# Resident Opinions Concerning Urban Deer Management in the Greater Winnipeg Area, Manitoba, Canada

by

Erin McCance

A Thesis submitted to the Faculty of Graduate Studies of

The University of Manitoba

in partial fulfillment of the requirements for the degree of

MASTER OF ENVIRONMENT

Department of Environment and Geography

University of Manitoba

Winnipeg

THE UNIVERSITY OF MANITOBA

FACULTY OF GRADUATE STUDIES

*****

COPYRIGHT PERMISSION

# Resident Opinions Concerning Urban Deer Management in the Greater Winnipeg Area, Manitoba, Canada

BY

Erin McCance

A Thesis/Practicum submitted to the Faculty of Graduate Studies of The University of Manitoba in partial fulfillment of the requirement of the degree

Of

MASTER OF ENVIRONMENT

**Abstract:**

This human dimensions study is a quantitative, four-wave, self administered mail-out questionnaire of a random selection of 4000 residents within the Greater Winnipeg Area (GWA) of Manitoba, Canada, conducted to investigate residents' opinions and tolerances toward a growing urban white-tailed deer population, and to assess residents' preferences concerning potential urban deer management strategies. The study adopts a modified version of Dillman (2007) mail survey methodology. Results indicate preference both for non-lethal methods of action and for resident involvement in the creation of management plans. The study suggests how human dimensions, along with biological and ecological information, might be incorporated into potential urban deer management decisions.

**Acknowledgements:**

I thank Tim Davis, Master of Environment candidate at the University of Manitoba, and Monica Sirski, with the University of Manitoba statistical advisory board, for their patience and tutelage. I acknowledge the funding support of the Manitoba Wildlife Federation, and Manitoba Conservation, without whose support this study would not have been possible.

I thank my thesis advisory committee: Robert Bruce, Regional Wetland and Wildlife Biologist for the Operations Division/Central Region, for locating information, providing guidance, and devoting many additional hours of work to assist me in this process, thank you. I thank Dr. Michael Campbell and Dr. Rick Riewe for their support and direction throughout this past year. I especially acknowledge and thank my primary advisor, Dr. Richard Baydack. I first met Dr. Baydack only weeks prior to the start of term, after nearly ten years of not having been a student, as a mother, potentially considering a life change to leave my career and return to the University of Manitoba to pursue this endeavor. It would not have taken much to discourage me at that time, since the mere notion and process seemed quite overwhelming. Without knowing me, Dr. Baydack instantly made doable what had seemed insurmountable to me. Dr. Baydack provided direction, guidance, and a good bit of faith. He continued to do this for me every step of the way throughout this process. You have made a difference for me as a student, Dr. Baydack. I thank you for this opportunity and privilege.

On a personal note, a number of people have been fundamental for me in this process. To my mother, whose insight led me here, I thank you for your continued belief in my abilities, and your devotion and commitment to seeing me through this degree. I

admire your strength, drive, determination, and courage. I model myself after you. To my father, whose support was instrumental, without whom this opportunity would not have been possible, thank you for your hard work, and your love. To my husband: it is difficult to articulate my appreciation for your continuous support. The decision to return to school has given me a new direction in life, which would not have been possible without your sacrifice, commitment, and motivation. I thank you for all you have done. I will always be thankful for this gift. To Matthew, for being a patient three year old who enjoyed many stories of white-tailed deer biology and mail survey methodology, I adore you!

*For Matthew*

## TABLE OF CONTENTS

**Abstract** ..... I

**Acknowledgements** ..... II

**Dedication** ..... 1V

**Table of Contents** ..... V

**List of Figures** ..... VIII

**List of Tables** ..... X

**List of Appendices** ..... XI

**Chapter 1: Introduction** ..... 1

Study Purpose ..... 4
Thesis Organization ..... 5

**Chapter 2: Literature Review** ..... 7

Distribution and Biology of White-tailed Deer ..... 7
White-tailed Deer Distribution ..... 7
Manitoba ..... 8
City of Winnipeg ..... 9
White-tailed Deer Biology ..... 12
Size ..... 12
Pelage ..... 12
Antlers ..... 13
Glands ..... 14
Teeth ..... 14
Eyes ..... 15
Senses ..... 15
Vocalization ..... 15
Gait ..... 16
Digestion ..... 16
Food Sources and Nutrition ..... 17
Life Span and Reproductive Rates ..... 18
Populations Genetics ..... 20
Sex Ratio ..... 21
Mortality ..... 21
Winter Adaptations ..... 22
Habitat ..... 23
Range ..... 24
Summer Range ..... 25
Winter Range ..... 26
Activity and Movement ..... 27
Activity and Movement in Manitoba ..... 29
Dispersal ..... 31
Behavior ..... 32

Breeding ..... 32
Birth ..... 33
Social Groups ..... 34
Social Hierarchy ..... 35
Yarding Behavior ..... 35
Water ..... 36
Impacts of White-tailed Deer on the Ecosystem ..... 36
Disease ..... 37
White-tailed Deer as a Keystone Species ..... 38
Twentieth Century Urbanization ..... 38
Human-Wildlife Conflict ..... 42
Human Dimensions of Wildlife Management ..... 47
White-tailed Deer Management ..... 54
Non-Lethal Methods of Management ..... 54
Public Education ..... 54
Habitat Modification ..... 55
Prohibiting Feeding Deer ..... 56
Chemical Repellants ..... 56
Scare Tactics ..... 57
Barrier Fencing ..... 57
Road Safety Signage ..... 58
Promote the Use of Deer Whistles on Vehicles ..... 58
Trap and Relocation ..... 58
Immunocontraceptives ..... 59
Surgical Sterilization ..... 61
Status Quo ..... 61
Lethal Methods of Management ..... 62
Selective Cull ..... 62
Trap and Euthanize ..... 63
Sharpshooting ..... 63
Controlled Hunting ..... 64
Regulated Bow and Arrow Hunting ..... 65

**Chapter 3: Methodology** ..... 67

Study area ..... 67
Survey Stratification ..... 68
Land Use and Cover ..... 68
Human Population ..... 69
Research Design ..... 69
Sample ..... 71
Mail Survey Construction ..... 72
Questionnaire Construction ..... 73
Pre-test ..... 76
Survey Implementation ..... 77
Cover Letter ..... 77
Mailing Timeline ..... 80
Non-Response Error Follow-up ..... 81

Analysis ..... 81
Database ..... 81
Statistics ..... 82
Global Information Systems ..... 83
**Chapter 4: Results** ..... 84
Pre-test ..... 84
Survey Findings ..... 85
Response Rate ..... 85
Demographics ..... 85
Overall Findings of Questionnaire ..... 87
Statistical Relationships ..... 113
Chi-Square Testing ..... 113
Gender ..... 113
Age ..... 115
Education ..... 116
Other ..... 116
Logistic Regression ..... 117
GIS Analysis ..... 121
Spatial Distribution of Response ..... 121
Spatial Distribution of Management Preference ..... 122
Non-Response Bias Follow-up ..... 124
**Chapter 5: Discussion and Conclusion** ..... 127
Study Limitations ..... 127
GWA Residents' Opinions, Tolerances, and Management Preferences ..... 128
Implications for Urban Deer Management ..... 130
Potential Urban Deer Management Plan ..... 131
**Works Cited** ..... 136

## LIST OF FIGURES

Figure 1: Graphical image of estimated WTD population growth within Winnipeg ..... 11
Figure 2: Annual number of white-tailed deer complaint calls in Winnipeg received by Manitoba Conservation ..... 46
Figure 3: Age of respondents. ..... 85
Figure 4: Highest education level of respondents ..... 86
Figure 5: Years lived in the GWA. ..... 87
Figure 6: Number of respondents who have seen deer in their neighborhoods ..... 88
Figure 7: Type of vegetation on respondents' property ..... 89
Figure 8: Type of landscape near residents' homes believed to be occupied by deer ..... 90
Figure 9: Type of wildlife-related activity respondents engaged in ..... 91
Figure 10: Number of respondents who know of human-deer conflict ..... 93
Figure 11: Number of respondents with a household member experiencing deer-related conflict ..... 94
Figure 12: Type of deer-related landscape damage experienced ..... 95
Figure 13: Type of property protection residents attempted ..... 95
Figure 14: Number of respondents who consider deer to be an esthetic resource ..... 96
Figure 15: Number of respondents who consider deer to be a nuisance ..... 97
Figure 16: Type(s) of wildlife residents are feeding ..... 98
Figure 17: Respondents' overall concern about the GWA deer population ..... 100
Figure 18: Number of respondents who believe public education is needed ..... 100
Figure 19: Method of public education respondents feel would be most effective ..... 101
Figure 20: Number of respondents who would like to see number of deer change ..... 102
Figure 21: Respondents' preferences in regard to deer population size changes ..... 102
Figure 22: Respondents' preference as to the most appropriate deer management strategy ..... 106
Figure 23: Respondents' preference as to the second most appropriate deer management strategy ..... 107
Figure 24: Respondents' preference as to the least appropriate deer management strategy ..... 108
Figure 25: Respondents' preference as to the second least appropriate deer management strategy ..... 108

Figure 26: Number of respondents who believe the deer population needs to be managed.....109
Figure 27: Respondents' opinion as to who should create the deer management plan .. 112

## LIST OF TABLES

Table 1: Resident level of interest in various deer-related activities ..... 92

Table 2: Resident attitudes toward deer in the GWA ..... 98

Table 3: Resident level of concern toward deer-related issues. ..... 99

Table 4: Resident rank of acceptability of potential urban deer management ..... 104

Table 5: Resident rank of effectiveness of potential urban deer management ..... 105

Table 6: Resident rank of importance of aspects of urban deer management ..... 111

Table 7: Resident rank of effectiveness of methods to gather public input ..... 113

Table 8: Age, gender, and education in relation to lethal methods of management ..... 118

Table 9: Age, gender and education in relation to those opposed to killing deer ..... 119

Table 10: Age, gender and education in relation to those wanting minimial the use of firearms within city limits ..... 119

Table 11: Age, gender, and education in relation to population reduction ..... 120

Table 12: Age, gender, and education in relation to two variables ..... 121

## APPENDICES

Appendix 1: Map of 2006 deer numbers from aerial survey conducted by MB Conservation ..... 141
Appendix 2: Deer density map per FSA ..... 142
Appendix 3: Map of 2005 GWA reported deer-vehicle collisions ..... 143
Appendix 4: Map of study area ..... 144
Appendix 5: GWA land use and land cover map ..... 145
Appendix 6: Map of the GWA human population based on the 2006 Statistics Canada Census ..... 146
Appendix 7: Map of the GWA population density based on the 2006 Statistics Canada Census ..... 147
Appendix 8: The survey ..... 148
Appendix 9: First mail out cover letter ..... 167
Appendix 10: Postcard thank-you/reminder ..... 168
Appendix 11: Final mail out cover letter ..... 169
Appendix 12: Non-response bias telephone Interview ..... 170
Appendix 13: Number of respondents by FSA ..... 177
Appendix 14: Number of respondents by FSA compared to 2006 deer numbers ..... 178
Appendix 15: Percentage of respondents finding lethal methods of action the most appropriate compared to 2006 deer numbers ..... 179
Appendix 16: Percentage of respondents finding non-lethal methods of action the most appropriate compared to 2006 deer numbers ..... 180
Appendix 17: Female respondents finding non-lethal methods of action the most appropriate ..... 181
Appendix 18: Male respondents finding non-lethal methods of action the most appropriate ..... 182
Appendix 19: Percentage of respondents wanting urban deer management compared to 2006 deer numbers ..... 183
Appendix 20: Degree of importance of minimizing the killing of deer compared to 2006 deer numbers ..... 184
Appendix 21: Degree of importance of minimizing the use of firearms within city limits compared to the 2006 deer numbers ..... 185

# CHAPTER ONE

# INTRODUCTION

Beginning in the late nineteenth century, with the realization that wildlife is an exhaustible resource, conservation efforts in North America assumed responsibility for assisting in the biological restoration of white-tailed deer (*Odocoileus virgianius*) populations from the threat of extinction (McCabe and McCabe, 1984). These conservation efforts, coupled with the unique survival strategies of the species, have enhanced white-tailed deer resiliency in a number of altered environments. The adaptability of white-tailed deer, varying according to geographic location, has contributed to the survival of the species in a wide variety of habitats and changing environmental conditions, in the midst of predators and in response to human impact. White-tailed deer are the most widely distributed large mammal in North America and are considered today's most popular big game species (DeNicola et al., 2000). This is an incredible success story for an animal that was threatened with extinction just over one hundred years ago.

The highly resilient and adjustable nature of white-tailed deer has contributed to their ability to survive in human altered landscapes. White-tailed deer have been successful in their ability to adapt and thrive in urban, metropolitan environments. Adams et al. define an urban environment as one that has a large central place and adjacent densely settled census blocks that together have a total population of at least 50,000 people (Adams et al., 2006). White-tailed deer find refuge in urban centers due to hunting restrictions, firearms discharge laws, and minimal predation (Adams et al., 2006).

Deer habitat is defined as the area where deer live. Bulloch (1987) suggests habitat is not synonymous with cover but rather suitable habitat is defined as the area where all habitat requirements of a species for a particular season (or year round) are met. This is in comparison to cover which is defined as the area where the animal finds protection (Bulloch, 1987). Urban environments provide white-tailed deer with adequate shelter, available water and both natural and human supplemented food sources. These factors, coupled with a high birth rate, have resulted in increasing white-tailed deer populations in largely human populated areas. In some cases, overabundant white-tailed deer populations have surpassed the biological carrying capacity of an area, where overabundant deer populations over-browse on flora and permanently alter the ecosystem (Conover, 2002).

