison re-introductions (Wood Bison Recovery Team 1987).

In 1966, Fuller proposed a management plan for the WBNP bison. His study took into consideration historical events, the incidence of disease in different areas of the park,

population dynamics, mortality factors and range conditions. He recommended the first aim of management should be to preserve the aesthetic values of the herd, a goal which could best be accomplished with a hands-off approach over most of the park (Fuller 1966).

In 1968, a five-year plan to fence and eliminate all free-roaming bison in the park, with annual testing and slaughtering for diseases was put forward (Novakowski and Choquette 1961). This plan was rejected due to high cost, and environmental and aesthetic concerns regarding fencing of the largest wild bison herd in the world (Carbyn et al. 1989).

In 1972, an alternate plan was devised to develop and maintain as large a disease-controlled herd as possible (Bison Disease Task Force 1988). Short term objectives were to implement a large scale vaccination program for anthrax and to monitor tuberculosis and brucellosis rates. As well, each animal would be tagged so that additional information on bison ecology could be accumulated. It proposed building several corrals spread out over the entire bison range to assist in capturing the bison (Carbyn et al. 1989).

The program went ahead and bison were rounded up and corralled at Hay Camp, Sweetgrass and Lake One. It was during these vaccination round-ups that the effects of human handling of bison was studied. It was found that the average mortality attributed to round-up injuries in chutes, through calves being trampled, and bison being gored was 2%. During the

vaccination period, approximately 610 bison died as a result of handling (Millette and Sturko 1977). Because of these high losses Millette and Sturko (1977) recommended that the anthrax vaccination program be terminated. In 1977 the vaccination round-ups were cancelled and the existing infrastructure (handling facilities) removed or left to rot (Bison Disease Task Force 1988). This cancellation of the vaccination program effectively ended the 1972 management plan.

The present management plan for WBNP (1984) states management of bison will take a hands off approach and natural processes will be permitted to regulate herd size unless population levels reach the point where survival of the herd is threatened. It specifically outlines: 1) that bison will continue to be fully protected and monitoring of the herd will be improved with research programs on disease; 2) herd dynamics and behavior research will utilize techniques which will not stress the bison; and 3) the CPS, Agriculture Canada, the Government of Alberta, and the Government of the NWT will designate buffer zones where livestock operations will be prohibited (Parks Canada 1984a).

In 1986, an inter-jurisdictional Steering Committee (Federal Environmental Review Office 1990) was formed to review the implications of bison being infected with tuberculosis and brucellosis in and around the WBNP area. The committee in turn created a Bison Disease Task Force to identify and assess what options existed with regard to the

following problems: 1) potential for infection of domestic livestock; 2) interference with re-introduction of wood bison; 3) danger to the health of users of bison meat; and 4) threat to the genetic integrity of free-ranging wood bison. The options which were found to be the most feasible by the Task Force included: 1) status quo; 2) fencing the park; 3) composite plan of using strategically placed fences combined with buffer zones; and/or 4) eradication of the diseased-exposed bison and replacement with disease-free wood bison (Bison Disease Task Force 1988).

In 1988 an Environmental Assessment Panel was established to examine all reasonable options for dealing with the bison issue, including those recommended by the Task Force in order to achieve protection for domestic livestock, free-roaming wood bison and human health (Federal Environmental Assessment Review Office 1990). After several months of public consultation and review of several technical reports, the panel presented its recommendations in August 1990. They concluded that complete eradication of bison in and around WBNP was the only method of eliminating the risk of disease transmission to domestic cattle, wood bison and humans. Once the disease-exposed bison were eliminated, the area would then be restocked with disease-free wood bison (Federal Environmental Assessment Review Office 1990).

In response to this report, local native bands, park staff and the general public were outraged. Park staff from WBNP

created a Bison Emergency Response Team, and in the process an internal memorandum was circulated through the park system and eventually leaked to the press. The memorandum cited reasons why the slaughter should not take place, with the primary reason being that it would set a precedent which could threaten the ecological integrity of all national parks (Struzik 1990). The combined effect of the memorandum and public pressure, resulted in the federal environment minister stating that Ottawa would seek to find a compromise which would satisfy all parties involved.

In 1991 a Northern Buffalo Management Board was established to seek an alternative solution. Their main objectives include: to ensure that a healthy free-roaming bison herd continue to be a major component of the regional ecosystem; to prevent the spread of bovine tuberculosis and brucellosis in and around WBNP; to assemble existing data and carry out specific studies such as predator prey relationships and through traditional knowledge and scientific research gain a better understanding of ecological interactions (Northern Buffalo Management Board 1991).

3.9.3 The Mackenzie Bison Sanctuary

In August of 1963, 16 wood bison from WBNP were released 25 km north of Fort Providence NWT. These bison were the founders of the present day MBS herd (Bison Disease Task Force 1988). The area to the west of Great Slave Lake was declared a bison Sanctuary by a Game Ordinance in 1963. Management

over the next 20 years generally consisted of monitoring bison numbers. The herd steadily increased to 100 in 1971, 600 in 1979, and 1200 in 1984 (Bison Disease Task Force 1988). In 1983 the NWT Department of Renewable Resources drafted a 10-year plan for the managers of the bison. The plan set out goals for the resource managers and options of how to attain those goals. The goals were: 1) maintain a viable free-ranging bison herd; 2) utilize the MBS for the purposes of transplanting wood bison to other areas; and 3) plan for the best utilization of surplus bison for residents of the NWT once the first two goals have been achieved (Northwest Territories Department of Renewable Resources 1983).

This draft was revised in 1987 and published as a management plan for the MBS (Northwest Territories Department of Renewable Resources 1987). Input was solicitated from, fish and game associations, resident hunters, conservation groups, and the general public. The following management goals were established by the NWT Department of Renewable Resources (1987) for the MBS herd: 1) maintain a viable free-ranging herd, as this herd is the largest herd of wood bison in the world. This goal should take precedence over all others; 2) increase the numbers of bison and their distribution through natural expansion of the range as well as providing bison for transplants in other areas; and 3) plan for the utilization of surplus bison by residents of the NWT once the first two goals have been satisfied. The plan also laid out several

management objectives: 1) to permit the number of bison in the sanctuary to increase through natural reproduction and recruitment to the estimated carrying capacity of 7100; 2) establish other wood bison populations through introductions and identifying new areas that could support bison, as well to enhance the expansion of the MBS into unused habitat adjacent to current range; 3) to maximize opportunities for non-consumptive and consumptive use of wood bison for the benefit of people in the NWT and Canada; and 4) to develop a comprehensive land management strategy to ensure bison range is protected from competing land uses. The status of the MBS under the NWT Wildlife Act inhibits the encroachment of agriculture, mining or other land uses not compatible with bison (Northwest Territories Department of Renewable Resources 1987).

Research in the MBS has concentrated on habitat availability and usage, size, composition, and distribution of bison. Radio telemetry will be used to monitor movements and habitat use patterns. This will allow for identification of seasonally important areas which are critical for management. A habitat evaluation program was conducted to determine range, composition and biomass available to the bison. It has utilized remote sensing, interpretation of aerial photographs and detailed ground truthing. Based on this it was found that the area could support approximately 7100 bison. Fire is recognized as an integral part of habitat management and is

considered beneficial for maintenance or improvement of habitat under some circumstances (Northwest Territories Department of Renewable Resources 1987).

Calf production and survival will be determined annually from detailed composition counts. These counts will occur during the post-calving period (June-July) and again in late fall. Total counts will be made opportunistically each year during other work or every second year if a reliable estimate cannot be made (Northwest Territories Department of Renewable Resources 1987).

Frequency of wolf predation and other sources of mortality will be monitored. Annual collections of 10 bison will be made and complete necropsies will be performed (Northwest Territories Department of Renewable Resources 1987).

As the population approaches the target number of 7100 hunting will be used as a tool to regulate the rate of increase. Initial harvest will be low with little overall effect on herd productivity, beginning with a quota of 20 bulls in 1987, and then 40 in 1988. All hunting will be supervised by Renewable Resource Officers who will accompany the hunters and take biological samples from the bison. Hunting will be restricted to certain seasons and in areas away from non-consumptive users (Northwest Territories Department of Renewable Resources 1987).

A community based interpretive center which will include displays and films, as well as bison product handicrafts will

be established in Fort Providence. The purpose of this will be to increase public awareness and appreciation of the wood bison. As well, a full time bison ecologist and technician will be hired to complement the efforts of Renewable Resource Officers (Northwest Territories Department of Renewable Resources 1987).

3.9.4 Yellowstone National Park

Established in 1872, YNP was the world's first national park. It encompasses an area of 8,992 square km and has approximately 2,300 free-roaming plains bison (Meagher pers. comm. 1990). Bison have been part of the ecology in the Yellowstone area since prehistoric times. It is the only area in the United States which has continually had free-roaming bison (Montana Department of Fish, Wildlife and Parks et al. 1990). At the time the park was created, hunting of bison was still permitted and the only protection was against wanton destruction of wildlife (Meagher 1974). Regulations were passed that prohibited hunting of bison in 1883, but it was not until 1894, with the passing of the Lacey Act which created penalties and jurisdictional authority against killing of wildlife, that enforcement occurred (Meagher 1974). This protection came at a time when the number of free-roaming bison left in YNP numbered less than 50 (Montana Department of Fish, Wildlife and Parks et al. 1990). Park administration felt the herd was too close to extinction, so in 1907 the park purchased two semi-domestic plains bison herds and released

them into a fenced enclosure in the Lamar Valley, later called the Lamar Buffalo Ranch. Over the next few decades this captive herd flourished, aided by supplemental feeding and predator control mechanisms. The herd increased to a level where culling and castration were required to control numbers (Meagher 1974).

In the early 1930's the philosophy of bison management in YNP began to change and it was decided to phase out the Lamar Buffalo Ranch. In 1936 the bison from the Buffalo Ranch were transported to the Mary Mountain area to re-establish their historic range, and the herd was allowed to intermingle and interbreed with the small original wild population. Regulation of the numbers of the free-ranging population began in 1955 as the new Mary Mountain Herd increased rapidly in its new habitat. Herd cullings were held at irregular intervals between 1955-1966. Studies in 1963 revealed the bison herds could persist without the interference of culling programs, so it was decided herd reduction programs would cease. Comparatively low reproduction rates, low increment rates, and heavy mortality during severe winters were strong enough influences on the bison to allow for natural regulation (Meagher 1974).

A major concern among resource managers is the fact that a large percentage of the bison (30-50%) are infected with brucellosis (Meagher 1974) with estimates ranging as high as 70% (Budd pers. comm. 1991). The disease was first reported

in YNP in 1917 (Meagher 1974). Over the last decade, progress has been made throughout the United States in a nation-wide effort to eradicate brucellosis from domestic cattle. This has resulted in an increased focus and concern over brucellosis in the YNP bison (Thorne et al. 1989). In 1968 an attempt was made to try and control bovine brucellosis and minimize the potential for contact between bison and cattle. Park officials decided that instead of trying to control the rate of disease of infected bison, they would implement a boundary control program to try and contain the bison within the park. From 1968 to 1974 a handful of bison migrated out of the park and were of little concern to adjacent landowners (Meagher 1989). However, the situation changed during the winter of 1975-76 when approximately 80 bison moved downstream along the Yellowstone River and foraged near the northern boundary of the park close to Gardiner, Montana and over the next several years this movement continued (Meagher 1989).

To combat the conflict between bison and adjacent landowners, the Montana State Legislature passed a law in 1985 which added bison to its list of legally hunted big game.

> "It is the intent of the legislature that the regulated hunting of wild buffalo allowed by House Bill No. 763 be considered only one of many solutions available to the Department and the National Park Service for controlling the migration of wild buffalo across the boundaries of Yellowstone National Park. The legislature encourages further negotiations and cooperation between the Department and the National Park Service to seek other methods of controlling, as soon as possible, the migration of wild buffalo into Montana from Yellowstone National Park" (Montana Department of Fish, Wildlife and Parks et al. 1990).