Urban deer populations may potentially lead to human-deer conflict. As white-tailed deer populations increase in metropolitan areas, the number of human-deer conflicts generally increase (Adams et al., 2006). White-tailed deer cause commercial and residential property damage by eating natural and managed flora, and pose a significant human health and safety concern. Urban deer are involved in an increasing and alarming number of motor vehicle accidents (Decker et al., 2001). As well, white-tailed deer are a host for some diseases transmittable to humans (Hesselton and Hesselton, 1982). Yet, despite the increasing occurrence of urban human-deer conflict, white-tailed deer are a valuable resource, supplying humans with economic benefits. White-tailed deer are highly valued by many urban residents for their aesthetic appeal and they have won the hearts of the majority of the human population (Decker et al., 2001).

Urban residents experiencing increasing human-deer conflicts have a wide spectrum of tolerances, opinions, and beliefs in regard to the deer living in their communities. Some residents vigorously attract and feed white-tailed deer while their neighbors are actively lobbying for deer removal. This sets the stage for the dilemma facing wildlife managers who are called upon to reduce human-deer conflict in urban environments. Deer-human problems are defined differently by each stakeholder (Decker and Gavin, 1987). Wildlife management in urban centers must take into account the numerous and diverse values of these newly introduced stakeholders. It has been argued by various scholars such as Decker (2001), Manfredo (1989), and Messmer et al. (1997), among others, that although biological and ecological data will always be essential in effective wildlife management, inevitably wildlife management is a human activity with human defined goals and objectives. The effectiveness of long-term successful urban wildlife management action will depend on the ability of managers to integrate the biological, ecological and human dimensions of wildlife management (Riley et al., 2002). Wildlife management must address the cultural carrying capacity of white-tailed deer populations in the urban center in question. Cultural (social) carrying capacity has been defined as the maximum wildlife population which society will accept within a given area (Decker and Purdy, 1988). Cultural carrying capacity is not static and stakeholders' acceptance of white-tailed deer population size varies over time or in response to changing variables. It is also highly unlikely that diverse stakeholders will see eye-to-eye on acceptable wildlife population size or on the course of management action that should be considered to alleviate the conflict (Decker, 2001). Evaluating opinions, beliefs and values of numerous stakeholders in a community provides an

opportunity for wildlife managers to base urban wildlife management decisions on the biological and ecological dynamics of wildlife, and on human dimensions as well.

**Study Purpose**

The Greater Winnipeg Area (GWA), in Manitoba, Canada, like many other North American metropolitan centers has experienced a large growth in human and urban white-tailed deer populations over the past two decades. Coupled with the increase in the urban deer population size, an increase in the number of human-deer conflict cases has been reported. Manitoba Conservation has noted a significant increase in the number of complaint calls involving human-deer conflict within the GWA over the last 20 years (Manitoba Conservation unpublished data, Winnipeg District Occurrence Report).

This study examines, by use of a quantitative, four-wave, self-administered mail out questionnaire, GWA residents' opinions concerning the urban white-tailed deer herd and potential white-tailed deer management. The study investigates GWA urban residents' tolerance of an increasing urban deer population and of frequent deer-human conflict, and evaluates residents' acceptance of various urban deer management strategies. A variety of strategies, both lethal and non-lethal, can be employed to manage urban white-tailed deer populations and to attempt to reduce human-deer conflict. The study assesses whether a GWA urban deer management strategy can be developed that pays heed to the preferences of urban residents; that is at the same time feasible; and that balances residents' safety with conservation of an urban white-tailed deer population.

## Thesis Organization

This document is divided into five chapters. Chapter One, the Introduction, provides an overview of urban white-tailed deer population growth and human-deer conflict in metropolitan areas. This Introduction outlines the challenges wildlife managers face when creating management plans in metropolitan areas occupied by many newly introduced stakeholders with a diversity of opinions and beliefs.

Chapter Two is a literature review of white-tailed deer distribution, biology, behavior, and white-tailed deer impact on the ecosystem. The second section of this chapter discusses twentieth century urbanization and how this societal shift has influenced the urban-wildland interface and human-wildlife co-existence. The third section focuses on human-deer conflict in urban areas. The fourth section discusses the human dimensions of wildlife management and the importance of integrating human dimensions into urban wildlife management. The final section of this chapter presents a literature review of the lethal and non-lethal methods of urban deer management.

Chapter Three is a description of study design and methodology. The first section is a description of the study area. The second section describes research design, survey stratification, and survey construction. The third section offers a breakdown of the methods of analysis utilized in this research.

Chapter Four provides survey results. The first section presents the results of the pre-test. The second section presents survey respondent demographics and overall findings from the survey. The third section presents statistical findings and relationships. The fourth section presents a GIS analysis of survey results. The fifth section outlines the findings from the non-response bias interview follow-up.

Chapter Five presents a discussion on the survey findings and study objectives divided into four sections. The first section of this chapter reviews the limitation of the type of study I have conducted; the second section discusses the GWA residents' opinions and tolerances toward the urban deer population and their preferences regarding potential urban deer management; the third section considers the implications these findings have for urban deer management; the fourth section deliberates whether a feasible urban deer management plan can be created that balances residents' safety with the conservation of an urban white-tailed deer population. The thesis concludes with a suggested management plan.

# CHAPTER TWO
# LITERATURE REVIEW

## Distribution and Biology of White-Tailed Deer

White-tailed deer (*Odocoileus virginianus*) are a highly adaptable and resilient species, and have developed unique characteristics enabling them to survive in a wide variety of habitats and changing environmental conditions (Baker, 1984). These complex strategies vary according to geographic location. White-tailed deer are the most widely distributed large mammal in North America (DeNicola et al., 2000). The highly adaptable nature of white-tailed deer has led to their ability to thrive in urban environments. White-tailed deer find refuge in urban environments due to the lack of hunting pressure, minimal predators, adequate shelter, available water, and both natural and human supplemented food sources.

## White-Tailed Deer Distribution

White-tailed deer have an extensive range throughout most of North America, and into South America. They have home ranges that extend from north-temperate to tropical environments. White-tailed deer live as far as 60 degrees north in southern Canada, to subequatorial South America approximately 15 degrees south latitude (Baker, 1984). There are pockets in the southwestern portion of the United States where the arid climate prevents white-tailed deer from living in these areas (World Deer web pages accessed on March 3, 2008). In Canada, white-tailed deer are found from Cape Breton Island and westward to south central British Columbia (Who's Who web pages accessed March 3,

2008). White-tailed deer, relative newcomers to Canada, have continued to extend their ranges across the country since the late nineteenth and early twentieth centuries, pushing northward into Canada with the help of agriculture, logging, restrictions on harvest, and long term easing of harsh winters (Hesselton and Hesselton, 1982). There are thirty subspecies of white-tailed deer in North and Central America. Sixteen of these subspecies are found in North America, with only three of these found in Canada. In Manitoba, the subspecies *O.v.dakotensis* is found (Baker ,1984).

*White-Tailed Deer in Manitoba*

White-tailed deer are relative new comers to Manitoba, having arrived sometime in the late 1800's, after a continued expansion northward, extending their range from Minnesota into Manitoba following the patterns of human settlement, and taking advantage of the beneficial land-use practices such as agriculture and logging (Goulden, 1981). The earliest accounts of white-tailed deer in Manitoba occurred in 1881; however, it was not until 1900 that white-tailed deer were regularly seen by settlers (Goulden, 1981). White-tailed deer thrived in the province between the early 1900's through until the 1950's, as this was a period of agricultural development in the southern regions of Manitoba, which created an ideal combination of farmland and wooded areas for white-tailed deer to occupy. As a result, white-tailed deer numbers increased and reached a population estimate of 200,000 deer by the late 1940's and early 1950's (Goulden, 1981). Following this period, white-tailed deer numbers began to decline in response to habitat loss, harsh winters, and heavy hunting pressure, with numbers dropping to an all-time low of only 30,000 deer by the winter of 1974 (Goulden, 1981). In response to this low population,

white-tailed deer hunting seasons were closed for the following three years, an initiative that, coupled with the luck of mild winters, resulted in white-tailed deer numbers climbing to an estimated 90,000 deer by the mid-winter of 1977 (Goulden, 1981). By the beginning of the 1980's white-tailed deer inhabited approximately 180,000 square kilometers of primary range in the province, where roughly 27% of the province had the climate and landscape suitable for year-round deer survival (Goulden, 1981). The parkland belt in agro-Manitoba created a productive deer range where in 1980, 60-70% of the Manitoba white-tailed deer resided (Goulden, 1981). A historic peak occurred in the summer of 1995 with an estimated 250,000 deer; however, the severe winter of 1995/1996 reduced population numbers (Manitoba Conservation web pages accessed on March 3, 2008). White-tailed deer currently occupy ranges in the province from Flin Flon/Cranberry Portage in the northwest, south of the William River in the central region, and south of Atikaki Provincial Wilderness Park in the northeast. Isolated summer reports have come from Lynn Lake and Herchmer, approximately 140 km south of Churchill (Manitoba Conservation web pages accessed on March 3, 2008).

*White-Tailed Deer in the City of Winnipeg*

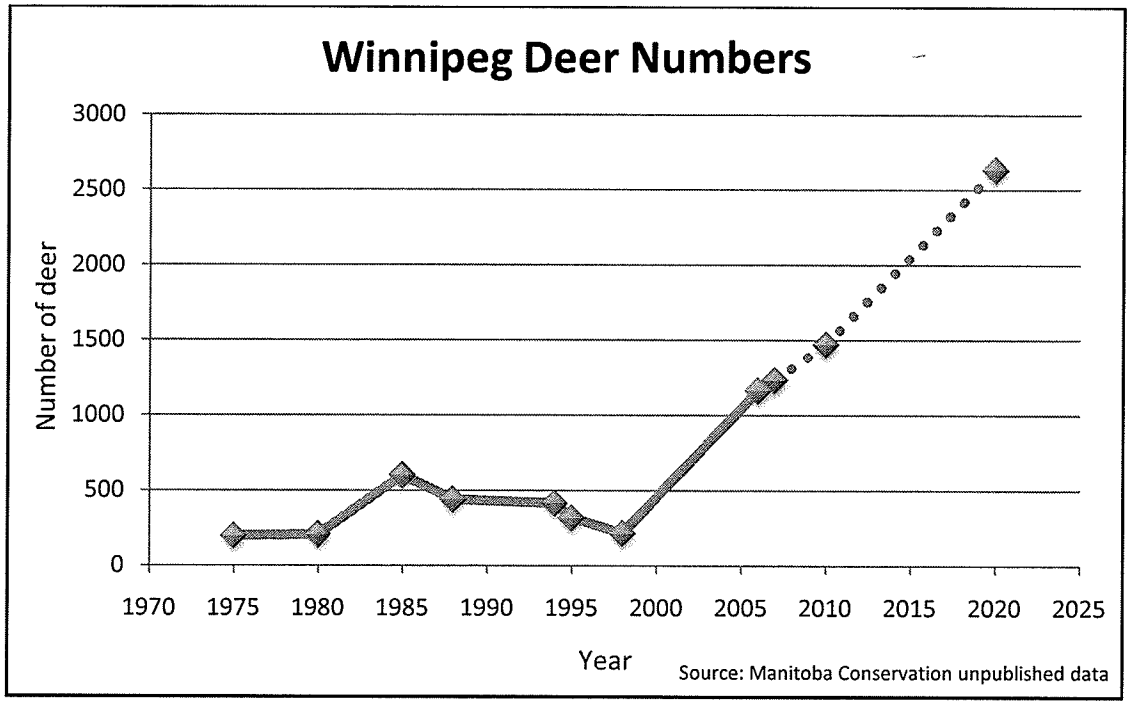
White-tailed deer have been an integral part of the City of Winnipeg landscape for over 100 years. White-tailed deer were observed in small numbers in wooded areas along the Assiniboine and Red Rivers and the Charleswood area of the city up until the mid-1970's, with a population estimate of 200 deer at that time (Shoesmith and Koonz, 1977). Deer hunting occurred on most of the unoccupied land within the city, land now generally occupied and within the Perimeter Highway. In 1981, the City of Winnipeg

enacted By-law #2890/81 that prohibited the discharge of any gun or other firearm within the city limits (City of Winnipeg By-Laws web pages accessed on October 30, 2008). This By-law unified former By-laws from Rural Municipalities. By the mid-1980's, the white-tailed deer herd in Winnipeg was estimated at 600 deer (Manitoba Conservation, 2007). Increasing concerns over the growing urban white-tailed deer populations resulted in a joint Manitoba Conservation and City of Winnipeg strategy to reduce the urban herd by live-trapping and relocating the deer to locations outside of the city (Manitoba Conservation, 2007). The objective of this joint strategy was to reduce the urban deer herd to a population size of 300 deer, and indeed, trapping and relocating efforts removed 283 deer from the city (Manitoba Conservation, 2007). But the City of Winnipeg urban deer population continued to grow in the early 1990's, and aerial surveys conducted in 1994 and 1995 recorded observations of 415 and 318 deer respectively. The severe winters of 1995/1996 and 1997/1998 reduced the urban Winnipeg and provincial deer herds again: an aerial survey conducted in 1998 recorded an observed 215 deer. Since the late 1990's, however, white-tailed deer population numbers have been increasing: an aerial survey in 2006 recorded 1,166 deer inside of the Perimeter Highway (Hagglund, 2006). It is important to note that the 2006 aerial survey, which involved the use of a helicopter, was the first comprehensive survey conducted in the City of Winnipeg. Previous population estimates were obtained through surveys conducted with the use of a wing aircraft where only a limited number of selected areas covered, a point that must be considered when comparing estimated herd size.

Without management, the urban deer herd has the potential to grow by 6% per year; that is, the urban deer population may grow to over 1450 deer within the city by

2010, and potentially grow to over 2600 deer within the city by 2020 (Manitoba Conservation, 2007). Figure 1 provides a graphical representation of the estimated white-tailed deer population growth within the City of Winnipeg between 1970 and 2007 with projected potential population growth through until 2020. Such growth in the urban white-tailed deer population may result in an increase in human-deer conflict, such as deer-vehicle collisions. Appendix 1 provides a closer look at the location and number of white-tailed deer within and around the City of Winnipeg as identified in the 2006 aerial survey conducted by Manitoba Conservation. Appendix 2 provides the urban deer density by postal code zone in the GWA.

**Figure 1:**



## White-Tailed Biology

*Size*

In general, white-tailed deer males are 6-7 feet in length and weigh between 151-311 pounds. Females average between 5 feet to 6.5 feet in length and weigh 90-210 pounds (Forsyth, 1999). By and large, white-tailed deer are larger in the northern areas of their range, depending on environmental and nutritional factors. In Manitoba, bucks weigh between 200-300 pounds and mature, non-pregnant does weigh 60-75% of the buck weight (Goulden, 1981). Males achieve maximum weight between the ages of 4-5 years, and females are full grown by one year of age. Fawn weight is variable depending on the nutrition of the doe, and the number of embryos in utero (Hesselton and Hesselton, 1982).

*Pelage*

White-tailed deer pelage changes with seasonal variation. Certain morphological parameters, such as hair density and color, may vary among white-tailed deer populations. White-tailed deer in Manitoba undergo two complete molts each year. The summer coat is reddish brown, with short, thin, wiry hair (Goulden, 1981). The summer coat is replaced in late summer early fall with a winter coat. The winter coat is grayish/brown, longer, thicker, and brittle with excellent insulation qualities. The hair continues to grow in length and diameter through the beginning of winter with the greatest size and thickness by mid winter (Hesselton and Hesselton, 1982). A fawn has a reddish coat sprinkled with light dorsal spots the size of quarters which provides camouflage protection for the early stages of life (Goulden, 1981). Between 3-4 months

of age, fawns will lose these spots. Fawns will molt their first summer coat and their new coat will be the same as an adult (Hesselton and Hesselton, 1982).

*Antlers*

The antlers of white-tailed deer are bony deciduous structures that arise from the permanent pedicles of the frontal bones and are covered with soft, velvety skin and hair with highly vascularized membranes (Hesselton and Hesselton, 1982). Antlers in white-tailed deer are present in males; however, there are a few cases where females will develop antlers due to a hormone imbalance (Goulden, 1981). Antlers develop on an annual cycle, and are shed every year following the rut. New antler growth begins in early spring and is assumed to be triggered by increasing daylight which causes the pituitary gland to secrete a hormone to stimulate antler growth (Hesselton and Hessleton, 1982). During the summer months, testosterone secretion is increased with further simulates antler and testes growth and development. Maturing testes secrete increasing amounts of testosterone with a peak in November. Prior to this peak in November, the antler growth stops and the antlers harden. The vascular membranes, which transport the required nutrients for antler development, stop delivering nutrients and blood flow, causing the velvety membranes to dry up and fall off. These changes are usually associated with buck behavior of rubbing their antlers on small trees and bushes. This behavior sharpens the antlers creating sparring weapons used during rut activity (Hesselton and Hesselton, 1982). Antler shedding is associated with a sharp decline in testosterone levels, which occurs toward the end of the breeding season in December to early January (Goulden, 1981). Antler growth is related to genetics and nutrition, with

nutrition, specifically dependent on the calcium and phosphorous levels in the animal's diet, playing the most substantial role in the antler size (Sauer, 1984). The relationship between poor antler growth, poor range, and/or overpopulated deer range has been recognized (Hesselton and Hesselton, 1982). A buck will produce its first set of antlers when it reaches a year of age. Although nutrition and conditions are considerations for antler development, generally, a buck will produce the same configuration of antlers year after year (Hesselton and Hesselton, 1982). Antlers will generally grow larger with age until the animal is between 5-6 years old (Hesselton and Hesselton, 1982).

*Glands*

White-tailed deer have four prominent sets of glands: preorbital glands, metatarsal glands, tarsal glands, and the interdigital glands. All of these glands function as sensors and tools of communication to varying degrees (Hesselton and Hesselton, 1982).

*Teeth*

White-tailed deer have 32 teeth, where the upper incisors are missing. The teeth are permanent by 16-18 months. Teeth can be the best predictor of white-tailed deer age and can provide valuable information for wildlife managers. (Hesselton and Hesselton, 1982). Wildlife managers may attempt in the field to examine the wear patterns on the animal's teeth. For a better analysis and comparison, wildlife managers may use a cross-section of the animals tooth against another control tooth from a deer in the same age category, and from the same habitat, counting the annual growth rings on the tooth (Sauer, 1984). These growth rings provide the best estimate of the deer's age.

*Eyes*

White-tailed deer depend on motion and depth perception to locate and identify an object by light. The combination of monocular vision to each side with the binocular vision to the front provides white-tailed deer with a wide field of vision (Sauer, 1984).

*Senses*

White-tailed deer are sensitive to sight and sound. They depend on their acute senses of hearing to monitor the location and behavior of other animals and predators. They have large ears that are constantly on alert (Sauer, 1984). Their sense of smell helps deer to identify individuals by the scent produced by the tarsal glands of other deer. White-tailed deer use scent to identify food sources. Deer smell every morsel before consuming it, an amazing habit that allows deer to choose the highest nutrient food sources. Smell is also important for the bucks during the breeding season to be able to identify a doe in heat (Sauer, 1984).

*Vocalization*

Very little communication among white-tailed deer is vocal; however, there are some known ways in which this method of communication does occur. Some ways in which they use vocal communication are: adults and fawns may groan when restrained; fawns may call to dams on occasion; and bucks may bleat when chasing does during the rut (Sauer, 1984). But the most frequently heard vocalization is the sound of their snort or foot stomp when they are disturbed or frightened (Sauer, 1984).

*Gait*

Two common gaits observed with white-tailed deer are the gallop and the trot. Both of these gaits are used to escape predation and/or disturbance. White-tailed deer can reach speeds of up to 58 kilometers/hour and are able to bound over large obstacles. White-tailed deer are able to jump over objects that are 2.1 meters ( 7 feet) high from a standing position, and with a running start are able to clear objects that are 2.4 meters (8 feet) high (Sauer, 1984). In Manitoba, white-tailed deer are known to reach speeds of 50 kilometers/hour, and clear heights of 3 meters from standing position, and jump over 9 meters horizontally (Goulden, 1981). This difference may be attributed to the larger size of the animal in northern geographic locations.

*Digestion*

White-tailed deer are ruminants. They have a four-chambered stomach which allows the species to graze and browse and then retreat to bed down and chew their cud. Chewing their cud suggests the animal will regurgitate its food and re-chew the food that was swallowed earlier. This adaptation allows deer to feed under the security of night darkness, and avoid increased susceptibility to predation. During the day, the deer bed down and chew their cud (Goulden, 1981).

*Food Sources and Nutrition*

White-tailed deer are a generalist species. Since they have adapted to a number of geographical ranges, they have the ability to utilize a wide variety of food sources. The daily energy requirement for deer weighing 50-60 pounds (23-27 kg) is 3600 calories, or 0.9kg. For a deer weighing 101 pounds (46 kg), the nutritional requirement is 6300 calories/day or 1.5-1.7kg intake. For a deer weighing 152 pounds (69kg), the necessary intake is 9,900 calories, or 2.5-2.7kg/day (Hesselton and Hesselton, 1982). White-tails need water, energy, nitrogen, essential fatty acids, calcium, phosphorus, magnesium, sodium, chlorine, potassium, sulfur, iron, copper, iodine, cobalt, manganese, selenium, chromium, fluorine, nickel, silicon, vanadium, tin, arsenic, molybdenum, and vitamins A, D, and E (Verme and Ullrey, 1984). In addition to this long list of requirements, white-tails need indigestible fiber to support normal digestive tract function. On hot days, deer must have an adequate supply of water, and snow is consumed when liquid water is not available (Verme and Ullrey, 1984). White-tailed deer are referred to as browsers and grazers. Their feeding behaviors are adapted to their geographic location. White-tailed deer that have inhabited the corn belt of the United States since the early 1900's now primarily rely on cultivated crops over browse (Hesselton and Hesselton, 1982). The role that browse plays in the diet depends on its availability and quality. Generally, the white-tailed deer diet consists on tender shoots, twigs, leaves, mast, certain fruit, succulent herbage, agriculture crops, and acorns (Hesselton and Hesselton, 1982). In Manitoba, deer primarily eat stems, leaves, fruit, buds, bark off of shrubs and trees. They thrive on shrubs such as dogwood, saskatoon, choke cherry, willow, snowberry, wolf willow, and high-bush cranberry (Goulden, 1981). In the southwestern portion of the province,

snowberry or buck rush may be the single most important winter food source for deer. Deer in Manitoba rely on twigs and acorns from oak, trembling aspen, green ash, American elm, Manitoba maple, white cedar, and tips of young evergreens (Goulden, 1981). In agricultural areas, deer eat crops such as alfalfa, sweet clover, green fall rye, cereal grains, and sugar beets. Grassland areas are especially important during the summer and fall months. Deer in Manitoba rely on these grasslands and herbaceous plants such as pea-vine, vetches and goldenrod for essential sources of energy for the long winter (Goulden, 1981). Research suggests that white-tailed deer may exhibit stage-dependent selection of temperate plants, since mature-stage growth may have more concentrated proteins in some species (Swihart and Picone, 1998). In the City of Winnipeg, deer survive both on natural and human supplemented food sources. Some major food sources include sugar beet tailings left in fields, waste hay and grain in fields and near riding stables, alfalfa, and other agricultural food sources. Natural foods such as snowberry, red-osier dogwood, chokecherry, rose and bur oak are also eaten (Shoesmith and Koonz, 1977). Residents may also feed white-tailed deer a wide variety of seeds, grains and human food items.

*Life Span and Reproductive Rates*

White-tailed deer in the wild can live up to 16.5 years, but they are seldom found to live past 10 years. In captivity, white-tail deer can live up to 20 years (Forsyth, 1999). In Manitoba, white-tailed deer are found to live over 6 years and occasionally up to 14 years. By 4 years of age, these deer are considered to be in the prime of their lives (Goulden, 1981). The reproductive rates of white-tailed deer vary depending on nutrition

and geographic location. On good range, 60-70% of female white-tailed deer breed during their first year (Hesselton and Hesselton, 1982). The success of this breeding is largely dependent on nutrition. Generally, deer have a high birth rate. Healthy females on good range often give birth to twins, and 10-15% will bear triplets (Hesselton and Hesselton, 1982). In cases of poor range and nutrition, estrus may not occur. Time of year in which breeding occurs is directly related to geographical location. Breeding occurs in January and February in white-tails found in Arizona and Mexico (Hesselton and Hesselton, 1982), while in white-tails found closer to the equator, year round breeding is thought to take place (Hesselton and Hesselton, 1982). In Manitoba, breeding occurs in November. Fawns are born in late May and early June 7 months after conception (Goulden, 1981). Where good range conditions exist, and following a moderate winter, most does bear twins, and occasionally triplets are born, especially in older deer (Goulden, 1981). Usually in Manitoba, younger females between 6 months and 2 years will have only a single fawn, and 1/3 of female fawns will breed in their first autumn (Goulden, 1981). A study conducted to assess the reproductive performance of white-tails in southwestern Manitoba suggests that pregnancy rate in adult does of 98% (Soprovich, 1991). Where deer survivability is high, white-tailed deer population numbers can increase rapidly in an area (Adams et al., 2006). As stated, deer have a high reproductive potential. In the fenced George Reserve in Michigan, 6 white-tailed deer introduced into the environment grew to 222 deer within 7 years (DeNicola, 2000). In many urban environments, high white-tailed deer numbers have led to increasing occurrences of human-deer conflict (Adams et al., 2006). In many urban communities white-tailed deer have gone beyond the cultural carrying and in some cases, the

biological carrying capacity, of their environment (Adams et al., 2006). As white-tailed deer populations continue to grow, they potentially over-browse on vegetation, in some cases, permanently altering native flora.

*Population Genetics*

White-tailed deer are widely distributed, and larger deer are observed in northern ranges. Biological, physiological, and behavioral adaptations occur depending on the geographic location of the white-tails. These genetic differences account for many of the observed phenotypes in deer; however, the genetic basis for differentiation between subspecies is unknown (Smith et al., 1984). Increase in body size in northern ranges may be due to higher-quality diet, and/or genetically controlled upper-size limit. The genetic reasons are still not clear (Smith et al., 1984). A total of 35 loci have been studied on white-tailed deer and of these 27 have more than one allele. This allows the level of genetic variability to differ considerably across populations (Smith et al., 1984). White-tailed deer have proven to have the highest level of genetic variability of any large grazing mammal (Smith et al., 1984). It is suggested that the success of white-tailed deer to adapt to various environments could be attributed to their high genetic variability. Each deer differs genetically but also each population differs in allele frequency (Smith et al., 1984). Over space, and time, these populations begin to differ morphologically depending on their range and historic selective pressures (Smith et al., 1984). These genetic variations may enhance white-tailed deer survival in different geographic locations. White-tailed deer have also bred with mule deer in ranges where these two species overlap. Discussion has been given to whether these offspring should be

considered a new distinct species; however, without morphological and behavioral differences being identified, these offspring are considered a subspecies (Bradley et al., 2003).

*Sex Ratio*

The sex-ratio in white-tailed deer favors males. In utero, there is an increased incidence of male to female fetuses (Hesselton and Hesselton, 1982). This may have implications for management. If deer herds are intensely managed, with a rapid reproduction turnover, the result will be the increase of males in the herd with fewer younger-breeding females (Hesselton and Hesselton, 1982).