After twelve years of monitoring bison movements and failed attempts to maintain bison exclusively within the park, it was concluded that management options are limited. Maintaining the bison solely within the park appears to be an impossible task and allowing the bison to re-populate vacant habitat outside the park in Montana is not politically feasible. The only effective method that would maintain bison solely within YNP would be complete fencing. However, this contradicts the park's policy of preserving a free-roaming wild bison herd, and is also economically, politically and ecologically unrealistic. Since movement was destination-oriented and there was an apparent lack of food stress, supplemental winter feeding programs or population reduction within the park would not be effective in terminating the movements (Meagher 1989). Removal of bison that move to the northern boundary would probably eliminate what seems to be an acquired knowledge. Meagher (1985) notes however, that a removal of bison within the park would be unacceptable politically. Culling of bison outside of the park boundary appears to be the only viable alternative to minimize the conflict with adjacent landowners, though it won't alter the movements it might lessen the conflicts (Meagher 1989).

Because they are free-roaming, the bison of the YNP area are subject to various federal, state or private land jurisdictions (depending on their location). To properly manage the bison, a cooperative management system was

required. In 1989 a Memorandum of Understanding involving the Montana Department of Fish, Wildlife and Parks, YNP, the National Park Service, Gallatin National Forest, and the U.S. Forest Service was developed:

> "to provide cooperative and mutual management of wildlife species that are common and shared by the Park, State and Forest. It is recognized that the Yellowstone ecosystem is an enormous complexity of ecological communities and the diversity of management requirements and procedures is equally complex. It is recognized and understood that each agency operates under different legislative mandates and management objectives. However, when feasible, the Park, State and Forest shall coordinate research and monitoring activities, and share resulting data, and shall coordinate and share management responsibilities and activities" (Montana Department of Fish, Wildlife and Parks et al. 1990).

An interim management plan (Montana Department of Fish and Parks et al. 1990) was created to deal with the immediate problem of bison migrating out of YNP. The agencies that created this plan were the Montana Department of Fish, Wildlife and Parks, the National Park Service and the United States Forest Service. In the plan four main management objectives were established for the northern YNP bison. These were: 1) to reduce the potential for disease transmission of brucellosis to cattle; 2) to reduce the potential for human conflict and property damage; 3) to ensure opportunities exist to view free-roaming bison in YNP; and 4) to maintain a self-sustaining population of bison.

To accomplish the above objectives, a core number of 200 bison were identified for the northern herd. It was also decided that there would be two sets of management activities,

one when the herd is below the core number and another when it exceeds it. Prior to reaching the 200 limit it was decided active management would include: 1) initial monitoring via daily ground patrols to track bison movement; 2) use of aerial flights whenever the northern boundary is approached by the bison; 3) physical attempts to prevent bison from migrating out of the park only when it is predicted the chosen action will be successful; 4) reducing bison as required when the bison are out of the park that pose a threat to livestock or to private property; and 5) the State of Montana continuing to conduct the reduction programs of bison outside of YNP, with the assistance of park rangers (Montana Department of Fish, Wildlife and Parks et al. 1990).

When the core limit is exceeded, special efforts will be put into effect to protect livestock from contact with bison through: 1) aggressive attempts to herd bison into the park when they are considered to be posing a threat to cattle, this may include selective shooting of bison that pose an immediate threat to livestock; 2) creation of Emergency Management Zones on remote state land outside of the park some distance from cattle herds, with attempts made to herd bison into these areas; and 3) if these efforts are unsuccessful in reducing the risk of contact, then under the jurisdiction of the State of Montana, bison will continue to be removed through hunting (Montana Department of Fish, Wildlife and Parks et al. 1990).

Chapter IV

Results

4.1 Landowners

4.1.1 Questionnaire

In total, 22 landowners were selected from Canwood and Big River municipalities to receive the mailed questionnaire. Interviews were arranged a few weeks later and consisted of an informal meeting at the landowners residence. Twenty-one of the 22 landowners were interviewed (one was away for the summer). The absent landowner has not had bison on her property since the early seventies.

A distinction was made between sightings of lone bulls and herds (a herd was determined to consist of two or more bison). This study focused on observations of bison herds located outside the park rather than lone bull sightings. For approximately the last five years at least one lone bull has remained outside of the park for much of the year and is observed on a regular basis by several landowners. Past attempts to herd the bull back into the park have been unsuccessful. Landowners are not too concerned with the bull, therefore it was decided by park managers to let him be although when possible the lone bull's activities are monitored.

Eighty two percent (n=18) of the landowners in the study

area had at some point between 1969-1990, experienced bison on their property. Thirty six percent (n=8) stated they had observed bison on their property almost every year since the 1969 release.

The largest herds reported outside of the park by landowners were 40 in 1987 and 41 in 1991. On both occasions the bison were observed on the same landowner's property, located adjacent to the south crossing area (Fig. 5).

The types of bison activity observed by landowners on their properties varied, but the majority of observations were of bison grazing, on pastures, hay, or crops. Less frequently observed activities included wallowing and travelling. Types of damage caused by the bison included hay and crop damage from wallowing and trampling however, the most serious was considered to be damage to fences.

Most landowners (64%) (n=14) stated that there is no present need for active management of the bison to reduce conflicts. Landowners who expressed there should be some future active management, were the 36% (n=8) that experienced the most occurrences with bison. Suggestions offered by these landowners concerning suitable forms of management were varied and included: 1) complete fencing of the park; 2) fencing only those areas where the bison exit the park; 3) extending the Texas Gate; 4) using a pole across the Texas Gate; 5) controlled burning in the park; 6) attaching reflectors to

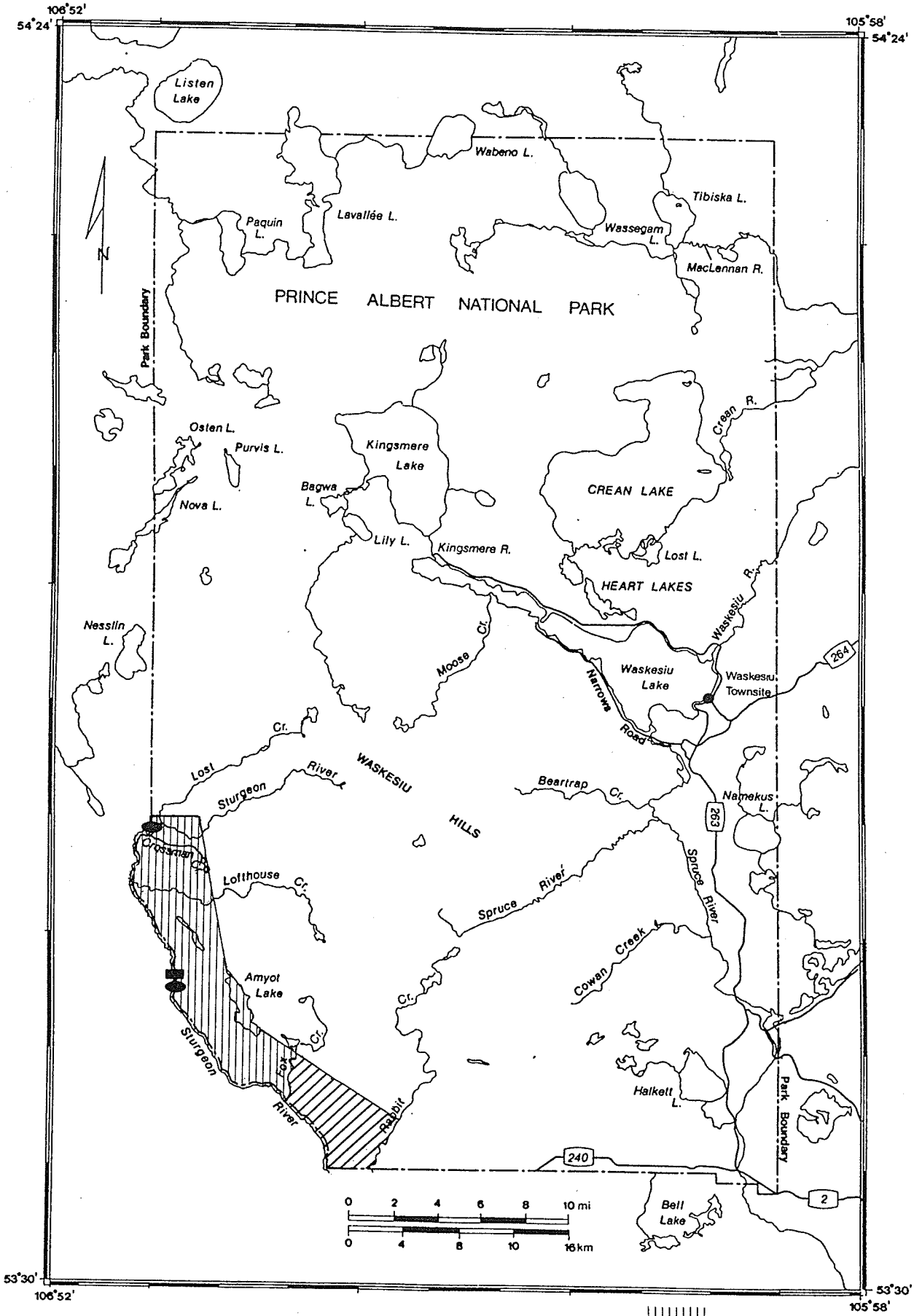


Figure 5: Bison's summer range in PANP. Main herd. Crossing areas. Bulls only. Texas Gate.

landowner fences; and 7) prompt attention by wildlife officers to herd the bison into the park as soon as possible. The majority of landowners felt that as the bison herd increases, the number and severity of bison/landowner conflicts will also increase.

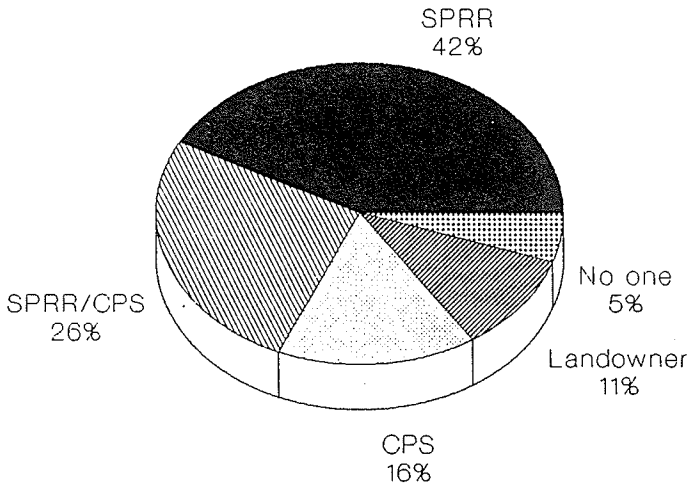
4.1.2 Interviews

Ninety percent (n=19) of the landowners felt the SPRR should take an active role in protection of bison when they are outside of PANP. Most agreed there should be total protection for the bison both in and outside of the park boundary.

Eighty one percent (n=17) of the landowners stated they would have some degree of tolerance to damage caused by the bison. Two (10%) stated they would be willing to tolerate damages of up to $500. One landowner indicated he had on several occasions left a strip of fallow land on the edge of his field to provide a wallowing area for bison should they happen onto his property. Several landowners agreed a few key factors would be critical in determining their level of tolerance: the time of year the bison were out; number of bison; and length of time the bison were allowed to remain on their property. Two landowners (10%) stated any damage on their land would be considered serious and would not be tolerated for any length of time.

Ninety percent (n=19) of the landowners chose to answer the question concerning who should be held accountable for damage caused by the bison. Of those, 42% (n=8) felt the SPRR should be responsible, 26% (n=5) thought responsibility should be shared equally between the SPRR and the CPS, 16% (n=3) felt the CPS alone should be responsible, 11% (n=2) thought the landowner should be responsible, and one (5%) felt no one is responsible (Fig. 6).