*Mortality Factors*

Unfortunately for white-tailed deer, high birth rates are accompanied by high death rates. In Manitoba roughly 20-25 % of deaths in white-tails occur just after birth caused by poor nutrition during pregnancy, or harsh weather conditions at birth. Surviving fawns face the difficult task of surviving daily life. Predation in Manitoba by dogs, coyotes, timber wolves, and bears is a threat, added to which are accidents, pests, disease, parasites, and the ongoing search for food (Goulden, 1981). Mortality over six months of age is the result of sport hunting, illegal harvest, disease, parasites, accidents with vehicles/trains, and predation. Since Manitoba is at the northern limiting range for white-tailed deer, severe and harsh winter weather can take a significant toll on the population (Shoesmith and Koonz, 1977). Mortality by winter weather is unpredictable and must be considered by managers when creating long-term management strategies. In a productive

but heavily hunted herd, the annual death rate in Manitoba will be between 35-50% (Goulden, 1981). In the City of Winnipeg, the greatest mortality factor to the deer herd is deer-vehicle collisions. Manitoba Public Insurance Corporation (MPI) records over 300 reported deer-vehicle collisions per year in Winnipeg (Susan Ekdhal, Senior Business Analyst, Road Safety MPI personal communication October 6, 2008). The City of Winnipeg picked up 263, 305, and 257 dead deer in 2005, 2006, and 2007 respectively within the city limits (Susan Ekdhal, Senior Business Analyst, Road Safety MPI, personal communication September 9, 2008).

*Winter Adaptation*

Among the unique characteristics that help white-tail deer survive and extend their range northward is their ability to adjust to winter. Many biological adaptations allow the white-tailed deer to survive these harsh conditions. White-tails undergo physiological and behavioral adjustments to accomplish this. Some physiological adjustments are the deposition of subcutaneous fat to build up energy reserves for the long winter months. The aforementioned change to their pelage helps to minimize thermal exchange to the cold environment. In addition, deer will voluntarily reduce their food intake over the winter despite the availability of food entering into a semi-hibernation state (Verme and Ullrey, 1984). In the spring, thought to be in response to longer daylight, the deer's metabolism shifts back to its higher rate. It is during this time that the deer is most vulnerable. Due to the lack of energy reserves at this time of year, the deer must get proper nutrients or death may result (Verme and Ullrey, 1984).

These fascinating diverse biological and physiological aspects of white-tailed deer give them the ability to adapt to numerous habitats. As a result of their incredible adaptability, white-tailed deer have been able to expand their range, colonize new areas, and increase their distribution on the continent. In addition to these biological and physiological adaptations, white-tails have the ability to inhabit a wide variety of landscapes and modify behaviors to increase their survival in different geographic locations.

*Habitat*

White-tailed deer are commonly known as "edge animals." They are found in edge habitat where they can take advantage of feeding on grasslands while remaining close to the forest to escape for protection and shelter. In general, white-tail deer are home in forest, forest edge, swamp and swamp edges, open bushy areas, and mixed farmlands. White-tails are known for bedding down in sheltered woody areas throughout the day, while grazing open prairie grasslands by night (Forsyth, 1999). In Manitoba, white-tails locate where they find adequate food and water, and shelter from the elements or to escape from enemies. These deer tend to prefer young growth forests that provide a preferred habitat matrix of open areas to sheltered cover and provide new abundance of vegetation at their reach (Goulden, 1981). In Manitoba, deer are found in a number of different landscapes. In the Interlake area, white-tails take advantage of habitat in trembling aspen found among meadows and farming fields. In the southeastern portion of the province, white-tails live in a mix of broadleaved and coniferous forests that are combined with farm fields. In the southwest of the province, these deer live in the river

valley among grass and trees covering sand dunes, and mixed cropland. In the northwest portion of their range in Manitoba, white-tails find habitat in large forested areas and grasslands between Riding, Porcupine and Duck Mountains. The large marshland areas near Delta Marsh and Lake Manitoba are an unusual habitat choice; however, white-tails are found near these fringe marshes and lakes in the province (Goulden, 1981). In addition to these habitats, white-tails have found habitat and flourished in urban areas of the province. Human land use practices have also provided white-tailed deer with ideal habitats. Timber cutting, drilling for oil and gas, and agriculture are some of the practices that in many cases have provided the ideal habitat matrix of open areas to sheltered trees, regeneration of woody species or food from farm crops (Marchinton and Hirth, 1984). In some cases, however, human activity has reduced favorable habitat, and negatively impacted this species. Collisions with deer and vehicles on roadways, energy used to escape snowmobiles in winter, and heavy hunting pressure are examples of negative human impacts on deer habitat (Marchinton and Hirth, 1984).

*Range*

Under good range conditions, white-tails may live their entire lives in an area only 5-8 km long. White-tailed deer home range is smaller than any other North American deer species (Marchinton and Hirth, 1984). In Manitoba, this was demonstrated by a marked fawn in 1963 that was found 10 years later only 2 km's from where it was originally marked (Goulden, 1981). High habitat diversity tends to reduce range size, as poor habitat diversity means deer must travel farther distances to meet their needs (Beier and McCullough, 1990). The home range size must be suitable for the animals to find all

essentials for life and reproduction, yet small enough for the animals to gain survival advantages of their familiarity with the area. The size of the range may also be dependent on the density of the population. In high density situations, ranges are extended to respond to forage depletion (Beier and McCullough, 1990). In habitat where wooded cover or food supplies are scarce, white-tails may inhabit a much larger area between summer and winter ranges. Some tagging in Manitoba, for example, has shown white-tails to have travelled up to 150 km's from where they were originally tagged. Yearling males move the longest distance, perhaps due to social pressure, or as a means of genetic diversification (Goulden, 1981). White-tails may take excursions or "trips" away from their home range. This exploratory event may be a precursor for future dispersal (Marchinton and Hirth, 1984). Shoesmith and Koonz color-marked white-tailed deer in the City of Winnipeg in 1972 and found the urban deer population to be sedentary and to remain within the city limits year round (Shoesmith and Koonz, 1977).

*Summer Range*

The summer range for white-tails is almost anywhere throughout their permanent range. This includes a variety of landscape types, such as farmer fields, hay meadows, fence rows, gardens, forest edges, and marshy swamps (Goulden, 1981). Depending on geographic location, landscape type vary but generally, white-tails occupy any landscape within their range over the summer months provided it supplies adequate food, water, and shelter.

*Winter Range*

Winter range for white-tails varies according to geographic location. White-tails found in more southern latitudes may not make range changes between seasons since temperature fluctuation is minimal, while in the northern latitudes, white-tails migrate between summer and winter ranges. This adaptation is essential for their survival in northern latitudes. In winter in Manitoba, deer seek out tree-covered terrain for shelter from cold temperatures, deep snow, and energy-draining wind. When food is scarce, deer choose adequate shelter over an area with better food resources. However, if possible, deer will take advantage of agricultural crops, especially during the fall and winter migration, to store up energy reserves for the winter (Goulden, 1981). To conserve energy, deer try to find dense conifer canopy in lowland yards as this provides the best microclimate for bedding (Verme and Ullrey, 1984). Deer rely on a series of crisscrossing, hard-packed trails that extend from deer yards. Since their hooves are not designed to handle deep snow, these trails provide escape routes from predators, and prevent the deer from struggling in the deep snow (Forsyth, 1999). Throughout most of the year, deer live in small social units; however, in the winter large gatherings of deer can be found together where suitable winter habitat is found (Beier and McCullough, 1990).

Habitat loss is the most limiting factor for deer in Manitoba. Between 1961 and 1981, over 40% of Manitoba's white-tail range was lost (Goulden, 1981). This loss was due to the removal of brush for cropland, cottages, housing developments, highways, hydro-power lines, and water reservoirs. In addition, intense cattle grazing and the spraying of chemicals on pastures have negative impacts on deer. Forest maturation also

reduces reachable browse, and limits food availability. All of these factors impact deer herds in Manitoba (Goulden, 1981).

*Activity and Movement*

White-tail deer allocate their time to satisfy their basic requirements for nutrients, rumination, social interaction, and rest. The pattern of movement and the time allotted may depend on the age, sex, time of day, season and weather conditions (Beier and McCullough, 1990). Research suggests that white-tails are most active during dawn and dusk (Beier and McCullough, 1990). It has also been shown that deer in northern ranges are less active during the winter than in the summer months (Beier and McCullough, 1990). In northern regions, snow depth, deer density, and low temperatures have the greatest influence on the daily movement of white-tailed deer (Brinkman et al., 2005). Deer in all seasons tend to be more active during times where conditions are most favorable, taking into account temperature, wind speed, cloud cover, and relative humidity (Beier and McCullough, 1990). Beier and McCullough researched deer activity on George Reserve located near Pinckney, Michigan to determine white-tailed deer activity patterns and habitat use (Beier and McCullough, 1990). Their findings indicate that white-tailed deer in this range spent 95% of their time foraging. Very little time was spent travelling, grooming, and engaging in social interactions. This study revealed that there was an increase in activity noted during the late winter until May, and another peak in the fall, with a dramatic decrease in activity observed in January and February. It is believed that this decline in activity not only reflects weather but also the seasonal changes in metabolic needs (Beier and McCullough, 1990). The increased activity in

spring is consistent with the increase of the metabolic demands, and also could be due to nutritional requirements needed in late pregnancy and early antler growth (Beier and McCullough, 1990). The study found that these deer did not feed in the morning during winter months, but conserved energy and fed during the evening. In the three other seasons, however, the evening feed peaked well beyond sunset. During the time between June and August, there was a noted decrease in white-tail deer activity midday. This is thought to be due to heat stress and pests such as deer flies. It is also assumed that deer have an easier time meeting their nutritional requirements during this time of year and therefore do not need as much time to feed (Beier and McCullough, 1990). Consistent with other research, this study found deer to move from closed habitats during the day to more open habitats at night. This pattern of movement contributed to concealment from predators during daylight. Daytime closed habitats were used to rest and ruminate (Beier and McCullough, 1990). In summer, it was found that white-tails use some open tall grass habitat to bed down during the day. These tall grasslands provide concealment but reduce pests due to increased wind, and less standing water. Deer flies and other pests can be important factors in deer habitat selection and movement (Beier and McCullough, 1990).

Some differences between the sexes in deer were identified in the Beier and McCullough study. Their research indicates that females are active longer than males: on an average of 1.5 hours longer/day between January and July. Does were more active in winter, spring and summer. This is consistent with the increasing demands of pregnancy and early lactation and is magnified by the higher quality forage chosen by females which takes longer to consume (Beier and McCullough, 1990). Females are also territorial

during the weeks following parturition, which may account for differences between male and female activity during the summer months. Males were more active in the fall months which coincide with the breeding season, where males are travelling farther to find females in estrus. Females overall occupy only 31-35% of the male home range (Beier and McCullough, 1990). Males also opt to spend more of their time in closed forests and less time in open woodlots and grasslands. Beier 1987 is quoted in Beier and McCullough as suggesting that male use of lower quality forage may be an allometric relationship between body size and metabolic requirements that allow males to subsist on lower quality but higher abundance foods (Beier and McCullough, 1990). Differences between males and females also pertain to site fidelity. Females show high site fidelity between years and seasons. The advantage is thought to be that the deer are familiar with resources, and know the escape routes from predators. Males show little site fidelity. It is suspected this is due to social requirements (Beier and McCullough, 1990).

Deer activity increases with cloud cover, fog, and temperatures between 10-16 degrees celsius. Deer activity decreases with high winds, severe storms, severe cold temperatures, and high heat. Activity seems to show no change to moonlight, rain, and mild snow fall (Beier and McCullough, 1990).

*Activity/Movement in Manitoba*

A 1974 radiotelemetry study in Manitoba provides some insights into white-tailed deer movement throughout the Interlake area of the province. Results indicate that: males wandered farther than females during spring migration; the average distance between winter and summer ranges was between 13.4 -12.1 kilometers; the minimum summer

range size was between 236 and 139 hectares; males had significantly larger home range sizes comparative to females; the average home range size for males was 302 hectares, whereas with females the size was 125 hectares; fall migration began in late October, early November; the time of arrival on their winter range was directly related to snow conditions, and varied year to year; and individuals returned to the same summer and winter ranges each year of this study (Shoesmith and Bidlake, 1978). In 1972-1978, deer were marked and observed in the Charleswood area of Winnipeg. Nearly all deer were observed within 2-3 kilometers of their original capture site. Some seasonal movement occurred; however, all movement was well within the urban area and the range occupied was notably less than deer in rural areas of the province (Shoesmith and Bidlake, 1978). Shoesmith and Bidlake researched white-tail movement in the southwestern portion of the province during 1972-1973, and again during 1974-1976 (Shoesmith and Bidlake, 1978). White-tails in the Shilo/Spruce woods area moved from open sand hill and farming areas in spring and summer northwest to dense conifer cover during winter months. The largest movements in this area were observed by young deer dispersing into new areas (Shoesmith and Bidlake, 1978). In the Pembina Valley/Neelin area of the province, deer were found to move 32 kilometers between summer and winter ranges. During the summer, white-tails took advantage of the farmland and intermittent tree cover between the valley and the United States border. During winter, white-tails moves toward the valley for better shelter. Due to insufficient cover in the summer range areas, deer moved longer distances in this area of the province with the longest distance recorded of 64 kilometers between summer and winter ranges (Shoesmith and Bidlake, 1978). In the Lauder Sandhills regions of the province, a significant number of marked

deer were not found in this area over the summer but it did serve as a major wintering area for deer (Shoesmith and Bidlake, 1978). The Miniota-Assiniboine River area deer were noted to travel 2.8-32 kilometers between winter and summer ranges. Land west of the valley served as excellent summer range; however, due to insufficient tree cover, this area is not capable of serving as a wintering area for large numbers of deer. During the winter, the valley served as keep wintering areas for the white-tails in this portion of the province (Shoesmith and Bidlake, 1978). The southwestern portion of the province did provide suitable habitat for deer to find winter and summer ranges.

*Dispersal*

Dispersal is the movement away from an original home range to establish a new home range (Marchinton and Hirth, 1984). White-tailed deer have been noted to disperse. Dispersal may occur as the result of social pressure, lack of food, or to disperse genetics in breeding, and is often primarily observed in yearling males (Marchinton and Hirth, 1984). Sexual competition among bucks or social antagonism toward yearling bucks from their mothers may be some of the reasons yearling males disperse (Marchinton and Hirth, 1984). Dispersal may influence sex ratios as eventually, in un-hunted populations, females will begin to outnumber males. Dispersal may be slowed by barriers, such as extensive bog regions, mountains, or large expansive water bodies (Marchinton and Hirth, 1984). If populations are balanced, then immigration and emigration has little effect on herd dynamics. However, if the populations are well above or well below carrying capacity, dispersal may cause a significant imbalance in the population. White-tailed deer social dynamics can result in important changes in the herd demographics, and

may result in altered sex and age ratios, although northern areas may not be as effected due to the constraints of environmental conditions, and reproductive timing (Miller, 1997). Emigration seems to increase with higher population densities (Marchinton and Hirth, 1984).

*Behavior*

White-tailed deer have unique behaviors that vary according to where they live. Behaviors that have evolved in white-tails in northern latitudes differ from those in middle of southern latitudes. The ability of white-tailed deer to make these behavioral adjustments has made them successful in surviving in a wide variety of habitats. White-tailed deer have tremendous behavioral responses to their environment (Miller, 1997).

*Breeding*

The breeding season for white-tailed deer, known as the rut, occurs at different times of the year depending on where white-tails are located. In Manitoba, the breeding season begins in October, peaks in mid November, and tapers off in December (Goulden, 1981). In early rut, bucks become very aggressive and restless and engage in battle with rivals (Goulden, 1981). This is defined as the sparring phase of the rut (Marchinton and Hirth, 1984). This behavior suggests a survival of the fittest where the largest and most healthy buck passes along these genes. During the courtship phase, bucks break from buck groups, and travel alone in search for receptive does. The largest buck will follow the closest to a potential doe. (Marchinton and Hirth, 1984). A doe, when she is ready to mate, will be receptive for only one day. If she is not bred during this time, she will

become receptive twice more during the breeding season in 28 day intervals (Goulden, 1981). Since the female is receptive three times throughout the breeding season, more females are bred, which increases success rates for breeding. The third phase of the rut is known as the tending and copulation phase. The does are ready to be bred and stand for the buck. Single pairs isolate themselves and stay together for up to two days. Once bred, the buck will remain with the female for several hours to ensure he drives other males away (Marchinton and Hirth, 1984). Males do not form harems but they can breed between 6-8 does during one season (Goulden, 1981). Although the largest buck will dominate and copulate, yearling males are capable of breeding; however, they do not often get the chance to breed until they are 3.5 to 4.5 years old (Marchinton and Hirth, 1984). Time of year to begin breeding to ensure births occur in spring, and their breeding behaviors help white-tails survive.

*Birth*

White-tailed deer have a number of behavioral defense mechanisms, which increase the chances of fawn survival. When does are ready to give birth, they isolate themselves and seek a secluded spot to deliver. The birthing process is quick and may happen while the doe is standing. Does will not prepare a special nest or bed. Once born, fawns begin to nurse soon after birth and feed at 3-4 hour intervals thereafter (Marchinton and Hirth, 1984). Fawns are able to walk shortly after birth but remain hidden in a dry sheltered place in shrubs or long grass. Does separate their fawns in multiple birth situations to avoid predation of both young. In addition, does leave their fawns and return several times a day (Goulden, 1981). To avoid attracting attention to where they are hiding, does

remain near fawns only when feeding. Does reduce their home range size and vigorously exclude other deer from the immediate area to protect new fawn(s) during the first month (Marchinton and Hirth, 1984). For a short period of time, fawns do not have a scent. Does lick their fawns' anogential area while nursing to consume their waste to reduce any scent that may attract predators (Marchinton and Hirth, 1984). Fawns rely on their mother's milk for the first few days but may take some water and begin to nibble on green shoots at less than 10 days of age (Goulden, 1981). By two months of age, fawn activity is the same as that of the mother (Marchinton and Hirth, 1984).

*Social Groups*

There are two types of social groups within white-tailed deer herds: the doe family group and the buck groups (Marchinton and Hirth, 1984). Doe groups represent a single family unit, a single doe and her fawn(s). Does do not seem to tolerate each other. A month prior to giving birth, a doe will forcibly and repeatedly drive away her fawns from the previous year. By the fall, the does are less protective of the fawns from the current year and allow fawns from the previous year to join the social group once again. Female fawns usually rejoin the family unit at this time, where it is less common for the males (Marchinton and Hirth, 1984). In autumn, the doe group will be the doe, yearling doe and fawns from the present year. Buck groups are more social than doe groups. Two or three bucks may travel together in all months except during the rut. Buck groups may be 3-5 bucks in size. There is little interaction between them; however, they have been observed grooming each other. Smaller bucks will also yield to larger bucks in the group (Marchinton and Hirth, 1984). Yearlings, when driven away from does in the spring,

may try to join buck groups, with varying success. Some groups tolerate them while other groups drive them away (Marchinton and Hirth, 1984). On occasion, mixed groups form during feeding periods, but they break up after and return to their smaller social groups.

*Social Hierarchy*

White-tailed deer do exhibit aggression and in doing so establish dominant and subordinate members. Subordinate members learn to avoid interaction with dominant members, to save energy, and to reduce the risk of injury. Grooming is the only action that is not aggressive and occurs in both social groups. Subordinate members have been observed avoiding eye contact (Marchinton and Hirth, 1984). Signs of aggression are: holding the head up high in a dominant position, kicking does up on their back legs; bucks engaging in aggressive antler fights (Marchinton and Hirth, 1984). For does, age is the dominant factor over size. Does will often be seen leading a herd to a feeding site, despite the dominance of a buck (Marchinton and Hirth, 1984).

*Yarding Behavior*

During winter months, white-tailed deer frequently congregate in sheltered areas referred to as "deer yards" (Marchinton and Hirth, 1984). Yarding behavior allows deer to conserve energy, minimize radiant and convective heat loss, and increase protection against predation (Marchinton and Hirth, 1984). Thick coniferous cover, in particular northern white cedar, is chosen as it provides good shelter and is a high quality food source (Marchinton and Hirth, 1984). As mentioned, white-tailed deer reduce movement

and will often forego the morning feed to conserve energy and in response to lower metabolic rates (Marhinton and Hirth, 1984).

*Water*

White-tailed deer use water sources to escape from insects and predation. White-tailed deer are good swimmers and readily cross water bodies (Marchinton and Hirth, 1984). Deer are cautious when drinking and may take several minutes to listen before drinking (Marchinton and Hirth, 1984). The amount of water that deer need to consume will depend on temperature and the animal's physical condition. They are known to be able to survive without water for extended periods of time where rainfall, humidity, and succulent vegetation are high (Marchinton and Hirth, 1984). Most often white-tails will drink during twilight; however, pregnant does will drink throughout the day (Marchinton and Hirth, 1984).

White-tailed deer have developed behavioral changes that promote survival and assist this species in successful establishment of ranges in a wide variety of geographic locations. These behavioral biological and physiological adaptations create versatility for this species (Marchinton and Hirth, 1984).

**White-Tailed Deer Impact on the Ecosystem**

White-tailed deer are in many cases an invasive species. White-tailed deer have extended, and continue to extend, their home ranges and disperse into new areas. This colonization by white-tailed deer impacts new ecosystems. White-tailed deer are carriers of disease and parasites which impact other species within the ecosystem. White-tailed deer have

been considered a keystone species in an ecosystem, and therefore impact the ecosystem in various ways. In addition, white-tailed deer cause damage to regenerating trees and shrubs, and have been the source of controversy for humans negatively impacted by these herbivores.

*Disease*

White-tailed deer carry a number of bacterial, fungal, and viral diseases. Some of these diseases affect the host, while others do not. Diseases such as Brucellosis, and Malignant Catarrhal Fever (MCF) impact white-tails and have had an impact on cattle found within their range (Hesselton and Hesselton, 1982). Other diseases such as Anthrax, and Tuberculosis affect white-tailed deer and are feared for their possible transmission to humans (Hesselton and Hesselton, 1982). White-tailed deer carry deer ticks, which are the source of Lyme disease, which has become a public health safety concern (American Lyme Disease Foundation web pages, accesses on March 4, 2008). Giant Liver Flukes occur in white-tailed deer. Giant liver flukes are generally not a huge concern for deer and elk, but their transmission to moose and caribou can be debilitating (Hesselton and Hesselton, 1982). Meningeal worm, or brain worm, is carried by white-tailed deer and transmitted to other big game species via snails and slugs (University of Saskatchewan web pages, accessed on March 10, 2008). Brain worm does not impact white-tails, yet is thought to have affected co-existence of white-tails with caribou, moose, and mule deer as these species may be affected by the transmitted disease. The role that meningeal worm has played in the relationship between white-tails and other cervids is still unresolved scientifically (Gilbert, 1992).

*White-Tailed Deer as a Keystone Species*

White-tailed have multiple and often substantial impacts over their wide range of distribution. As noted white-tailed deer have been called a keystone species, that is, as defined by Waller and Alverson, a species that effects: the distribution or abundance of many other species; community structure by modifying patterns of relative abundance among competing species; and community structure by affecting abundance of species at multiple trophic levels (Waller and Alverson, 1997). Studies have shown that deer influence an abundance of woody species; that deer browse can be a significant problem for regenerating certain species; and that deer influence patterns of seedling recruitment (Waller and Alverson, 1997). Deer also impact herbaceous plant growth, and if they graze long enough in an area, or their population density is high, deer can remove herbaceous species altogether. Deer are known to have been responsible for the local extinctions of several herbaceous species (Waller and Alverson, 1997). In addition to the effects deer have on flora, local fauna is also impacted. High deer density has been shown to: reduce the abundance of canopy nesting birds in the area; reduce bird species diversity; compete with squirrels and snow shoe hares for acorns and oak mast; and impact higher trophic levels such as humans with the incidence of Lyme disease (Waller and Alverson, 1997). In short, white-tailed deer significantly impact ecosystems, and their colonization of new ecosystems may result in numerous ecological changes.

**Twentieth Century Urbanization**

The Greater Winnipeg Area, like many metropolis North American centers over the last fifty years, has grown, converted undeveloped land to developed land, and extended city

boundaries. The latter half of the 20th century represented a time when First World societies underwent a transition from rural, agricultural, to urban lifestyles (Adams et al., 2006). Population growth and capitalization, coupled with the influx of people into urban centers, resulted in stretched city limits and the creation of infrastructure in previously natural, undeveloped habitat. Considering American urbanization, Adams et al. in *Urban Wildlife Management*, suggest that this movement toward urban lifestyles was the result of three social events following the end of World War II: first, automobiles and homes became more affordable allowing returning soldiers and their families to move to urban areas; second, the Highway Revenue Act was passed in the United States in 1956 creating the Highway Trust Fund which enabled the establishment of a network of highways through, around and outside of urban areas, providing quick and easy exit routes from cities in the case of war; third, many traditional farming families had had enough of the tough conditions of farming and moved into cities to find new work. The affordability of housing and cars; cheap gas; highway construction; and increasing job opportunities in urban centers all contributed to a movement in society from rural to urban living (Adams et al., 2006). Today, roughly 80% of Canadians live in urban centers (Canadian Education Association web page accessed on March 5, 2008), as do 80% of Americans (Adams et al., 2006).

This influx of society from rural and agricultural to urban living centers meant that city limits were extended to accommodate for the growing number of residents. Urban sprawl took over. Previously undeveloped land was developed and habitats became modified and fragmented. Such changes to land use impacted wildlife. Some animal populations were displaced and colonized new home ranges. Some animal

populations diminished, while others adapted to these new urban environments. By the end of the twentieth century, public attitudes toward wildlife were changing. Many urbanites were generations removed from living in close proximity to wildlife. "Many, if not most, are several generations removed from a culture of living close to the land. They are more likely to value wildlife similarly to the way they value companion animals and people" (Adams et al., 2006). Many urbanites began to build homes on urban edges, attempting to reconnect with nature in their back yards. Increasing interest emerged in viewing wildlife. As Daniel Decker et al. states in *Human Dimensions of Wildlife Management in North America*, the U. S. Fish and Wildlife Service in 1996 estimated that 61 million people spent about 1.3 billion hours watching and feeding wildlife close to their homes (Decker et al., 2001). Feeding and attracting wildlife to their property provided urbanites the opportunity to view wildlife. Adams et al. suggest the installation of feeders and wildscaping yards were the primary methods urbanites used to reconnect the natural world to their constructed environments (Adams et al., 2006). New housing developments emerged promoting natural landscapes and increasing likelihood of wildlife viewing opportunities for homeowners. San Julian suggests that many home owners are trying to attract animals by developing their back yards into islands of urban wildlife habitat and in doing so, they create pockets of habitat that usually support more animals than an equal amount of woodland acreage because of supplemental food supplied by residents (San Julian, 1987). City design itself has created habitat islands: some examples of the pockets of habitat or remnant habitat patches (RHP) are city parks, buffer corridors along river edges, cemeteries, golf courses, and in the GWA, the urban Assiniboine Forest, riparian habitat of the Seine, Red and Assiniboine rivers, and the

urban wetlands of Fort Whyte (Bulloch, 1987). Adams et al. suggest that RHP's become islands embedded in a matrix of urban/suburban landscape. Small RHP's that are isolated with no connectivity to other natural habitat areas can result in dwindling wildlife populations (Adams et al., 2006). Since a majority of the twentieth century focused on creating policy and legislation to protect species from exploitation and overharvest, few mid-century planners considered green space corridors for wildlife movement through urban centers. Wildlife populations unable to adapt to human manipulated habitats diminished while others, able to adapt to urban environments and small RHP's, flourished.