Overall, landowner attitudes were positive toward having a free-roaming herd of bison in the area. One landowner (5%) expressed negative feelings toward the bison herd, however this was limited to when the bison were outside of the park boundary. A general concern raised by several landowners was that they would like to have greater accessibility to PANP's west side, ranging from designated biking, hiking and skiing trails to vehicle access. It was also noted that knowledge of the free-roaming bison herd was not widespread in areas adjacent to the park. Two landowners (9%) were unaware of the bison's existence in the area. Several landowners appeared to be concerned that local natives could legally hunt bison in certain areas when bison are out of the park. Landowners in general were interested in discussing bison issues and were appreciative of information packages received.



SPRR-Saskatchewan Parks and Renewable Resources
CPS-Canadian Parks Service

Figure 6: Responsibility for bison damage.

4.2 Ecological Management Considerations

The various ecological properties identified below were based on 103 ground observations and nine random aerial surveys over known bison range.

4.2.1 Historical Evidence of Bison in the Prince Albert National Park Region

The area around PANP has been classified as the area of transition between the historical southern range of the wood bison and the northern range of the plains bison (Fig. 2). Cranial measurements (van Zyll de Jong 1991) of the three skulls collected were compared to those of historical plains and wood bison. Based on a rough estimation, their age was determined to be in the range of 120-150 years old (Greenfield pers. comm. 1990). Two of the skulls were from bulls and their cranial measurements clearly fell within the range of the historical plains bison leading van Zyll de Jong (1991) to conclude they were from a plains bison population.

The third skull was that of a bison cow. Because the number of historic (Bison athabascae) cow skulls are limited, comparisons had to be made with the findings of McDonald (1981) which indicated the skull was well within the range of historical plains bison. As a result, van Zyll de Jong (1991) stated there could be little doubt the cow came from the same plains bison population as the two bulls.

4.2.2 Mortality

The first free-roaming bison mortality found in PANP occurred in May of 1990, when the carcass of a yearling was located. Based on the evidence near the carcass it was determined to have been killed by three wolves (Baird pers. comm. 1990).

In 1991, three additional bison mortalities were discovered. The first was a one-week-old female calf found in May. Autopsy results from the Western College of Veterinary Medicine determined the cause of death was a direct result of puncture wounds suffered on either side of its neck. While the actual source of the puncture wounds is unknown in all likelihood they were from a wolf attack (Wobeser 1991).

The second bison mortality was discovered in July. Based on cementum analysis of its primary incisors (Matson 1992) the bison was determined to be a five-year-old cow. With only partial skeletal remains in the area, the exact cause of the cow's death was uncertain. However, dried blood stains on nearby trees and shrubs indicated the cow probably had been preyed upon. There was a great deal of wolf sign (scat, tracks) at the site which led the author to believe the cow had been preyed upon by wolves.

The third mortality was discovered in August. The bison was determined to be a yearling based on cementum analysis of its primary incisors (Matson 1992). The exact cause of death

was difficult to determine from it's skeletal remains. However a marrow sample from a femur revealed the animal had a fat content of 95%, indicating the bison was healthy at the time of death (Leighton 1991). Due to the amount of wolf sign (scat, hair, tracks) at the site and area it is believed predation by wolves caused the yearling's death.

4.2.3 Disease Status

Since their original release in 1969, only one bison has been tested for disease, the calf carcass found in May of 1991. It was found to be disease free and determined to be relatively healthy prior to being killed (Wobeser 1991).

4.2.4 Natality Rate

During the summer of 1989, 11 calves were observed within the main herd. In 1990, 10 calves were observed, and in 1991, eight calves were observed (not including the one mortality). These calf numbers represent natality rates of 20% in 1989, 17% in 1990, and 12% in 1991.

4.2.5 Total Counts

Highest observed total counts for the three summers were obtained from random aerial surveys. The total number of bison counted were: 55 in 1989; 59 in 1990; and 67 in 1991.

4.2.6 Growth Rate

The average finite rate of growth for the herd over the three-year period was 11%, this transforms to an exponential growth rate of r=.104.

4.2.7 Herd Structure

In August of 1989 the main herd consisted of a minimum of 11 calves (23%), three yearlings (6%), five juveniles (2-4 year old) (10%), 20 adult cows (42%), and nine adult bulls (19%) at least seven others were unclassified.

4.2.8 Habitat

During the summer months bison were observed feeding almost exclusively on either sedges or grasses. Both ground and aerial observations confirm bison prefer to forage during the summer on the large open sedge-grassland meadows. Of the total ground observations, 44% of the observations were of bison located on the sedge-grass meadows around Amyot Lake and north to the Snare Lake meadows; 21% of the observations were of bison travelling on road surfaces; 18% were of bison in a closed mixed forest; 12% of the observations were of bison on agricultural lands; and 5% were of bison located in shrub areas.

Of the aerial observations, bison were located on sedge-grass meadows near Amyot and Snare Lakes 56%; 22% in a closed mixed forest while the remaining 22% of the bison observations were on a travel surface.

4.2.9 Range

The summer range of the free-roaming herd in PANP encompasses an area of approximately 150 square km (30 km north to south and 5 km east to west) and extends from

Rabbit Creek in the southeast to Lost Creek in the northwest, and from Amyot Lake in the east to the Sturgeon River in the west (Fig. 5). The range of the main herd however is more restricted, as only bulls were observed between Fox and Rabbit Creeks (Fig. 5). The bison's temporary range outside of the park on adjacent lands occurs within the study area between the two crossing areas along the park boundary, encompassing a total area of approximately 10 square km (10 km north to south and 1km east to west).

4.2.10 Interspecific Competition

On three occasions bison were observed foraging within 50 m of lone elk bulls. Both species appeared to be indifferent to one another. White-tail deer were observed within 50 m of bison on nine occasions. Both species paid little if any attention to one another.

4.2.11 General Herd Behavior

Based on ground observations mixed groups in PANP were more gregarious than bull groups throughout the summer months (Table 1). In general bulls were observed more often alone and at greater distances sometimes up to 30 km away from the main herd. Based on ground observations the largest mean group size occurred during the post calving period (June and July), while aerial observations indicated that the largest mean group size occurred during the post calving

TABLE 1

GROUND OBSERVATIONS (1989 - 1991)

	# OF OBS.	# OF BISON	MEAN GROUP SIZE
MAY			
Mixed	22	195	9
Bulls	4	7	2
JUNE			
Mixed	18	259	14
Bulls	2	2	1
JULY			
Mixed	18	265	15
Bulls	11	11	1
AUGUST			
Mixed	23	187	8
Bulls	5	5	1
TOTAL:	**103**	**931**	

period (June) but also during the rut (August) (Table 2). On adjacent lands outside PANP herds consisted exclusively of mixed groups (Table 3). Only one calf was observed out of the park over the three summers.

On three occasions in PANP bulls made aggressive actions toward the author. Each ended with threat displays which included pawing, bellowing, elevation of the tail, thrashing of shrubs and small trees. On one occasion a bull made a bluff charge stopping approximately 10 m away.

4.3 Bison Migrations onto Adjacent Lands

Bison migrated from the park onto adjacent landowners properties twice in 1989, on six occasions in 1990, and on five occasions in 1991. Over the three summers, all 13 of the migrations occurred in May and June (Fig. 7).

4.4 Migration Routes

The bison used two areas exclusively to migrate out of the park. The first is located approximately .5 km south of the Texas Gate (Sturgeon Bridge) (Fig. 5). This appears to be the main migration corridor as the bison utilized this route 93% (n=12) of the time. This crossing is one of the few locations along the Sturgeon River which does not require a significant amount of energy expenditure to cross. It is one of the narrowest places on the river to cross (approximately 7 m wide and 2 m deep) and has relatively firm ground on either side.

TABLE 2

AERIAL OBSERVATIONS (1989 - 1991)

	# OF OBS.	# OF BISON	MEAN GROUP SIZE
MAY			
Mixed	3	33	11
Bulls	1	1	1
JUNE			
Mixed	3	130	43
Bulls	0	0	0
JULY			
Mixed	3	49	16
Bulls	0	0	0
AUGUST			
Mixed	6	145	24
Bulls	0	0	0
TOTAL:	**16**	**358**	**22**

TABLE 3

OBSERVATIONS ON ADJACENT LANDS (1989 - 1991)

	# OF OBS.	# OF BISON	MEAN GROUP SIZE
MAY			
Mixed	8	110	14
JUNE			
Mixed	5	46	9
JULY	0	0	0
AUGUST	0	0	0
TOTAL:	13	156	12

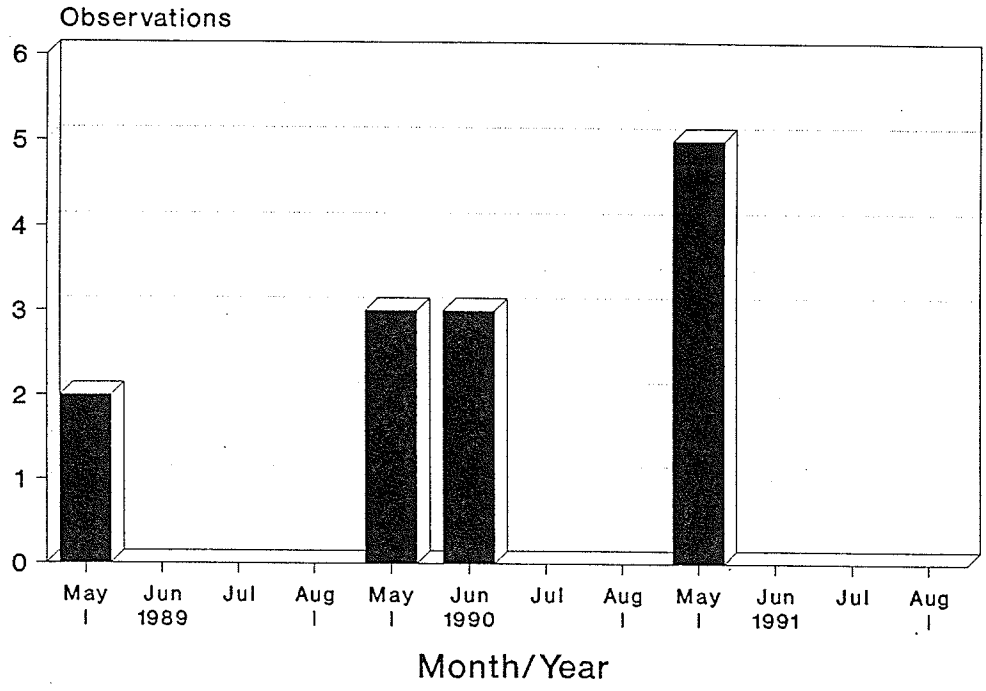


Figure 7: Bison occurrences on adjacent lands.

In addition this particular area along the river is the nearest location to an adjacent landowners field.

The second area of crossing is located north of the Sturgeon River where it exits the park, and becomes part of the park boundary (Fig. 5). The park road across the river allows for easy access out of the park and on to leased Provincial Crown Lands. This land is exclusively pasture and the lessee grazes approximately 50 head of cattle on it. On the one occasion the bison utilized this route they crossed the park boundary and then followed a trail along the Sturgeon River southwest across the Provincial Crown Lands and eventually made their way onto an adjacent landowners hay field. At both crossing areas the bison utilized the same route on their return to the park.

4.5 Bison Activities on Adjacent Lands

While outside the park, bison were observed grazing, travelling and wallowing, in landowners pastures (Fig. 8), hay and crop fields (Fig. 9), summerfallow, and roadways. Damage observed as a result of bison included wallows in crops (Fig. 10), hay fields, and downed barbed wire fences (Fig 11).

4.6 Cattle in PANP

These migration corridors are not restricted to bison as cattle also used them to migrate into the park from adjacent lands. Cattle were observed in the park on seven different

Figure 8: Bison grazing on landowners pasture.