As noted above, public attitudes toward wildlife were shifting in the latter portion of the twentieth century. Manfredo et al. suggests (Manfredo et al., 2003; Manfredo, 2008) that increasing affluence, education and urbanization has resulted in a shift in attitudes from traditional utilitarian focus to protection oriented with respect to wildlife. This societal shift suggests traditional uses and management of wildlife may no longer be preferred by the majority of urbanites. This presents challenges for wildlife managers called upon to reduce human-wildlife conflict and manage urban wildlife populations. The protectionist orientation with regard to wildlife may be connected to the growing non-consumptive interests in wildlife. In Canada in 1991, an estimated 84.3 million days were spent by Canadians engaged in primary non-consumptive wildlife activities (Environment Canada web pages, accessed on March 10, 2008). Urbanites spending considerable time and money attracting wildlife to their property to increase their connectivity to the natural world and to increase wildlife viewing opportunities quickly became aware of some of the downfalls that accompany living in close proximity to

wildlife. By feeding birds and small mammals, urbanites began to attract larger mammals that found food left out, or fed on the birds, small mammals, and even domesticated pets found in yards near feeders. Attracting wildlife led to property damage, vehicle accidents, and human health and safety concerns. As a result, of these inter-related changes of urban sprawl, habitat modification and fragmentation, changing public attitudes and uses of wildlife, human-wildlife conflict increased in urban areas.

**Human-Wildlife Conflict**

As white-tailed deer populations continue to grow in urban environments, the number of human-deer conflicts is increasing (Adams et al., 2006). White-tailed deer adapt to urban and suburban environments, taking advantages of food sources found on residential and urban landscapes. Basic biological requirements are being met in urban environments. Shelter is readily available. Food and water are available and often supplied by urban residents. Urban deer populations are not checked and balanced by winter starvation and as a result populations continue to grow. Many urban environments also protect deer from hunting by placing hunting bans in urban and suburban areas as is the case in Winnipeg. A majority of the natural predators of deer have been removed by actions over the last century. The predators that remain, such as wolves, coyotes, and bears do not venture into urban centers with as much success, before they are identified and removed. The end result remains that large deer populations have adapted well to urban environments and have found conditions that favor population growth. In many cases, herbivore large mammal populations, such as deer exceed the biological carrying

capacity and the area is over browsed, in some cases, permanently altering native flora (Whittaker, 2001).

White-tailed deer cause property damage and present a human health and safety concern. They cause private property damage by eating ornamental trees, shrubs, flower beds, vegetable gardens and fertilized lawns (Swihart et al. 1998, Conover 1997, Vercauteren et al. 2005). White-tailed deer also pose a significant human safety concern, and are involved in an increasing and alarming number of motor vehicle accidents. In the United States, deer-vehicle accidents are a nation-wide problem. In 1991, there were 1 million driver vehicle accidents that occurred in the United States causing more than $1 billion in vehicle damage and over 200 human fatalities (Conover et al., 1995). In Contra Costa Country, in the Northeastern Bay area in California, Animal Control Officers removed 1200 deer carcasses from roads in 1996 in a largely urbanized area (McCullough et al., 1997). Similarly in Canada, deer-vehicle collisions are increasingly a concern. As deer populations continue to grow, and the number of vehicles on the road each year continues to increase, the number of serious collisions with deer is increasing (Canada Safety Council web pages accessed on September 9, 2008). Public awareness campaigns are in place to warn motorists of the danger, and new ways to prevent vehicles from hitting wildlife are being explored. In 2003, nearly 300 Manitobans were injured, some seriously, in vehicle-deer collisions. A total of 10,475 wildlife collisions, many of which were vehicle-deer collisions, were reported to Manitoba Public Insurance and a record $20.1 million was paid out in wildlife claims (Canada Safety Council web pages accessed on September 9, 2008). Today, Manitoba Public Insurance (MPI) spends over $27 million per year on automobile insurance claims involving wildlife of which 6500-

8500 of these collisions involve white-tailed deer. In the city of Winnipeg, the number of deer vehicle collisions is increasing. In 2005, 2006, and 2007, there were 325, 433, and 424 reported deer-vehicle collisions within the city. Appendix 3 provides a map of the 325 reported deer-vehicle collisions within the city of Winnipeg in 2005. These figures only record the reported deer-vehicle collisions, and it is believed the true number of deer-vehicle encounters is actually much higher. This is in comparison to the 48 deer-vehicle collisions reported in Winnipeg in 1976, when the estimated urban deer population was 200 animals (Shoesmith and Koonz, 1977). Similarly disturbing statistics such as these are recorded for provinces across Canada. Likewise a growing urban deer population in the GWA has resulted in an increasing number of deer-vehicle collisions.

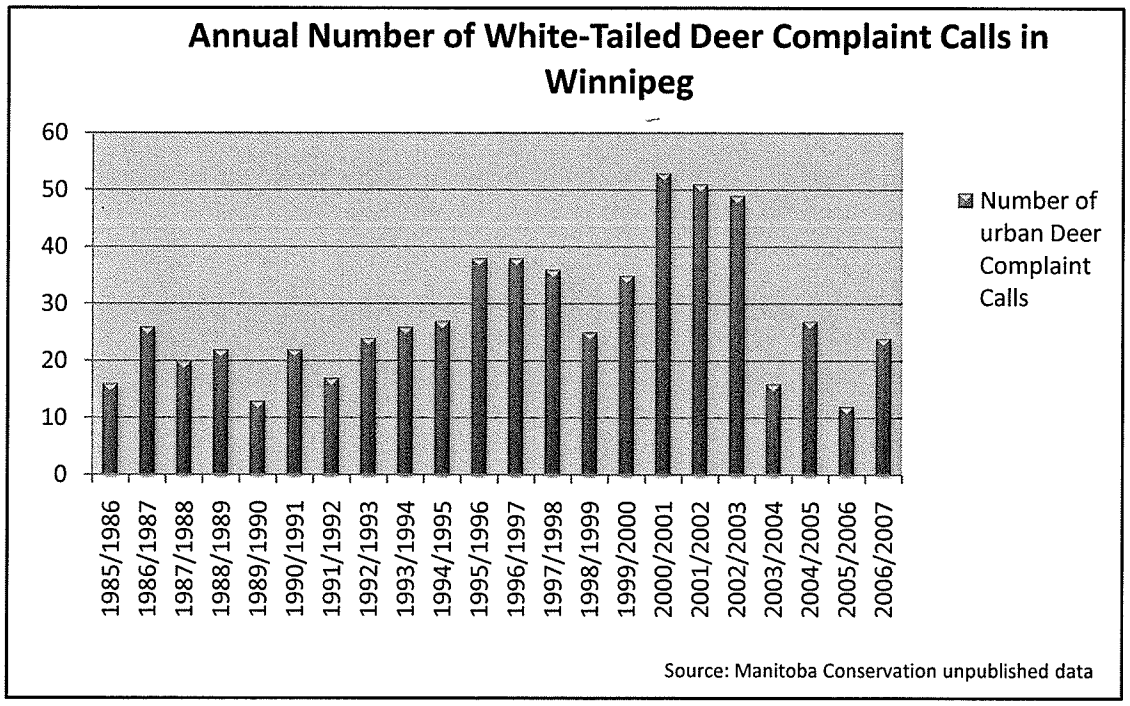
White-tailed deer are also a human health and safety concern since they are a host for diseases transmittable to humans. A well known white-tailed deer transmittable disease is Lyme disease. McCullough et al. suggest that deer moving back and forth between wildlands and urban areas bring ticks into frequent contact with humans and therefore the presence of deer in urban environments increases the risk of Lyme Disease (McCullough et al., 1997), a bacterial infection that people can contract from the bite of an infected blacklegged (deer) tick. Adult blacklegged ticks can be found from April to November; however, they are most common in October and November (Government of Manitoba news release web pages accessed on May 20, 2008). Overabundant deer populations increase public health concerns. In the United States in 1991, 16, 273 Lyme disease cases were reported, with an overall incidence of: 6.0 per 100,000 population (Government of the United States, Lyme disease web pages accessed on March 10, 2008). In 2002, with growing urban deer populations, the incidence of Lyme disease

increased to 23,000 new cases being reported in the United States where deer played a major role in the transmission (Lauber et al., 2007). With an increasing urban deer population, there is an increasing threat of human contact with deer ticks in many North American metropolitan centers. Throughout Manitoba, there is a chance of being exposed to Lyme disease through contact with infected blacklegged ticks; however, the greatest risk exists in the southeastern corner of the province where an infected blacklegged tick population is established. Since 1999, nineteen cases of Lyme disease have been reported by Manitobans, with sixteen of these cases reported in the last three years (Government of Manitoba news release web pages accessed on May 20, 2008). Seven of the cases reported were found in people who travelled to areas with established blacklegged tick populations outside of Manitoba. Since 2005, there have been five cases of Lyme disease identified by people who have visited the southeastern corner of Manitoba (Government of Manitoba new release web pages accessed on May 20, 2008). It is believed these ticks mostly come into Manitoba as nymphs on migrating birds in the spring. The nymphs drop off in Manitoba, molt to the adult stage and then pose a risk for transmission of Lyme disease if they have, for example, fed on an infected host in the larval stage. Until an established breeding population of blacklegged ticks exists in the GWA, white-tailed deer do not play a significant role in transmission of possibly infected blacklegged ticks in the area. Once a blacklegged tick population is established in the GWA, white-tailed deer may become a host for potentially infected deer ticks (Personal communication with Dr. Terry Galloway, Entomologist at the University of Manitoba on May 23, 2008).

White-tailed deer also cause significant losses for agricultural producers. In the United States, white-tails are estimated to have caused $100 million in agricultural damage in 2001 (Conover, 1997). White-tails have also significantly impacted the timber industry by feeding on growing trees and saplings and retarded tree growth altering the density and diversity of woody species (Waller and Alverson, 1997).

Manitoba Conservation has noted an increase in the number of complaint calls involving white-tailed deer in the city of Winnipeg. Figure 2 represents the number of complaint calls received by Manitoba Conservation involving white-tailed deer from 1980 until 2007.

**Figure 2**:




In a study of Metropolitan residents in the United States found that residents spend a significant amount of time and money attracting wildlife to their property; however, interestingly, these same residents are also likely to take wildlife management

into their own hands when human-wildlife conflicts occur (Conover, 1997). Of those surveyed in the Conover study, 57% actively tried to enhance wildlife populations in their neighborhoods; however, when nuisance problems developed, 69% of the same residents actively tried to manage the wildlife in their areas (Conover, 1997). Conover suggests that wildlife management has to shift in the 21st century to focus on urban wildlife conflict, such as escalating urban deer populations, and increasing incidence of human-deer conflict where traditional methods of game management may no longer be feasible. Due to the lack of training and response from wildlife management agencies, Conover argues, residents in urban areas have taken matters into their own hands (Conover, 1997). Human-wildlife conflict, and attempted resident-management, becomes problematic, however, when large mammals such as urban white-tailed deer are involved.

**Human Dimensions of Wildlife Management**

As the result of an increasing movement of society into urban areas over the last fifty years, urban sprawl, and infrastructure extend into previously undevloped habitat. Urban environments have provided suitable conditions for a number of adaptable wildlife species. Many wildlife species are displaced and end up in urban areas (Adams et al., 2006). Residents living in these communities display a wide spectrum of tolerances, opinions, and beliefs in regard to wildlife. Some residents promote wildlife in their neighborhoods, while others lobby actively for their removal. The stage is set for the dilemma that faces wildlife management in the 21st century.

Aldo Leopold, dubbed the father of wildlife conservation in America (Adams et al., 2006), recognized over sixty years ago the need to develop public wildlife

management that integrates biological, ecological and social considerations (Riley et al., 2002). Daniel Decker et al. suggest: "Although biological data will always be necessary to clarify the biological impacts of alternative management action, wildlife management is a human activity; it seeks to achieve human-defined goals and objectives. Actions taken to achieve those objectives are directed at and affect humans as well as wildlife and their habitats" (Decker et al., 2001). To date, funding and resources continue to support the biological and ecological research of wildlife management. Thomas Heberlein argues that funding and support needs to be re-directed to include a balanced program including the human as well as the biological dimensions of wildlife (Heberlein, 1991). It has been noted that the effectiveness of wildlife professionals in the 21st century will depend on their skill at integrating biological and human dimensions of wildlife management (Riley et al., 2002). Determining the diverse opinions and beliefs of numerous urban stakeholders, and understanding the reasons for these orientations, is essential for wildlife managers in creating successful, and acceptable long term urban large mammal management plans.

To begin, wildlife managers must assess the cultural (social) carrying capacity of large mammal populations in their communities. "The focus of social carrying capacity is how the density of people and their impacts affects the experiences sought by other recreationalist" (Decker & Purdy 1988, 53). The cultural carrying capacity is defined as the maximum wildlife population that a society will accept within a given area. In contrast, biological carrying capacity refers to the environmental resistance limiting wildlife population such as the quantity and quality of food, cover, and water (Decker & Purdy, 1988). Biological carrying capacity has long been the focus of wildlife

management studies. Cultural carrying capacity is difficult to determine since it is based on a variety of views of a large number of stakeholders. Decker and Purdy have referred to the understanding of how human beliefs and preferences affect decisions on the management of wildlife populations as wildlife acceptance capacity (WAC) (Decker & Purdy, 1988). The WAC concept represents the maximum wildlife population level in an area that is acceptable to people. What makes WAC even more complex is that the threshold of acceptance is not static. Stakeholders' acceptance of wildlife population size may change. Given these complexities, stakeholders often do not see eye-to-eye on the acceptable wildlife population size or on the course of management action taken to alleviate the conflicts. The benefits and liabilities urban wildlife population present to various stakeholders differ. "For any wildlife density, some people will complain there are too many animals and, concomitantly, other people will complain that there are too few. This creates a difficult situation for the government agency charged with managing the wildlife resource, because any action it implements will displease some people" (Conover 2002, 360). Wildlife management agencies have tried to balance the benefits and liabilities wildlife populations present to various stakeholders through policy decisions, partnerships, education and compensation.

Wildlife management agencies use policy and partnerships to attempt to balance the WAC among stakeholders. Evaluating the opinions, beliefs and values of numerous stakeholders in a community requires large amounts of time and resources. Wildlife management agencies have been delegated this responsibility by elected legislators who are responsible for the management of the wildlife resource (Conover, 2002). The use of public forums provides stakeholders the opportunity to express their views. Citizen

boards may be created to assist in overseeing wildlife management policy decisions. Gathering leaders from different stakeholder groups can be beneficial toward resolving differences. Working closely with landowners can help them adopt practices that benefit their property. In doing so, landowners also benefit and become stewards of wildlife and thus increase their appreciation for the presence of wildlife. Creating working partnerships between landowners and wildlife management agencies requires time, trust and good communication. Wildlife managers who traditionally focused on game management in rural areas with few stakeholders now need to have good interpersonal skills, be effective communicators, and be willing to listen to numerous stakeholders' opinions. Wildlife managers must be willing to address concerns in a timely and proactive manner in order to establish the trust needed to make these partnerships work. Such working groups and partnerships demand skill sets not previously required for a successful career as a wildlife manager (Conover, 2002).

Public education is becoming an increasingly important aspect of urban wildlife management and can be an effective means of increasing community tolerance for human-wildlife conflict. Public education can be used to provide accurate information to stakeholders and reduce their unfounded fears and increase public tolerance for wildlife damage (Conover, 2002). William Porter attributes the breakdowns in resolving wildlife management conflicts among stakeholders to three factors: ignorance, arrogance and process. Porter suggests that a lack of knowledge about biology, ecology and economics leads to values poorly formulated since they are based on inadequate information and understanding of the issues; that stakeholder perceptions are based in partial truth, and misconceptions (Porter, 1997). To aggravate the situation further, Porter argues, those in

positions of authority are more interested in action than analysis. A failure to fully understand the complexity of the issue results in quick decisions, where research is seen as a waste of time and resources. Porter stresses that the key to successful management begins with a successful process. Engaging stakeholders in the process of decision making is a crucial step (Porter, 1997). Another complication arises though the influence media has on wildlife value orientations and contribution to public education. Joseph Champ suggests that wildlife media is a potential contributor to people's current wildlife value orientations (Champ, 2002). Wildlife portrayed with anthropocentric qualities may provide a false representation of the actual biological and ecological factors of wildlife. It is increasingly important to ensure that public education is delivered from community leaders with factual information upon which urban residents can base decisions. Public education may potentially increase social tolerance for wildlife populations and provide stakeholders with an accurate and clear understanding of the conflict. Opposition to hunting in the 1970's in New Jersey was successfully reduced due in part to a reflection of large scale programs of public education (Applegate, 1979). Public education is a key initial step toward a successful process for wildlife management in the 21st century.

Increased tolerance for urban human-wildlife conflict may be achieved through compensation programs. Compensation assists government agencies and wildlife managers in balancing the benefits and liabilities of wildlife among stakeholders. Compensation is paid to some landowners for some forms of wildlife damage but not to all landowners for all forms of wildlife damage. Compensation is expensive and can lead to payouts over long time frames. Compensation is more often paid to rural landowners for wildlife damage of their crops, harvest, or livestock. As a result, compensation is not

seen as a viable long-term solution to urban large mammal wildlife management. Compensation has been used in creative ways; however, to promote responsible land ownership. Gehring and Potter suggest that compensation can be used as an incentive for farmers and large private landowners to mitigate wolf predation on livestock, that incentives might be paid to landowners who practice responsible animal husbandry, and proactive, non-lethal control tools on their property. Landowners thus become active managers, and stewards of wildlife. Gehring and Potter argue that compensation programs that compensate only for losses do not have as much potential to increase social tolerance as active land management incentives might (Gehring & Potter, 2005).

As Porter suggests, government agencies are often under pressure to produce results. To this end, government agencies may formulate quick decisions and implement policies and strategies that are not founded on the biological, ecological or social considerations of the wildlife-human conflict. The emergence of Adaptive Resource Management (ARM) in the early 1990's signaled the integration of science and management by focusing decision-making on hypothesis-testing and structuring management actions as field experiments (Enck et al., 2006). ARM promotes enhancing of science through the evaluation of management actions chosen to achieve specific objectives directed toward wildlife. ARM allow managers to proceed with management action knowing they do not have all of the information but that they will learn, adjust and adopt new information into management action. Management can proceed without having to wait for all the scientific information to be available, since managers know they will massage and adjust future management action based on what is learned in the field. ARM provides solutions for forward motion of action plans but managers need to

incorporate stakeholders into the decision making process before they establish objectives of management plans. Adaptive impact management (AIM) seeks to clarify "why" management is necessary. AIM begins with identification of stakeholder-defined impacts and stakeholders' beliefs about desired or tolerable levels of these impacts (Enck et al., 2006). AIM incorporates human dimensions into wildlife management. AIM ensures objectives of management action are based on analysis of stakeholders' attitudes, beliefs and values in the human-wildlife conflict. "With impacts identified and translated into fundamental objectives in terms of desirable levels of positive impacts and tolerable levels of negative impacts, further input from stakeholders (derived both qualitatively and quantitatively) and expert knowledge of scientists and managers can be combined to create a model of the system of factors thought to influence the levels of the identified impacts" (Enck et al., 2006). AIM builds community trust and public involvement in making decisions. AIM and ARM complement each other and when used together create a foundation of process upon which wildlife managers can successfully reduce human-wildlife conflict.

Understanding shifts occurring in society with respect to wildlife value orientation is also an essential aspect to understanding human dimension studies. As mentioned, Manfredo et al. suggest that wildlife value orientations are shifting away from the traditional materialist (priorizing physical security and economic well being), utilitarian focus to an increasingly post-materialist (prioritizing quality of life, self-expression, self-esteem) protection-oriented focus (Manfredo et al., 2003). These authors suggest that these value shifts are the result of increasing urbanization, increasing affluence, and increasing education (Manfredo et al., 2003). Understanding these value shifts may assist

wildlife managers in understanding human dimension results that show less support for traditional methods of management.

In summary, human dimensions is becoming increasingly important in wildlife management. As the incidence of human-wildlife conflict rises in urban areas, wildlife managers are attempting to create management plans that impact a large number of stakeholders with varying beliefs, tolerances, and attitudes. Using public meetings, working groups, developing partnerships, conducting surveys, and public education, wildlife managers should be able to develop an approach that involves stakeholders, identifies stakeholder impacts and management objectives.

## White-Tailed Deer Management

A variety of non-lethal and lethal strategies may be used to manage urban deer populations and to reduce human-deer conflict in metropolitan areas.

### *Non-Lethal Methods of Management*

#### *Public Education*

When considering the integration of human dimensions in wildlife management, public opinion becomes an important consideration. Often, public opinion is based on media influences (Champ, 2002) and public knowledge may be limited and may not have a factual foundation. Accurate information may influence people's views about the acceptability of one management strategy over another. Lauber et al. suggest that public opinion about management programs influences public policy and therefore good public policy is dependent on well-informed opinions about the implications of various potential

management strategies (Lauber et al., 2007). This management strategy suggests that no action is taken to reduce the deer population, but rather there is an investment in teaching people to reduce problem interactions by changing human behavior and perhaps in doing so, change deer behavior.

*Habitat Modification*

Habitat modification is one possible non-lethal strategy. In urban environments habitat modification could be considered by private residents, where these residents make decisions to plant flora not favored by white-tailed deer. In addition, city planners might consider landscape-specific variables such as thick forest cover near roadways, or preferred vegetation near highways (Nielsen et al., 2003). City planners might consider reducing densely treed landscapes, agriculture, and flora favored by deer near troubled roadways. Urban planners might also attempt to ensure that all urban land plantings are unpalatable to deer. DeNicola et al. suggest that habitat modification is rarely practical since urban deer are so adaptable to human manipulated environments that only large intensely urbanized areas devoid of any woodlot area would be suitable to deter deer. Since this is rarely the environment desired, habitat modification is deemed impractical (DeNicola et al., 2000). Nielsen et al. suggest that habitat modification can be effective in reducing deer vehicle collisions on troubled roadways; however, urban residents may perceive such modification as negatively affecting the esthetics and recreational opportunities of their communities. Reducing forest cover and shrubby areas on public lands near roadways did prove to decrease habitat suitability for deer and increase visibility for drivers (Nielsen et al., 2003).

*Prohibiting Feeding Deer*

Placing a ban prohibiting the feeding of deer is another strategy that might be attempted. Supplemental feeding is known to enhance deer reproductive rates, encourage deer to cross roadways, habituate deer to people, increase disease transmission, and promotes deer to congregate in sensitive areas (Doenier et al., 1997). This management strategy may be effective only if resources are available to enforce the ban and if the penalty of non-compliance on the ban is a large enough fine to encourage residents to comply. DeNicola et al. suggest that unless adequate resources are available for law enforcement agencies to enforce ban regulations, this is often an unsuccessful strategy since residents ignore the ban and continue to feed deer (DeNicola et al., 2000).

*Chemical Repellents*

Repellents have also been used to reduce deer browse on private plantings. Repellents have a high application cost, and have variable effectiveness where total elimination of damage should not be expected (DeNicola, 2000). Repellents reduce the attractiveness and palatability of treated flora. Environmental conditions may contribute to the need for continuous application, which can be costly and time consuming; therefore it is advised to use repellents with an adherent nature. Generally, this is only effective on a small scale especially with labor-intensive plants (DeNicola, 2000). Some repellents are odor based versus taste based. Having odor based repellents is advantageous since deer are often deterred upon approach reducing the damage of deer walking on plants. Other types of repellents are fear-induced and pain-induced repellents (DeNicola et al., 2000).

*Scare-Tactics*

Scare-tactics have also been used in urban centers to reduce the number of deer from a defined area. These scare-tactics are met with varying degrees of success. A study done on urban elk and mule deer found that animal-activated frightening devices equipped with loud alarms, repeated beeping and light activation did not deter the animals from feeding and residing in the area (VerCauteren et al., 2005). VerCauteren et al. suggest that many cervids living near or in urban areas, are already habituated to the sights, sounds and commotion of densely populated human areas. These non-lethal strategies are thought to be effective on a small scale, short-term basis but are not regarded as long-term viable solutions for reducing human-deer conflict.

*Barrier Fencing*

Fencing can be a reliable non-lethal method of management in site-specific areas such as airports, landscape or agricultural areas (Caslick & Decker, 1979). Fencing agricultural lands is a cost prohibitive solution, however. Several factors must be considered in order for fencing to effectively control deer and it may not be a feasible option over larger areas (DeNicola et al., 2000). Fence design, site history, deer density, crop or landscape value, local ordinances, and size of the area to be protected are all factors that must be considered to determine the effectiveness of fencing as a deer management option. Caslick and Decker argue in "Economic Feasibility of a Deer-Proof Fence for Apple Orchards," that wildlife managers and owners should carefully consider the economies of deer damage control when considering barrier fencing to ensure cost of losses exceeds the costs associated with fencing (Caslick & Decker, 1979).

*Road Safety Signage*

Fencing, warning signs, vegetation management, and roadside reflectors have been used to reduce deer-vehicle collisions with varying degrees of success. It is difficult to determine whether the increase in safety signage has caused motorists to reduce speed. DeNicola et al. suggest that motorists quickly become accustom to deer warning signage and as a result, disregard the signs and fail to reduce their speed. As a result, deer-vehicle collisions continue to occur (DeNicola et al., 2000).

*Promote the use of Deer Whistles on Vehicles*

Deer whistles are warning whistles attached to cars that have been used in an attempt to reduce deer-vehicle collisions. These whistles operate at frequencies of 16-20 kHz, a range in which deer are supposedly frightened by the frequency and decibel of sound (DeNicola et al., 2000). Unfortunately, there are no studies that indicate that deer are indeed frightened by the sound. In addition, no studies indicate the whistles effectiveness at scaring deer away from roadways. A study conducted on mule deer indicates that the vehicle whistles were not found to alarm deer, and are thought not to be loud enough to be heard over the vehicle engine and other roadway sounds (Romin & Dalton, 1992).

*Trap and Relocation*

Trap and relocation is another possible urban deer management option. Translocation is the trapping of animals in urban areas, and the release of these animals in new designated areas. Translocation has been preferred by some stakeholders who oppose lethal

management strategies. Unfortunately, translocation has many downfalls. It is rarely feasible due to limited release sites and animal stress suffered during transport (McCullough et al., 1997). Often, deer die due to stress during capture, transport, or as the result of an incapability to adjust to predation and other factors in the new environment. On Angel Island in San Francisco Bay, the California Department of Fish and Game relocated 203 deer after area residents indicated their opposition to the introduction of predators and lethal methods of management. A majority of the 203 relocated deer died within the first year with most of the deer dying within the first three months after relocation (McCullough et al., 1997). A similar trap and relocation of deer was conducted in 1991, where 29 black-tailed deer were trapped and relocated from Ardenwood Park, California, to the Ohlone Wilderness area, two hours from Ardenwood Park for release. Twenty seven deer were fitted with radio collars (two died during capture) where their movements were studied for one year. By the end of the year, twenty three deer of the twenty seven relocated were dead (Mayer et al., 1995). In addition to injury, death and suffering of the re-located deer, disease transmission is a concern. Translocated animals may import new parasites to residing animals of the same species, or of other resident species at the translocated site (Cunningham, 1996). Translocation is a costly and difficult as to finding suitable release sites.