Figure 9: Bison in landowners crop field.

Figure 10: Bison damage to landowners crop field.

Figure 11: Bison damage to landowners fence.

occasions; once in June and six times during August. The cattle utilized the same crossing areas as the bison except they used the north crossing five times and the south crossing only once. The main damage caused by cattle in the park include trampling of vegetation, and establishment of trails, some of which lead out of the park. There is the potential for cattle to introduce parasites and diseases to the bison as well as exotic species of vegetation into the park.

4.7 Attempts to Minimize Bison Occurrences on Adjacent Lands

In 1989, in an attempt to disrupt bison migration across the Sturgeon River the exact area of crossing was located. It was found that bison were crossing the river on a beaver dam. Once they crossed the dam the bison had access to an adjacent landowners field. A short fence was constructed across the dam to try and deter this migration. The bison were not observed out of the park again until the following spring. In the spring of 1990 the bison began crossing approximately 20 m south of the beaver dam. Once again a short fence was constructed across their path. However, it did not prove successful as the bison re-routed their crossing approximately 30 m to the south. It was decided short fences were not effective and at best were short term deterrents, therefore the fences were removed in the summer of 1991.

The effectiveness of the Texas Gate came into question in 1990 when a landowner tried to herd the bison back into the

park and observed four bison jumping the gate. In response a pole was placed across the gate to deter the bison from jumping it. The bison have been observed on six occasions near the gate by the author and they did not make any attempt to cross it. The bison actually appeared to be confused by the gate, as they sniffed, pawed at it and walked repeatedly back and forth beside it. It was decided that in most situations the Texas Gate is effective and unless the bison are under stress, they would not jump it. In addition, the pole was thought to be a barrier to other wildlife species movements such as deer who commonly jump the gate. In 1991 the pole was not used and there were no instances of bison jumping the gate. In an attempt to reduce the amount of damage to neighbouring fences, reflective tape was attached to a neighbour's barbed wire fence. This did not prove successful as the bison continued to knock the fence down when they migrated out of the park and travelled through that particular area.

Active methods to minimize conflicts involved herding bison into the park off landowner's properties. On four separate occasions bison were herded into the park. Bison were primarily herded on foot although on one occasion a vehicle siren and on one occasion crackershells were utilized to initiate movement. Both devices were successful in initiating bison movement. On all four occasions the bison

responded well and were easily herded into the park, using the same river crossing (south crossing) they previously utilized to migrate out of the park.

CHAPTER V

DISCUSSION

5.1 Problem Wildlife Management

Without an understanding of private landowner concerns wildlife-human interactions are strained resulting in unnecessary environmental stresses with potentially high economic losses (Rounds 1980). Where problem wildlife management exists as a result of depredation, wildlife managers should aim to minimize conflicts and promote a coexistence between wildlife and agriculture, and search for ways to mitigate damages to private property. It should be pointed out that if agriculturalists feel wildlife damage is serious enough they will attempt to resolve their own wildlife depredation problems with or without government assistance (Dorrance 1983).

In Saskatchewan, financial assistance to an owner of agricultural produce will be made available to prevent damage by big game or any native wildlife species for which there exists no open hunting season for that species. If the agricultural grower has satisfied the following: 1) taken all reasonable steps to protect the agricultural produce from damage; and 2) has informed a resource officer of the damage immediately upon noticing it. The preventative assistance program will reimburse the agricultural owner for any materials used to protect their agricultural produce that has been approved by a resource officer. If damage continues

despite preventative measures the minister may provide damage assistance to an agricultural owner. The total amount of assistance to each claimant annually is the lesser of $2500 or 75% of the damage. Compensation for damage to unharvested crops will amount to $2500 or 75% of the damage to a maximum of $50 per acre. There shall be no assistance when: 1) damage is assessed at less than $100; 2) due to insufficient surveillance by the owner of the agricultural produce which results in undue notification of a resource officer and the failure to incorporate preventative measures; 3) damage to hay bales left in the field; 4) damage to unprotected grain piles; and 5) damage that occurs in a Provincial Park or in the Northern Provincial Forest. Anyone receiving assistance is responsible for providing all labour necessary to utilize and maintain preventative materials (Saskatchewan Tourism and Renewable Resources 1981). Types of prevention measures currently available to the landowner include fencing materials, poly sheeting for covering haystacks, bloodmeal, scare rockets as well as the availability of special permits which allow the landowner to chase wildlife off their property (Saskatchewan Parks and Renewable Resources 1989).

In Manitoba, prior to 1950, landowners were left to deal with wildlife damage on their own. Since then, the Manitoba Department of Natural Resources (MDNR) has taken the position that effective wildlife management is founded on the goodwill and cooperation of landowners. It is the MDNR's policy that

landowners must accept some wildlife damage as part of the risk taken when owning land, however the Manitoba Government will provide compensation and damage prevention assistance according to the degree to which management of wildlife has contributed to the damage. Manitoba Department of Natural Resources has created several wildlife damage programs in response to landowner's needs, such as the problem beaver, wolf, fox, and coyote management programs. These are in addition to the big game crop damage prevention program and the big game damage compensation program. The big game damage compensation program began in 1974 and now pays farmers compensation for elk, deer, moose and black bear damage to certain crops (Purdy 1987).

Manitoba wildlife biologists and landowners have also worked together and created three committees in high depredation areas, one of which is the area surrounding Riding Mountain National Park (RMNP). The objectives of these committees is to communicate to landowners the types of damage prevention and control measures that are available and to communicate to wildlife managers landowner's concerns in relation to wildlife damage and management. In an attempt to deal with beaver/agriculture conflicts that surround RMNP an agreement was created between the Federal Government and the Manitoba Provincial Government in 1984. The agreement states:

> "whereas RMNP is a major production area for beaver which may emigrate from the park each spring and cause damage to agricultural crops and public works in the vicinity of the park; and whereas the emigration of beaver in their

> natural state is not susceptible to control by either Canada or Manitoba; and whereas Canada and Manitoba have agreed that it is in the national and provincial interest to undertake joint programs to reduce financial losses, due to beaver, to farmers and municipalities who have no legal recourse or means to recover or mitigate such loss... Canada and Manitoba shall each contribute 50% of the program cost to a maximum of $15,000 for each year of the program" (Parks Canada 1984b).

In Alberta, the Provincial Government provides financial assistance for material specifically required for the prevention of wildlife depredation on private and leased land for wildlife species protected by law. Usually the landowner provides the manpower (Dorrance 1983).

5.2 Landowners

Unlike the situation around PANP where most landowners have a positive attitude towards the bison and park, Schroeder (1981) found the majority (80%) of landowners adjacent to RMNP have negative feelings towards the park and its wildlife management. Schroeder (1981) identified and examined the factors that contributed to resource conflict around RMNP. As part of the study, 55 landowners along the periphery of the park were distributed questionnaires and interviewed. Part of the reason for the negative feelings appeared to stem from the fact that several of the landowners had suffered long-term depredation losses from wildlife migrating out of RMNP onto their properties. Beaver and elk caused the most concern to the landowners. Beaver damage consisted of flooding of crops, hay fields, roads, and trails. Additionally, several landowners felt beavers were flooding elk habitat within RMNP,

subsequently causing the elk to migrate out of the park in search of forage. Elk damage similar to bison damage around PANP included depredation to crops, hay fields, hay bales and damage to grain bins and fences.

Contrary to the situation around PANP where most of the landowners surveyed felt the Saskatchewan Provincial Government was most responsible for bison damage, most landowners around RMNP felt the CPS should be held responsible for beaver and elk damage. This difference may stem from the fact that several landowners around PANP are aware that the bison are in the area due to the release program by the Saskatchewan Provincial Government.

In terms of urgency for management activities to reduce the damage caused by migrating bison, the majority of landowners around PANP felt there was no need for immediate active management. However, landowners who experience regular conflicts felt active management in the future would probably be required. Landowners who suffer wildlife depredation surrounding RMNP demanded immediate action. Differences may be attributed to the severity of depredation that landowners have been exposed to around RMNP, compared to those adjacent to PANP.

Both groups of landowners would like to see greater access to their respective parks. Many remembered situations in the past when they were able to utilize the parks for the extraction of resources such as: hay; timber; and grazing of

cattle. Current lack of utilization of these park resources were viewed by members of both groups as wasteful.

Landowners surrounding PANP recommended the following management methods to reduce bison conflict: create more habitat within the park; fence areas of the park; and use various deterrents (bangers, or reflectors on fences) to restrict their migrations. When landowners around RMNP were asked to recommend solutions for reducing the damage caused by beaver and elk most recommended reducing the beaver and elk populations through trapping and hunting. They suggested designated trappers be permitted to trap beaver within the park, and landowners located along the park boundary be given special hunting privileges to control the number of elk also serving as compensation for damages incurred.

Overall it appears the landowners around PANP are more supportive of park management than those in the RMNP area. Landowners surrounding RMNP have suffered long-term wildlife depredation, and although landowners surrounding PANP suffer depredation it does not appear to be of the same magnitude.

With no known diseases within the PANP free-roaming bison herd landowner's main concerns are over physical damage to their properties. This may explain why the situation around PANP is not viewed by many landowners as a serious problem. Whereas the primary concern of landowners adjacent to YNP is possible disease (brucellosis) transmission from bison to domestic cattle. Concerns over physical damage caused by the

bison when they are out of YNP are relatively insignificant in comparison (Budd pers. comm. 1991).

In 1984 the entire region south of the Northern Provincial Forest in Saskatchewan was surveyed in an attempt to gain a better understanding of farmer's attitudes towards wildlife and wildlife damage. The study area was divided into four general ecological zones, with the area surrounding PANP classified as the Forest Fringe Zone. Results (Bergstrom 1985) indicated farmers in this area had positive attitudes toward wildlife, with most stating wildlife added to the enjoyment of living and working on a farm. These views concur with my survey results.

Bison presently are not the only problem wildlife species most landowners contend with, which may explain why many of the landowners interviewed did not consider the bison to be a major concern. In terms of severity of wildlife damage, farmers in the Forest Fringe Zone reported crop damage from waterfowl to be most significant, followed by beaver, big game and livestock predation (Bergstrom 1985).

Those landowners around PANP who have had the most occurrences with bison did feel there was a need for some form of future management to reduce occurrences. However, a negative attitude toward the bison has not yet developed. Bergstrom's (1985) study found a correlation between farmers experiencing long-term wildlife damage and negative attitudes toward wildlife.

Landowners adjacent to PANP who were interviewed were eager to learn more about bison and were appreciative of the literature presented. Additionally they were interested in suggestions to reduce bison occurrences on their land. Similarly Bergstrom (1985) found farmers in the Forest Fringe Zone, requested more information on wildlife species, and on wildlife damage prevention measures than farmers in other areas. Concerns were raised by several landowners adjacent to PANP over hunting of bison by natives on unoccupied crown land. Bergstrom's (1985) results indicated farmers in the Forest Fringe Zone were concerned over illegal hunting by poachers and also thought hunting by treaty Indians was significantly affecting wildlife populations. Most felt all forms of hunting in the area should be highly regulated and monitored. Overall, this survey of landowners adjacent to PANP provided similar results to Bergstrom's (1985) study.

5.3 Ecological Management Considerations

5.3.1 Historical Evidence of Bison in the Prince Albert National Park Region

The historical skulls collected from the landowners confirm that bison once roamed in the PANP region. Several landowners stated they can remember when finding old bison skulls in fields was a common occurrence. From the results of the cranial measurements conducted by van Zyll de Jong (1991) it would appear plains bison were indigenous to the area of

PANP. This corroborates Soper's (1951) findings.

Today, PANP is home to two herds of plains bison, the free-roaming herd and the captive display herd. The semi-domestic display herd no longer serves its original purpose of preservation and conservation and is inconsistent with National Park policy of maintaining natural ecosystems (Canadian Parks Service 1987b).

5.3.2 Mortality

It is uncertain what factors are the most important in regulating growth of large herbivore populations. Caughley (1976) states that the growth of an ungulate population is primarily determined by the availability of forage regardless of the numbers of predators. Others (Mech and Karns 1977, Berry 1981, Messier and Crete 1985) suggest herbivore populations can be maintained below levels at which food is limiting due to predation or disease.

During 1990-1991 four known bison mortalities in PANP, were attributed to predation. Prior to 1990 the free-roaming herd suffered few known mortalities. The first occurred in 1978 when a park warden was called to destroy an adult cow which was in a weakened state in an adjacent landowners yard. It was determined the cow had a blocked intestine (Minton and Schmidt 1984). The only other known mortality occurred during the fall of 1988 when local natives killed an adult bull on adjacent unoccupied crown land (Burant pers. comm. 1989). Through the years there have been a couple of suspected

mortalities: one calf was not observed as a yearling by Collingwood (1980a) and Minton observed six calves in the spring of 1984 however only five were observed in the fall.

Predation on bison in PANP, does not appear to be concentrated on a particular age class. However, it is probable more calves are being preyed upon than are observed due to the fact that unless the carcasses of the calves are located immediately they probably will not be found as predators and scavengers can readily consume the entire carcass of a calf, leaving little evidence. If the herd was monitored closely throughout the year more predation would likely be observed.

A study completed in WBNP by Carbyn and Trottier (1987) found wolves displayed a preference for bison herds with calves and would actively seek them out. Similar patterns were observed in the SRL (Van Camp 1987). The majority (83%) of the observed mortalities due to predation in the MBS were calves. Gates and Larter (1990) suggested the increased bison calf biomass has resulted in an increased nutritional status for wolves, subsequently causing an increase in wolf density in the MBS. In recent years, Gates and Larter (1990) suggest declining calf survival as the main factor contributing to the decrease in the rate of growth of the MBS wood bison herd.

Evidence in the area of the yearling found in 1990 revealed that wolves chased the lone bison several km prior to bringing it down (Baird pers. comm. 1990). Skeletal remains

from the adult cow and yearling found in 1991 were located along the tree line on the edge of large open meadows. This might indicate the bison were fleeing from wolves and headed for cover, or perhaps the bison were more susceptible to attack along the treeline as the wolves were able to use the trees for concealment while stalking the bison. Gates (pers. comm. 1991) states that it is unusual for an adult bison cow to succumb to predation in mid-summer (Gates pers. comm. 1991). The cause of the cow's death is unknown, however, I suggest the following scenarios. The cow may have been ready to calve and wandered to the edge of the meadow and being vulnerable was attacked. Or, perhaps the cow had some physical handicap such as a broken bone, arthritis or some type of disease or parasite which rendered her weak and vulnerable to predation.

During the observed wolf attack on a calf in PANP, the calf ran to a cow while the cow positioned herself between the wolf and the calf, then actively chased the wolf away. In WBNP, Carbyn and Trottier (1987), observed several types of defence strategies bison would utilize to protect their calves. These included: a calf running to a cow, a bull, or to the center of the herd. All three are designed to distance the calf from the wolves as well as to keep an adult bison between the calf and the wolf.

In PANP, it was approximately 20 years after the bison began inhabiting the area before wolf predation was observed,

with more frequent observations occurring in subsequent years. Similarly in the MBS, Gates and Larter (1990) stated wolf predation on the herd was first recorded in 1983, approximately 20 years after the re-introduction of bison into the area. Since then, 24 occurrences of wolf predation have been observed (Gates and Larter 1990).

Predation in PANP by wolves was recognized during the summer primarily due to the fact the herd is not closely monitored during the winter. All of the observed mortalities from predation in the MBS occurred during the winter months (Gates and Larter 1990).

In recent years the number of elk and moose have been declining in PANP (Tarleton 1988), which may be one explanation why observed wolf predation on bison has increased. In the MBS Gates and Larter (1990) believe that as alternate prey sources for wolves (caribou and moose) decreased in numbers, the amount of wolf predation on bison increased.

In PANP, the calf mortality found in 1991 may also have been the result of an opportunistic black bear attack. While Wobeser (1991) thought it was likely due to a wolf attack, unlike other mortalities found, there was no evidence of wolves near the carcass. However, the calf survived for several hours following the attack and may have moved a distance from the actual attack site (Fau pers. comm. 1991). In northern bison herds black bears have occasionally preyed

on bison calves but are generally thought to have an insignificant impact compared with wolves (Britton and Graves 1983). Van Camp (1975) suggested black bears may prey upon calves during the calving season in the SRL.

Wolf predation can seriously affect calf survival and combined with other factors can have a significant impact on population growth of free-roaming bison populations (Britton and Graves 1983). The author believes this to be the situation beginning to appear in PANP. The incidence of observed predated bison has increased over the last three summers possibly explaining why the number of observed calves has decreased.

5.3.3 Disease Status

Presence of disease can create a serious problem for managers of bison herds in close proximity to domestic cattle, due to ranchers fear of possible disease transmission. PANP's free-roaming bison herd has not been tested for disease since the original transplant bison were given a clean bill of health in 1969 (Barrie 1969). Following their release, the bison have periodically mixed with adjacent landowners livestock both within and outside of the park. While there is no evidence to suggest the bison in PANP carry disease, the area surrounding PANP was one of the last reservoirs of brucellosis occurring in domestic cattle in Saskatchewan and the area was not declared brucellosis-free until 1983 (Tessaro pers. comm. 1991). The calf carcass located in May of 1991

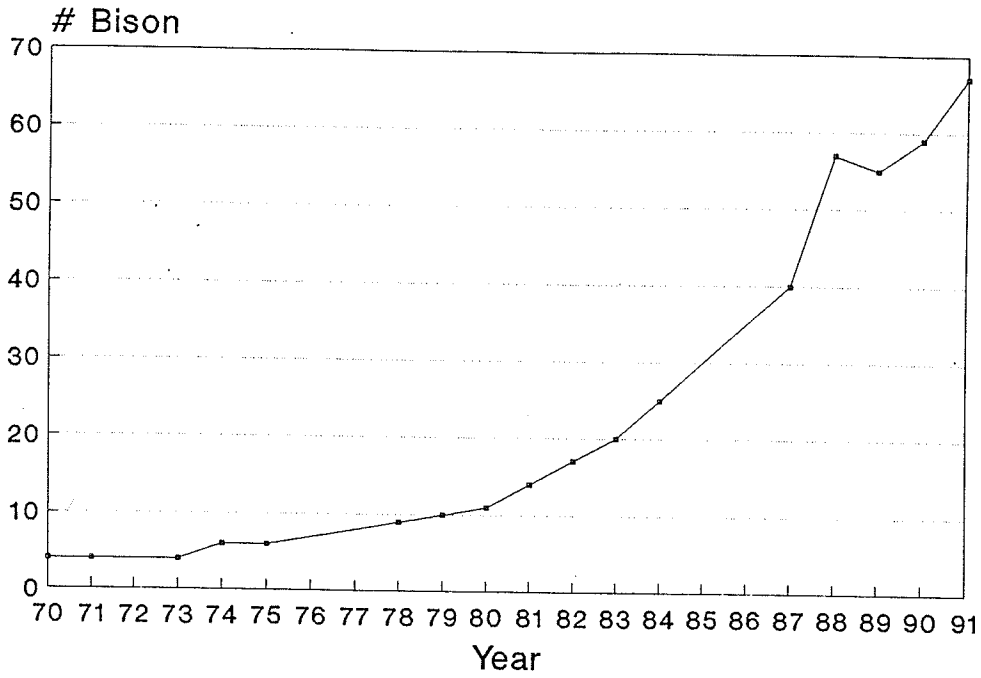
was found to be disease free and in good physical condition at the time of death (Wobeser 1991).

The possibility of disease transmission from bison to cattle is the focus on two of the largest free-roaming bison herds in the world, WBNP and YNP's. Tuberculosis and brucellosis which presently exist in the bison in and around WBNP were originally spread to bison via domestic cattle in the early 1920's (Ogilvie 1979). The exact origin of brucellosis in YNP is unknown and may well be endemic to the area (Meagher pers. comm. 1990). While transmission of bovine brucellosis from free-roaming bison to cattle has not been confirmed (Meagher 1989) transmission has occurred under experimental conditions (Tessaro 1989).

5.3.4 Population Growth

Caughley (1976) proposed four separate stages in an eruptive population: an initial period of rapid growth; a subsequent period of stability; a period of rapid decline; and in the final stage the population fluctuates with an amplitude determined by a variety of environmental factors. The average reproductive growth in bison varies considerably from herd to herd, as well as from year to year.

Growth rates of PANP bison appear to be decreasing in recent years, from an average growth rate of 19% (1978-1984) (Minton and Schmidt 1984 and Minton 1984) to an average of 11% (1989-1991). Based on total observed counts however the herd is still in a period of growth (Fig. 12). A similar growth



(Missing data: Years 72,76,77,85,86)

Figure 12: Total observed bison.

pattern appears to be occurring in the MBS, where the growth rate has decreased from a high of 26% in 1975 to a low of 10% in 1987. The main reason for the decrease in growth rates of both herds is attributed to predation.

A combination of several factors, such as the presence of disease (tuberculosis, brucellosis, and anthrax) high predation rates, changing habitat, severe winters, accidents (drowning), slaughters and hunting in and around WBNP caused the bison population to decrease at an average rate of 5% during the 1970's and 1980's (Messier 1989).

The average growth rate from 1973-1980 in the YNP bison herd was 12% (Houston 1982). While this is similar to the rate in PANP, the main regulator of population growth in the two herds appears to be different. Yellowstone National Park bison suffer little predation, however their severe winters act as the main population regulator. Secondary population regulators in YNP include brucellosis, and in recent years hunting of bison outside of the park (Meagher pers. comm. 1990).

Overall it appears population growth of bison is not regulated by one factor but rather a combination of factors none of which act in isolation of the other. These include: predation, severe winters, disease and hunting. Predation is the main observed population regulator and perhaps the reason herd growth has decreased in recent years, however the PANP free-roaming herd is still in a period of growth.

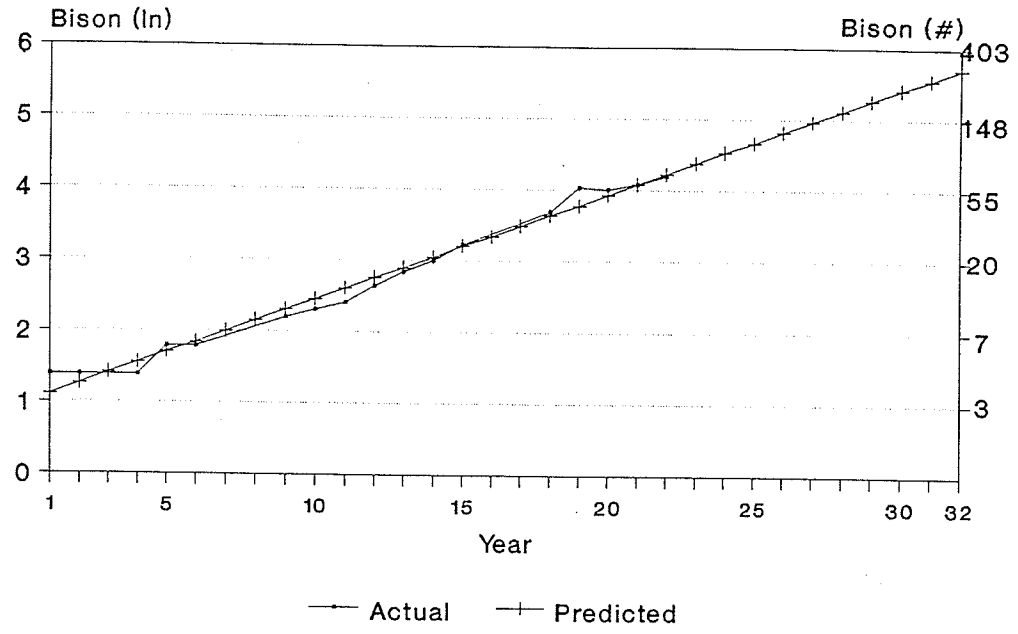
5.3.4.1 Regression Analysis

The natural log regression equation for the trend in population growth of the PANP free-roaming bison herd from 1970-1991 was determined to be, ln=.96398+.14837*year (year being the number of years following the release), with a correlation coefficient of .99, and an r-square value of .98. Using the regression equation to predict future numbers the herd will achieve 300 bison in approximately 10 years (Fig. 13).

5.3.5 Herd Structure

Herd structure within a bison population varies over time, from season to season and between herds. The main difference in the PANP free-roaming bison herd structure in 1989 from previous years is that fewer yearlings and bulls were observed. One explanation is that juveniles were not previously classified, as a result yearlings and adults may have been over represented (Table 4). Another reason may be that with increased predation less calves are surviving their first year. Fewer bulls being observed can be attributed to bulls solitude existence and depending on the time of year or even time of day bulls may or may not be near the mixed herds.

Herd structure observed in PANP (1989) is similar to the findings in WBNP of Fuller (1960) and Wilson (1991). Although in 1991 there was a significantly higher percentage of cows observed in WBNP. This may be explained by the fact juveniles were not separately classified, and different



(Year 1 - 1970)
(Year 32 - 2001)

Figure 13: LN regression of actual and predicted bison abundance on time (ln=.96398+.14838*year).

TABLE 4

HERD SIRUCTURE (%)

PRINCE ALBERT NATIONAL PARK

YEAR	BULLS	COWS	JUVENILES	YEARLINGS	CALVES
1978	22	34		33	11
1979	50	30		0	20
1980	46	27		9	18
1981	36	29		14	21
1982	35	29		18	18
1983	40	30		15	15
1984	36	32		12	20
1989	19	42	10	6	23

WOOD BUFFALO NATIONAL PARK

1960	21	39	15	9	16
1991	17	60	-	4	18

YELLOWSTONE NATIONAL PARK

1973	16	28	16	17	22

methodologies used. In WBNP the segregation survey concentrated on herds which contained cows and calves.

The main differences in herd structure between PANP and YNP (Meagher 1973) is that PANP herd has a smaller percentage of yearlings and juveniles but a higher percentage of adults (Table 4). This is probably due to the different population regulators. In PANP, predation may be the reason fewer younger bison were observed while in YNP severe winters combined with the presence of brucellosis may stress older bison resulting in fewer adults.

5.3.6 Calf:Yearling/Cow Ratio

Fuller (1960) stated free-roaming bison produce two calves every three years and therefore a ratio of 0.66 calves to cows is possible. In PANP, (1989) the ratio of calves to cows was 0.55, and the ratio of yearlings to cows was approximately 0.15. From 1978-1984 the average ratio of calves to cows was 0.64 and 0.39 yearlings to cows. Currently fewer calves are surviving their first year than previously observed. This is attributed to increased observed predation on calves, and also modification to the classification of bison.

In 1991, the ratio of calves and yearlings to cows in WBNP was 0.31, and 0.07 respectively (Wilson 1991). Wilson (1991) hypothesized that calf numbers may be under represented as the count takes place during the third week of June toward the end of calving season. It is speculated predation and other causes may have reduced the numbers of calves and yearlings

prior to the segregation count. In the MBS in March of 1989 the ratio of calves to cows was 0.44, and the ratio of yearlings to cows was 0.22 (Gates et al. 1991). In all three areas only a portion of calves survive their first year, lending support to the theory that predation can have a significant impact on certain age classes of free-roaming bison.

5.3.7 Habitat

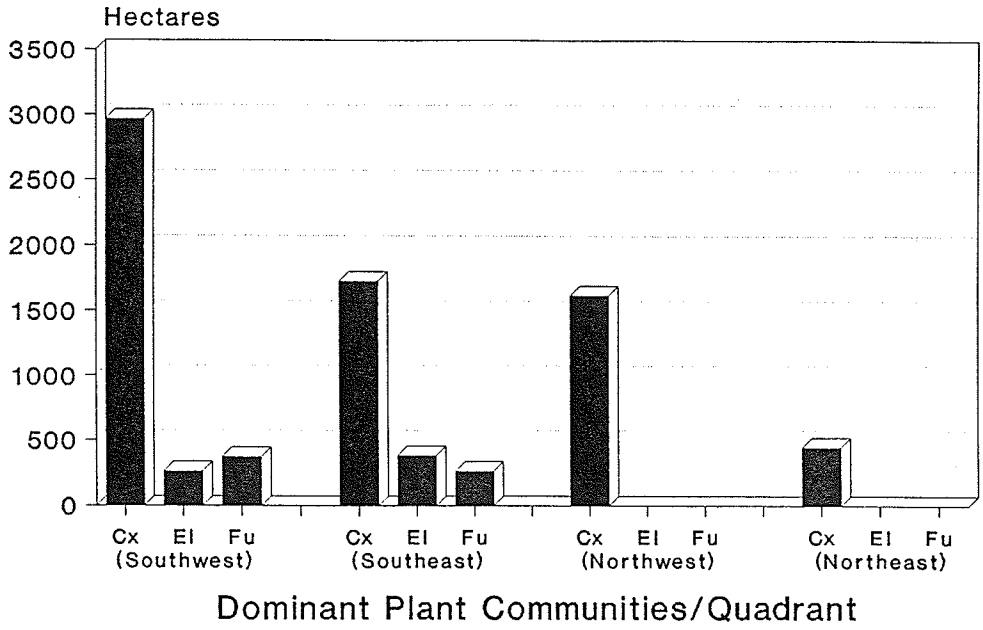
Bison are generally considered grazers and hence prefer various sedges and grasses. In PANP, bison preferred sedge-grass meadows throughout the summer. In WBNP, bison preferred forested areas interspersed with meadows during the summer while in winter bison preferred upland meadows, lowland floodplains and delta marshes (Soper 1941). This pattern is still being observed (Mercer pers. comm. 1991). Studies in the SRL (Reynolds et al. 1978, Hawley et al. 1981) indicated two genera made up approximately 80% of bison's diet, slough sedge (Carex artherodes) and reed grasses (Calamagrostis spp) while browse (Salix) made up approximately 3% of the bison's diet. Bison were not observed browsing on (Salix) in PANP. This may be explained by the fact the preferred sedge-grass forage appears abundant.

Larter (1988) found wood bison preferred sedges, particularly slough sedge (Carex artherodes) in the MBS. Sedges made up approximately 97% of their diet during the winter. In the summer the bison in the MBS were found to have

a more diverse diet consisting of sedges, grasses, willows, and lichens (Cladonia mitis). A large difference was also found in habitat preference from one summer to another. In 1986, sedge accounted for 70 to 90% of the bison's summer diet while in 1987 sedge dropped to 30 to 40% of their summer diet (Larter 1988). In 1987 (Salix) made up 39% of the summer diet. Larter (1988) believed this change to (Salix) in 1987 may have been caused by the decreased availability of standing sedge. Larter (1988) concluded that availability of forage was the main factor in determining habitat selection by wood bison. In general bison in the MBS appear to have greater variety in their summer diet than the free-roaming bison in PANP, which foraged exclusively on sedges and grasses. This difference may also be explained by the fact that primary bison forage, sedges and grasses were abundant in PANP and to different feeding habits of plains and wood bison of which the latter has pronounced seasonal changes in diet (Larter 1988).

5.3.8 Habitat Abundance and Distribution

Plant communities dominated by grasses within PANP occur primarily in the southern third of the park, along the southern and southwestern boundaries. The abundance and distribution of primary and secondary bison habitat throughout the four quadrants of PANP indicates that the majority of bison habitat occurs in the southern half of the park with the largest areas of primary bison habitat found in the southwest quadrant (Fig. 14) (Table 5). Both winter and



(Cx-Carex, El-Elymus/Agropyron,
Fu-Festuca/Stipa)
(Dominant->40% of an area)

Figure 14: Primary bison habitat within PANP.

TABLE 5

DISTRIBUTION OF PRIMARY AND SECONDARY BISON HABITAT IN PRINCE ALBERT NATIONAL PARK

* DOMINANT PLANT COMMUNITIES	QUADRANT	# OF HA	TOTAL (%) IN PRINCE ALBERT NATIONAL PARK
Primary Bison Habitat			
Carex (Cx1)	S.W.	2965	44
	S.E.	1728	26
	N.W.	1621	24
	N.E.	442	6
Elymus/Agropyron (El1)	S.W.	263	41
	S.E.	382	59
Festuca/Stipa (Fu1)	S.W.	372	59
	S.E.	262	41
Secondary Bison Habitat			
Salix/Carex (Sx1)	S.W.	3881	38
	S.E.	4252	42
	N.W.	1271	12
	N.E.	815	8

* Dominant Plant Community occupies 40% or more of an area (Padbury et al. 1978).

summer aerial observations reveal that the free-roaming herd's present range coincides with the largest areas of sedge-grassland meadows in PANP (Fig. 15). Aerial observations that occurred during the winter revealed that bison were observed more frequently in areas of secondary habitat (Salix/Carex). These areas occur along creeks and ponds and are quite wet during the summer however following freeze up bison can utilize these areas. There is also more shelter in these areas than in the large sedge-grassland meadows. While the southeast quadrant has a substantial amount of primary bison habitat it has even more secondary habitat. Presently the habitat in the southeast occur's several km from the bison's present range (Fig. 15). However, this may be an area for future range expansion by the bison, particularly for winter utilization.

Landowners properties that fell within the study area are predominately under agricultural production. The approximate division of this land includes 72% (9621 ha) in pasture, 10% (1334 ha) in hay, 17% (2244 ha) in various crops, and 1% (135 ha) unfenced forest. The area south-east of the study area consists of a provincial wildlife management area and community pasture (4276 ha). The area to the northwest is the beginning of the Northern Provincial Forest encompassing approximately 35,534,000 ha.

5.3.9 Succession

The sedge communities within PANP are considered

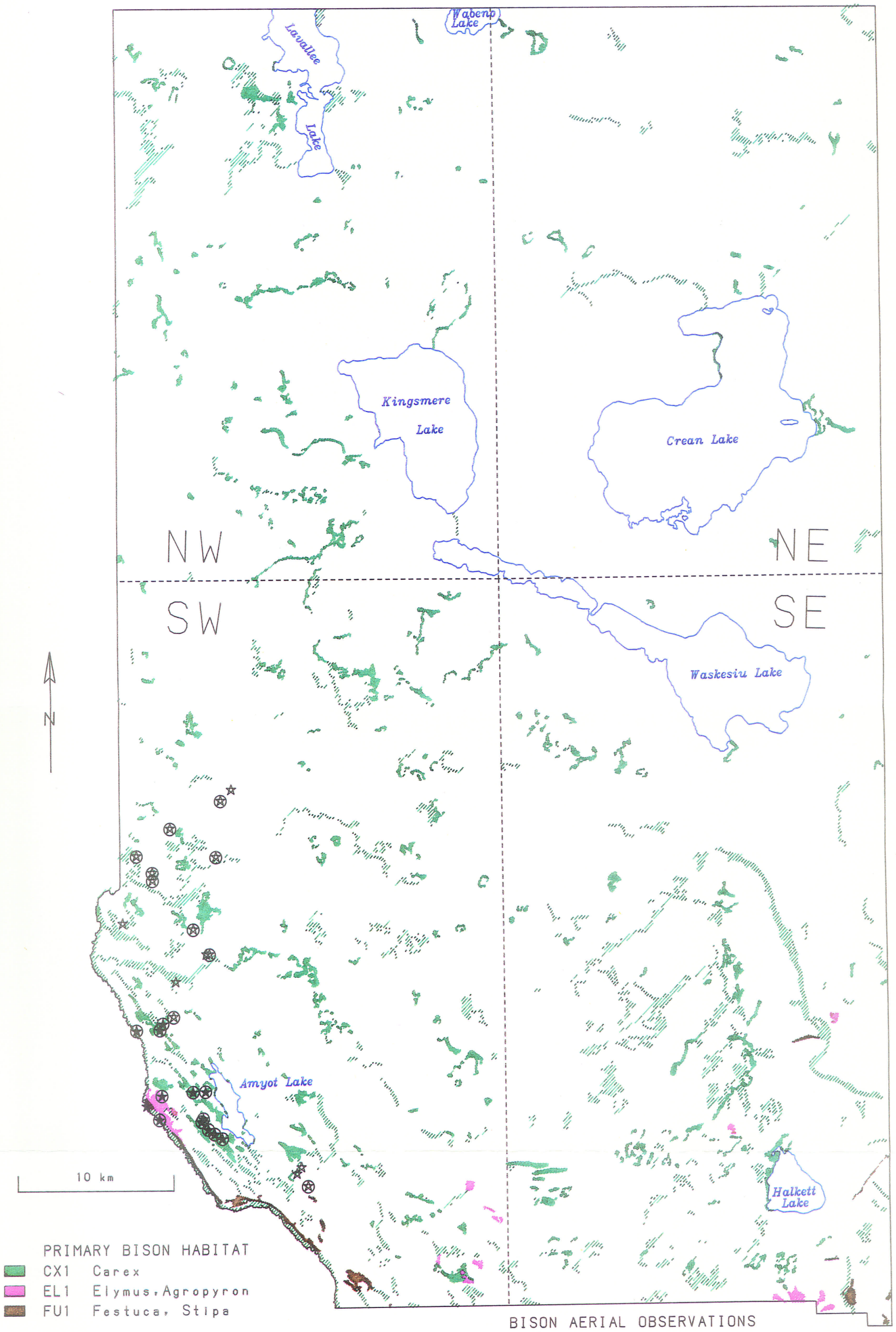


Figure 15: Bison habitat distribution and availability in Prince Albert National Park, and bison aerial observations, 1971 - 1991

relatively stable although the long term successional trend is toward (Betula/Carex) (birch/sedge) communities. In the large sedge meadows near Amyot Lake the succession of sedge is toward a (Salix/Carex) (willow-sedge) community particularly where previous burning and mowing have inhibited invasion of (Salix) (Padbury et al. 1978). From approximately 1930 (Cameron 1975) to 1958 (Peterson and Henry 1978) park wardens burned the shrub-grassland areas along the southern and southwestern boundary of PANP each spring. The burning was an attempt to minimize the threat of wildfire and maintain open grasslands which were aesthetically pleasing to people and preferred by elk (Cameron 1975). Cameron (1975) felt the cessation of burning is one factor which may have contributed to loss of grassland habitat within the park. Large meadows around Amyot Lake were also hayed by local landowners regularly until 1968 and as recently as 1977 (Tarleton 1988). Peterson and Henry (1978) studied the effects of haying on ungulate utilization of the sedge meadows in the southwest quadrant of PANP. Selected meadows were cut in the fall of 1977 by local landowners. Ungulates preferred the cut meadows to the uncut ones and also utilized cut meadows more the following winter. They recommended that further cutting of hay be done in early summer to allow for plenty of regrowth by winter. Local landowners feel a significant portion of the meadows that were once open in the park have now given way to willow and aspen reducing the overall abundance of sedge and

grassy areas (Reimer pers. comm. 1990).

5.3.10 Range

Dispersal is crucial to the existence of a species in a heterogeneous environment (Vance 1984). There are two basic types of dispersal: innate dispersal (Howard 1960); which appears to be instinct, and pressure dispersal (Caughley 1977); which involves dispersing to new areas only when density of animals reaches a certain threshold or when competition for food resources is intense. According to Waser (1985) it is the competition for vital resources that is limiting to reproduction and is the main factor in determining dispersal.

The range of the main herd is bounded by Fox Creek in the south, Lost Creek in the north, Amyot Lake in the east and the Sturgeon River to the west. These findings are similar to Collingwood's (1980a) except that his most southerly sighting of the main herd occurred near Pie Plate Creek which is approximately 4 km south of Fox Creek. Collingwood (1980a) also observed bulls south of the main herd's range around Rabbit Creek. Collingwood (1980a) found bison to be concentrated on the northern fringe of their summer range around Crossman Creek and the confluence of the Sturgeon River and Lost Creek in autumn and by November bison were on their winter range located northeast of Crossman Creek near Kiyam Lake.

Over the past several years PANP free-roaming bison's

summer range has remained relatively stable. This is probably due to the fact herd size is relatively small and there have been no large scale changes in habitat quality and distribution. However, in recent years bison have been observed in the meadows near Amyot and Snare Lakes during January and February (Baird pers. comm. 1990), indicating this area may contain habitat utilized annually.

In PANP, lone bulls were frequently observed on peripheral habitat patches several km from the main herd. No large scale shifts in the main herd's range were observed during the study period. Gates and Larter (1990) found wood bison bulls in the MBS to have an innate dispersal disposition, as they were often located on peripheral habitat patches several km from main cow herds. It was only when the main herds (cow/calf and sub-adult groups) moved to peripheral areas that resulted in range expansion. Gates and Larter (1990) felt the herd was responding to environmental pressure because on both occasions when major shifts occurred they corresponded with periods of high densities of bison, the critical density occurring between 0.5-0.8 bison per square km. Possible expansion areas in the MBS depend on the distribution of vacant meadows, as bison do not occupy areas where meadows are absent (Gates and Larter 1990). Larter and Gates (1990) also found female wood bison have larger home ranges than male wood bison. They speculated that this was due to the more gregarious nature of females and their high mobility, as they are associated with

larger groups resulting in females requiring larger grazing areas.

Overall it appears bulls in PANP exhibit innate dispersal while the main herd has not yet exhibited significant range expansion, probably due to the fact that numbers are relatively low.

5.3.11 Interspecific Competition

McHugh (1958) placed bison at the top of the interspecific dominance hierarchy. In PANP, both white-tail deer and elk were observed on several occasions within 50 m of the main bison herd, but in each case appeared indifferent to one another. Forage is not a limiting factor therefore animals could easily avoid one another. If, in the future, bison and elk populations increase, there is potential for competition and displacement outside of PANP.

In YNP, elk and bison will associate within 10 m of one another in spite of their seeming intolerance (Houston 1982). Bison and white-tail deer at Colorado National Monument did not appear to compete for food (Capp 1964). Moose are primarily browsers and as a result do not compete with bison for forage (Reynolds et al. 1982).

5.3.12 General Herd Behavior

In PANP, the largest bison herds were observed in large open meadows during summer. Group size also appeared to be determined by sex, with the largest groups consisting of cows, calves, and juveniles while adult bulls were generally

confined to smaller groups. In WBNP, Fuller (1960) believed both mixed and bull herds were smaller in forested areas than in large open meadows and that environmental factors such as available range and weather were main factors in determining herd size. In the MBS, Larter (1988) found mixed herds were largest during the summer and generally there was a tendency for smaller groups to be observed in forested habitats. Larter (1988) suggested the main factors affecting groups size were, sex, season, year, and temperature.

In PANP, both ground and aerial observations indicated the largest group size occurred during the post calving period. Bull groups appeared to be small in PANP throughout the entire summer. In the SRL Van Camp and Calef (1987) made similar observations with the largest mixed herds being observed during the post-calving period in June and July. They speculate this was in response to predation as large herds provided greater protection for calves. In WBNP this phenomenon was also observed with the largest herds observed during the post-calving period (Carbyn et al. 1989).

In PANP, aerial observations also revealed large groups during the rut similarly Wind Cave National Park reported mixed herd size was the largest during this time (Iowa Cooperative Wildlife Research Unit 1981).

5.4 Bison Migrations onto Adjacent Lands

Over the past three years free-roaming bison in PANP

migrated out of the park exclusively during the spring. Over the past three years, 100% of bison observations outside of the park occurred during May (62%) and June (38%). From 1989-1991 the bison were observed out of the park 13 occasions or on average four times per year.

The following possibilities are offered as to why the bison migrate onto adjacent lands during the spring. Spring is calving season and the cows may expand their range briefly and prefer the open areas outside of the park to guard against predators. Another reason may be the bison are searching for new spring forage. Areas adjacent to the park have earlier forage growth than the park. Within the park, the old layers of growth from previous years are not removed thus requiring a longer time period for the new green shoots to appear and become available to bison. In late June once this new growth is readily accessible within the park the bison appear to be content to remain within PANP. From 1978-1985 bison migrated out of the park the majority of the time during June (Minton and Schmidt 1984, Minton 1984, Tarleton 1985) (Table 6). Prior to 1987 bison were observed out of the park on more occasions during the summer although during this period bison could simply walk out of the park on a roadway. Construction of a Texas Gate across the road in the fall of 1987 deterred migration as the bison were forced to cross the river in order to exit the park in this area.

Resource managers around YNP are faced with the continual

TABLE 6

BISON MIGRATIONS ONTO ADJACENT LANDS

YEAR	FEB.	MAR.	MAY	JUN.	JULY	AUG.	SEPT.
1976				1			
1978			1		2	1	
1979			1	2	1	1	
1981			2	1	6	3	1
1982				2			2
1983			1	1	1		
1984	1	1	2	5		1	
1985			1	1			2
1986				1	1	1	
1987			3	3	2		
*1989				2			
*1990			3	3			
*1991			5				
TOTALS (%):	2	2	28	32	19	10	7

* (After Texas Gate)

problem of migrating bison leaving the park and crossing onto private and public lands. Research to determine why range expansion occurs, as well to establish effective means of disrupting or controlling this expansion was undertaken. The initial migration out of YNP was attributed to a severe winter. In subsequent winters even though they were mild, seasonal migration from YNP continued. This change in movement pattern from 1976 to 1987 was not found to be significantly correlated with a population increase of bison. Available forage did not appear to be a limiting factor particularly in mild winters when there appeared to be an abundance of available forage within YNP (Meagher 1989). Meagher (1989) suggested an acquired knowledge of areas having less snow could have been one reason for continued movement.

While the herd size in PANP has increased from 1978 the number of occurrences per year on adjacent lands has decreased. However, the average number of bison out during each occurrence has increased from an average of eight in the period 1979-1983 (Minton and Schmidt 1984) to an average of 12 during 1989-1991.

5.5 Migration Routes

Migration routes out of PANP consist of bison travelling down the Sturgeon Valley and then crossing the Sturgeon River. Once across they are either on a landowners field or leased provincial crown pasture land.

In PANP, bison do not travel great distances once outside the park with the furthest observation occurring one km from the park boundary. In addition, bison do not remain out of PANP for extended periods (longest being two days) as they have returned on their own or have been herded back into the park.

Movements of bison out of YNP first followed natural topographic routes along the Yellowstone River. However, once the bison located the plowed winter roads they became the primary migration routes. In both PANP and YNP bison appear to seek the easiest migration route in the area and once located use it in subsequent years. Unlike PANP, bison in YNP travel several km from the park and remain out for several weeks (Meagher pers. comm. 1990). This could be due to the fact that lands adjacent to the main area of crossing in PANP are predominately under seeded crops which bison do not prefer for grazing. Lands adjacent to YNP are almost exclusively grazing land which are preferred by bison.

5.6 Cattle in Prince Albert National Park

Not only do bison migrate onto landowners properties but cattle also migrate into PANP. Over the three summers of the study there have been a total of 260 cattle in the park compared to 156 bison out of the park over the same period. The main causes for cattle leaving their pasture are fence breakage, lack of forage in late summer, or the Sturgeon River

has dried up enough in late summer to permit the cattle to get around existing fences. Presently this is not a major concern, however it may become so in the future. Bison may interbreed with the cattle, contact certain diseases or parasites from cattle, or simply follow the trails established by cattle out of the park. Additionally, when cattle break fences the opportunity exists for bison to gain easy entry onto the landowners property.

5.7 Attempts to Minimize Bison Occurrences on Adjacent Lands

Between 1989-1991 bison were herded off landowner's properties on foot, with the aid of a vehicle siren, and with the use of crackershells. Similar methods were used in the past (Minton 1984). These methods were effective in herding bison into PANP. Bison have been observed near the Texas Gate on several occasions and in most cases it has proven effective in blocking travel. The gate was jumped once, by four bison as they were being herded back into the park by a local landowner. In PANP short fences were constructed on known bison trails out of the park. It appears this method of deterrence only results in bison finding new travel routes. Reflective tape attached to adjacent landowners fence was also ineffective as the bison continued to knock it down when out of the park.

As an alternative to controlling the spread of brucellosis within the park, YNP adopted a boundary control program.

During the initial stages the program involved park officials shooting bison that were observed approaching designated areas. For several years the likelihood of a large scale movement out of the park seemed unlikely (Meagher 1985) as only three bison (all bulls) were shot in the first 6 years of the program. However, the situation changed during the winter of 1975-76, when approximately 80 bison moved west down the Yellowstone River and then north of their traditional winter range near Gardiner, Montana (Meagher 1989). This movement peaked in 1988-89 when 900 bison were observed along the northern park boundary and on state land. This movement was originally viewed by park staff as highly unusual, due to the severe winter and not likely to re-occur. However, in subsequent years this migration continued, and under pressure from various interest groups, the National Park Service implemented experimental management practices to deter bison from migrating to areas near the north boundary (National Park Service 1986). Several different methods were used including: herding; physical barriers; and various scare devices. Herding of bison on foot was effective the first winter, but unlike the situation in PANP bison soon became unresponsive. Use of a helicopter resulted in the bison scattering for cover which made them even more difficult to move. It also resulted in damage to fences as domestic animals on private lands outside the park were frightened. Its use was subsequently discontinued. Physical barriers such as cattle guards (Texas

Gates) and short fences were placed on known trails to block travel routes only resulted in movement elsewhere. Scare devices used in YNP included: vehicle sirens; tin can rattles and crackershells. These devices had little effect alone, but when used in combination with vehicular or human movement, effectively displaced bison. However the bison in YNP soon grew accustomed to these devices and overall they were not successful in producing any large scale movements. Pain inflicting devices such as bird shot and rubber bullets were effective, but only on individual bison hit. Because lack of available forage was not determined to be a main cause for migration baiting with hay was unsuccessful, as was the scattering of charcoal on snow to increase spring melt and make forage sites more available. In general, the methods attempted in YNP to maintain the bison within the park appear to have been futile (Meagher 1989).

Overall, methods used to maintain bison within PANP were more effective than similar attempts in YNP. This may be due to several factors including: 1) the average herd size of bison outside of PANP is considerably smaller; 2) the distance the bison travel once outside the park is less; 3) the bison once out of PANP spend shorter periods of time outside of the park; 4) vacant preferred winter habitat does not exist in areas adjacent to PANP unlike YNP; and possibly 5) bison in PANP have not yet grown accustomed to deterrent activities.

5.8 Aerial versus Ground Bison Surveys

Using different observational methods can lead to inaccurate estimates of total bison numbers, sex and age ratios. Aerial surveys almost always underestimate animal abundance (Caughley 1977) and ground counts produce biased estimates of sex and age ratios (Downing et al. 1977). In PANP, aerial observations revealed the largest total counts, however it was difficult to age/sex the bison from the air. While it was easier to age/sex the bison from the ground it was difficult to find large numbers of bison together at the same time in large openings to allow for accurate evaluation. The herd usually consisted of smaller groups and would usually wander off into nearby cover when approached. Meagher (1978) considered aerial censuses in winter as the preferred method of determining bison population levels in YNP. A study conducted by Wolfe and Kimball (1989) compared ground and aerial surveys in estimating bison population numbers and sex ratios. They determined aerial surveys provided accurate estimates of adults in the population but estimated the accuracy of calves was much lower. They stated timing as an important consideration if accurate numbers of calves are to be determined. Ground surveys used to determine sex ratios produced severely biased estimates but were still better than sex ratio estimates from the air.

CHAPTER VI

CONCLUSION and RECOMMENDATIONS

"No aspect of a conservation program can progress faster than with public acceptance and understanding" (Leopold et al. 1952).

The challenge presented to resource managers is one of balancing the historical and intrinsic significance of maintaining a viable free-roaming bison herd which as a major herbivore represents a missing link in the regional ecosystem. While at the same time, not placing undue stress on adjacent landowners, but rather continuing to maintain their positive support.

A primary responsibility of governments should be to assist users of private and public land through advice, information and education on the most suitable methods for prevention and control of wildlife depredation (Dorrance 1983). Presently the situation around PANP with regard to landowners' concerns over the bison is not at a critical stage which requires an urgent and immediate solution. Landowners generally have a positive attitude toward the bison and most have and are willing to continue to tolerate bison on their property occasionally. The main concerns of landowners around PANP are over the damage to crops and fences. While these landowners have traditionally suffered depredation from elk, moose, deer, bear and beaver, bison are unique in that landowners have few options available to deal with the bison. If bison/agricultural conflicts increase in severity there

will be a need for additional options available to the landowner. Options should begin with prevention methods, control methods then finally compensation to landowners for damage.

The primary concern of mangers of the PANP free-roaming herd as well as most landowners, is not so much the present situation but the potential conflicts that may develop in the future as the herd continues to increase. The opportunity exists for a proactive wildlife management program rather than the traditional reactive one. It will be to the benefit of all the main stakeholders (CPS, SDNR, landowners, and local native groups) if a management strategy is put into place in the near future and built on the current positive attitude of adjacent landowners.

There presently exists large information gaps about the ecology of the free-roaming herd. Resource managers of other free-roaming bison herds identified these gaps in their bison management plans. Which included focusing on the following: monitoring total numbers and mortalities; determining herd structure; habitat usage; the availability and distribution of this habitat; range and migrations. This paper only introduced these ecological management considerations. Research into understanding these factors should be considered during the planning for a management strategy for the herd.

Wildlife management in National Parks has evolved from active programs such as feeding, culling, meat production,

disease and predator control to a more passive hands off approach. It was the Department of Dominion Parks which was responsible for the initial plains bison conservation effort in Canada and the CPS continues to be one of the main agencies responsible for plains bison conservation. Therefore the CPS should be a key organization in the creation of a national bison strategy.

6.1 Recommendations

The author recommends the CPS do the following:

1) Consider PANP's free-roaming bison herd a unique resource which is part of the ecological integrity of the area and that preservation of a viable population be given priority in management. This will require the cooperation of the following groups: SDNR; local landowners; and local native groups in the development of an integrated planning program for the region.

2) Initiate and participate in discussions with the above groups. Discussions should allow for information exchange and for the establishment of common goals and objectives for the bison and serve as a forum for conflict resolution. An interim management plan should be established with short term goals and objectives created. The following options to minimize conflicts could be considered: 1) fencing areas of known bison migrations, 2) expanding the Texas Gate and construct another one at the north crossing, 3) prompt

attention by the CPS or SDNR personnel to actively herd bison from landowners properties when feasible and to assess damages and if necessary 4) removal of problem bison through hunting by local natives when bison are on unoccupied crown land.

2) Over the long term facilitate input from the stakeholders and other interested groups. Then develop a comprehensive management strategy for the bison herd in the area. A regional ecosystem approach should be established which could focus not only on the park and the park's resources but on provincial and private lands surrounding the park. The entire issue of wildlife depredation should be considered with bison being one feature.

3) Ecological management considerations which should be considered in a management plan for the bison include:

a) Total counts conducted annually to determine population trends, this would be accomplished best using aerial surveys during March.

b) Segregation counts conducted annually to determine age and sex class. Both air and ground observations should be utilized.

c) Mortalities should be monitored when observed. Attempts should be made to determine cause of death. It would be useful to collect specimens such as primary incisors for aging, bone marrow for determining health status prior to death, tissue samples for disease and possible (DNA) testing.

d) Summer and winter habitat within the region

should be studied to determine quantity and quality of preferred bison forage namely, the grasses and sedges. This should include establishing an approximate carrying capacity for the area, and whether controlled burning has a role in maintaining bison habitat.

e) Determine winter range through ground and aerial surveys and closely monitor any changes in range.

4) In order to accomplish the above there will be a funding requirement to achieve the goals of an integrated mananagement program. Resources presently dedicated to a captive herd of semi-domestic bison could be used for research and management of the free-roaming wild bison.

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Appendix A

LANDOWNER QUESTIONNAIRE

LANDOWNERS
STURGEON VALLEY AREA

SUBJECT: FREE-ROAMING BISON

I am a student at the University of Manitoba, and am working toward a master's degree in Natural Resources Management. This summer (May-September 1990) I will be collecting data on the free-roaming bison herd in and around Prince Albert National Park. A large part of my data will consist of a questionnaire which I hope will determine any major concerns you have with the bison.

In case you are not all that familiar with the bison herd, I will give you a brief summary of their background. In 1969, 50 plains bison were released approximately 60 km north of Montreal Lake, Saskatchewan by the Saskatchewan Department of Natural Resources. The bison however did not stay in this area and migrated south. Eventually two small herds formed, one the result of a capture and re-release near Primrose Air Weapons Range, the other independently chose to occupy the southwestern portion of Prince Albert National Park. This herd has slowly increased from ten in 1979 to the 1989 count of approximately 55 animals. This herd is only one of three such free-roaming plains bison herds in Canada and the only one in a Canadian National Park.

I will be giving you a phone call about a week after you receive this letter, during which I would like to arrange a time at your convenience that I could talk with you about the questionnaire. As I know most of you are extremely busy, I would not expect to take more than half an hour at the most. The questionnaire is attached. You can fill it out at your own leisure and I can pick it up when I stop by. The purpose of this information is to consider the views of local landowners in the long term management of this herd. The success of this project depends a great deal on the information I receive from this questionnaire. Your cooperation is greatly appreciated. I am looking forward to talking with you.

Sincerely,

Doug Bergeson
University of Manitoba

Att.

University of Manitoba
Land-Owners' Questionnaire: Free-roaming Bison

Thank you for your time. This study is designed to tell us your views on the long-term management of the free-roaming bison herd in Prince Albert National Park.

I have attatched some extra paper if you do not have enough space for your answers.

Please remember that completion of the questionnaire is voluntary. If you choose to respond, your answers will be protected by Canada's Access to Information and Privacy Acts. If you have any questions about this study, or if you would like to receive a summary of its findings, please contact me at the Natural Resources Institute, University of Manitoba, at (204) 474-8373.

Thank you,

Doug Bergeson, University of Manitoba

1. Have you ever had bison on your property? If so, in which years and in which months? If not, please go to Question 3.

2. If you have had bison on your property, please describe their activity.

3. Do you feel that anything needs to be done to reduce the number of times that bison roam onto farmland? If so, do you have any suggestions?

(Please turn over to continue...)

4. Do you foresee any change in bison activity in the future?

5. Do you have any other concerns or suggestions about the bison herd?

Thank you again for your participation in this study. Your input will help to determine the future management of the bison herd with your views in mind.

Please hold on to this questionnaire. I will contact you about a week after you it arrives to arrange a time to pick it up. In the meantime, I look forward to meeting you.

Appendix B

LANDOWNER INTERVIEW QUESTIONS

1.) Do you feel there is a need for protection for the bison outside of Prince Albert National Park?

2.) Should there be improved access on the west side of Prince Albert National Park to encourage a greater awareness and appreciation of the bison?

3.) Is there any amount of damage caused by the bison herd that you are willing to tolerate?

4.) Who do you feel should be responsible for any damage caused by the bison herd?