*Immunocontraceptives*

Fertility control is another non-lethal strategy in the experimental phase of implementation. Fertility control has been advocated by some stakeholders as the humane alternative to lethal management (Lauber et al., 2007). Administering

immunocontraceptives effectively is difficult, however, especially in free-range herds. Immunocontraceptives are not considered a viable cost-effective management option since the method is still experimental (Turner et al., 1996; DeNicola et al., 2000); since the time-to-reduction is unacceptable (Merrill et al., 2006); since the probability of successfully delivering sequential doses of contraceptives to free-ranging herds is low; and since the cost and effort required to capture, mark, and treat every female is prohibitive (Nielsen et al., 1997). In a case study in Coyote Hills in the San Francisco Bay area, 15 adult does were inoculated with the fertility control drug porcine zona pellucid (PZP) and fitted with radio transmitters (McCullough et al., 1997). In the fawning season the following year, none of the treated does produced fawns; however, the following fawning season (the second fawning season after treatment) the does produced fawns. This case study confirmed the expected one-year maximum effectiveness period of PZP (McCullough et al., 1997). In addition to the high cost of treatment and the difficulties encountered by repeated treatment of does in a free range herd, there are also concerns over the effect fertility control treatments may have on doe movement and behavioral changes. Hernandez et al. suggest that some side effects of PZP treatment are repeated estruses, an extension of the breeding season, and increased movement and ranges (therefore increased concerns over deer-vehicle encounters in urban areas) in immunized does (Hernandez et al., 2006). Hernandez et al. did not find in their research any difference in doe movement or range changes once treated; however, they did not evaluate the potential changes that may occur with male movement and range change when treated females exist in the herd, suggesting male movement changes may be more pronounced than females (Hernandez et al., 2006).

*Surgical Sterilization*

Surgical sterilization might be a successful way to reduce urban deer population size; however, there are many concerns with this method of management. Cost, time-to-reduction, stress on deer during capture and procedure, behavioral changes in the herd and herd dynamics, and considerable management effort are a few examples of such challenges (Merrill et al., 2006). Surgical sterilization requires the capture and sterilization of a substantial number of fertile females, although fertile females are only a fraction of the deer that are encountered and males and previously sterilized females will likely also be captured. This increases the stress suffered by deer and increases the waste of manager resources and effort (Merrill et al., 2006).

*Status Quo (No Management)*

The effectiveness of this management option is unknown. We do know that without management the GWA deer herd has the potential to grow 6% per year (Manitoba Conservation, 2007). Given this, the GWA deer population has the potential to grow to over 1450 deer by 2010 and over 2600 deer by 2020. Such increases in the urban deer population will liekly result in an increase in human-deer conflict and an increase in the number of deer-vehicle collisions within the city. Since the GWA is located within Manitoba, a province at the northern limiting range for white-tailed deer, severe winter weather can have a significant impact on the urban deer population. Severe winter weather in 1995-1996 and again in 1996-1997 did have a substantial impact on the urban deer population, dropping the estimated deer population in the GWA to only 215 deer

(Manitoba Conservation, 2007). Since there are many dynamic, changing variables to consider when approaching and urban deer management plan, it is difficult to determine the future impact of status quo.

*Lethal Methods of Management*

Traditionally, hunting was the primary method used to control population growth in rural areas. However, hunting is limited in urban and suburban environments due to perceived concern for public safety, and firearm discharge laws. In addition, hunting is faced with other challenges. Many recreational hunters do not see themselves as wildlife managers and may not be willing to make the adjustments necessary to control overabundant urban wildlife (Brown et al., 2000). Hunter numbers are also declining in some areas, and there is speculation as to whether there are enough hunters to effectively reduce overabundant wildlife populations (Brown et al., 2000).

*Selective Cull*

The urban deer population could be immediately reduced by selectively shooting deer. The meat from the deer that are dispatched could be used by charitable organizations, although such an initiative increases the costs of the management action. Deer could be culled by professional staff with Manitoba Conservation, hired professionals from an outside organization, or by city police. Selectively culling deer could be used to remove diseased and injured deer from the urban herd. Bait sites could be set up to lure deer to these specific areas where they are culled. This management action might not be effective in areas where housing density and urban activity is high and it might encounter

opposition because of perceived safety concerns. This method of management would need to be repeated periodically to maintain the deer population at the desired level.

*Trap and Euthanize*

Trap and euthanasia is a lethal technique that can be considered in areas where there is concern over the discharge of firearms. Deer are trapped using box traps, clover traps, drop nets, or rocker nets and then euthanized using chemicals or using a gunshot or a penetrating captive bolt to the head (DeNicola, 2000). Meat can be delivered for human consumption to shelters as the animals have been euthanized by gunshot or other physical means avoiding chemicals (DeNicola, 2000). This method is generally expensive and deer are greatly stressed during the restraint phase of the capturing process (DeNicola and Swihart, 1997). Schwartz et al. compared three methods of chemical immobilization and euthanization of urban deer. The authors suggest that rifle shots to the head resulted in low cortisol concentrations (used to measure the response of deer to stress). As a result, they recommend euthanasia of deer by rifle as the most efficient and humane method of euthanasia of urban deer (Schwartz et al., 1997).

*Sharpshooting*

Sharpshooting can also be used to address overabundant deer in urban areas. Sharpshooting involves employing trained, experienced professionals to lethally remove deer through sharpshooting. This method has been considerably successful (DeNicola et al., 1997). There are several methods recommended for sharpshooting programs such as: use of bait to attract deer to designated areas prior to removal; shooting deer from

portable tree stands, ground blinds, or from a vehicle during the day or night; when possible, selecting the head (brain) or neck (spine) shots to ensure a quick and humane death; processing of deer in a closed and sheltered facility; and donating of meat to food banks (DeNicola, 2000). Bait sites can be used to effectively increase the visibility of deer. Using bait sites in urban areas may increase hunter success and may be used to shift deer activity away from residential areas to enhance shooting safety, make deer more accessible, and increase perceived public safety by sharpshooting in less densely populated areas (Kilpatrick and Stober, 2002). In east-central New Hampshire in 1996, sharpshooting was adopted to reduce overabundant deer populations in the town of Long Island. Since humaneness and safety were the primary concerns of the public, a professional and organized sharpshooting management strategy was considered a success as the plan was able to effectively address these concerns, reduce the deer population, and donate a large amount of venison to local food banks (DeNicola et al., 1997).

*Controlled Hunting*

Controlled hunts have also been used as a lethal method of management in urban and suburban areas. Controlled hunting is the application of legal, regulated deer hunting in combination with stringent controls or restrictions as dictated by elected officials (DeNicola, 2000). Controlled hunting incorporates a variety of restrictions for hunters such as limited hunting dates and times, restrictions on movement, and antlerless-only permits (McDonald et al., 2007). Controlled hunting is often controversial and can be costly. Controlled hunts, however, have been successful in many locations (Kilpatrick and Walter, 1999). Robert Deblinger et al. suggest that a controlled hunt implemented in

the mid 1980's in Massachusetts did achieve deer population reduction and the desired ecological outcomes. Although this deer management plan did encounter significant opposition from animal rights and anti hunting groups at the beginning, once the controlled hunt was underway, public relations improved as people recognized the careful, scientific way the program was established, organized and operated (Deblinger et al., 1995). This controlled hunting program had high hunter success rates, hunter proficiency tests, hunter education opportunities, and proved successful in achieving the ecological and sociological objectives of the management plan (Deblinder et al., 1995).

In order for hunting to be effective in achieving desired population reduction, two phases must be considered. The first phase is the initial reduction in the population abundance. The second phase is maintenance of the population at this new desired level (Brown et al., 2000). Adequate hunter numbers and hunter participation under these restrictive conditions is essential to hunting as an effective method of population control (Brown et al., 2000).

*Regulated Bow and Arrow Hunting*

Regulated bow and arrow hunting is another lethal method of management that can be considered. In many suburban and urban communities in the United States, firearm discharge laws only allow bow hunting within communities (Kilpatrick et al., 2007). Managers should ensure that before a regulated bow hunting management plan is considered and hunting limits are set, research into various aspects of the deer herd are conducted for the sake of the sustainability of the herd, the value of the habitat, and to reduce deer dispersal, possibly further into urban areas. Immigration and emigration of

deer must be considered. As is argued by Porter et al., management to reduce deer densities in a local area is predicated on the assumption that deer from the surrounding landscape will not move into an area where the population density has been reduced (Porter et al., 2004).

Another matter that a bow and arrow management strategy needs to consider is the change in deer range patterns that may occur with an archery season. McDonald et al. point out that archery hunting caused female white-tailed deer in an urban area to change their home range use patterns. Female deer used the hunted area less frequently than during the pre-hunt period (McDonald et al., 2007). McDonald et al. suggest that human activity levels and increased hunting pressure caused increased deer movements. It would be important for any proposed management strategy to ensure that considerations of the impact of increased deer movement are understood and implications are measured.

Bow and arrow hunting may also be presented with the challenge of support from hunters. In a human dimensions study conducted by Kilpatrick et al. bow hunters had varying support for hunting over bait in urban areas. Support for bow hunting in urban areas did increase when a special season was suggested for urban harvest outside of the existing archery season (Kilpatrick et al., 2007).

# CHAPTER THREE
# METHODOLOGY

This chapter focuses on the thesis design and methodology. First, a description of the study area is presented. Second, a description of the research design, survey stratification, and survey construction is discussed. Lastly, a breakdown of the methods of analysis utilized in this research is presented.

## Study Area

The Greater Winnipeg Area (GWA), the study area for this research, is a city located in the province of Manitoba, one of the three western prairie provinces in Canada. Manitoba is a province spanning 647,979 sq. kilometers (250,116 sq. miles) (Government of Manitoba Geography web pages accessed on September 29, 2008) with a 2008 population estimate of 1,208,000 people (Manitoba Bureau of Statistics web pages accessed on September 29, 2008). The largest and capital city in Manitoba, Winnipeg, is the 7$^{th}$ largest municipality in Canada located near the longitudinal center of North America, approximately 100km (62 mi) north of the border with the United States and 70 km (43 mi) south of Lake Winnipeg (Government of Manitoba Community Profiles web pages accessed on September 29, 2008). Winnipeg is located where historically a tall grass prairie ecosystem thrived (Scott, 2007). The city has a humid continental climate (Koppen climate classification), with the summer typically humid and hot, seeing temp rise to 35 degrees Celsius. Spring and fall are highly variable seasons. The typical winter in Winnipeg is long and cold seeing temperatures reach minus 35 degrees Celsius.

Winnipeg is very sunny with an average of 317 sunny days per year (Government of Manitoba Map for New Comers web pages accessed on September 29, 2008).

*Survey Stratification*

Appendix 4 provides a map of the study area, outlining the GWA as defined by Canada Post (Canada Post web site accessed on June 20, 2008). This image illustrates the GWA, divided into the 35 urban FSA (forward sortation areas) used by Canada post for mail delivery. A forward sortation area is defined as the area that represents the first three characters of the postal code (Toronto Star media kit website accessed on November 27, 2008).

*Land Use and Land Cover*

Appendix 5 provides an image of the land use and land cover of the GWA and near surrounding areas. The study area for this research is outlined in red. The pale pink represents urbanization. The yellow represents agriculture, which occupies a majority of the land around Winnipeg. Extensive agriculture is found only in the southern portion of the province, with the most common type of farm found in rural areas being cattle farming (34.6%), followed by grains (19%) and oilseeds (7.9%). Approximately 12% of Canada's farmland is found in Manitoba (Morriss, 2007). The airport is located on the western side of the city. Near to city center is the historic confluence of the Red and Assiniboine Rivers near city center, which is now commonly known as "The Forks." Just outside of the study area, approx. 25 km NE of Winnipeg is Birds Hill Provincial Park. Birds Hill covers 8300 acres (35.1 sq. km) of aspen/oak parkland and is home to a

stable and relatively large white-tailed deer population (Trenaman, 2007). Within the city interior is a unique forested area known as the Assiniboine forest. The 700-acre (2.8 sq.km) or 287 ha area represents forest, prairie and marsh land and is located only 13 km from downtown Winnipeg. The Assiniboine forest is believed to provide thermal cover for white-tailed deer (City of Winnipeg web pages accessed on September 26, 2008).

*Human Population*

Appendix 6 provides a look at the human population in each FSA within the study area. The 2006 Statistics Canada population census indicates the City of Winnipeg and the GWA to have a population of 636,177 and 641,009 respectively. The population of the city of Winnipeg has grown by 4.3% since 1991 (Government of Manitoba web pages accessed on September 29, 2008).

Appendix 7 provides a map of the population density of each FSA within the GWA. The dark red shading on the image represents the FSA with the highest population density, occurring near the city center, and the light pink indicates the lowest population density of the GWA.

**Research Design**

The study used a four-wave, self administered, quantitative, mail-back questionnaire to survey a random selection of 4000 residents within the GWA. The study was designed by adopting a modified version of the Tailored Design Method established by Don A. Dillman in *Mail and Internet Surveys: The Tailored Design Method*, 2007, a revision of

the earlier Total Design Method developed in *Mail and Telephone Surveys: The Total Design Method*, 1978. A mail survey was chosen as the instrument for this research for a number of reasons. First, mail surveys are considered an effective means of assessing public opinion. Second, using a mail questionnaire has advantages since mail surveys have a higher probability of reaching the respondents where other methods fail (Dillman, 1978). In addition, mail surveys reduce the social desirability bias, where respondents answer questions in a way they feel is acceptable and popular. Respondents are found to be the most honest in their answers on mail surveys (Dillman, 1978). Based on the social exchange theory, an effectively constructed mail survey: appeals to a respondent's usefulness; increases perceived rewards for respondents who participate; decreases perceived costs in responding; and promotes trust between researcher and respondent through outlining the beneficial outcomes that result from the survey findings (Dillman, 2007). Random mail surveys also tend to be more representative of public opinion than either public meetings or advisory groups (Green et. al., 1997). Residents have also indicated their appreciation for the opportunity to express their views and mail surveys have been useful in providing agencies with the opportunity to inform, and educate the public (Stout et al., 1996). Mail surveys have been utilized by many researchers and wildlife managers with success. Decker et al. 1987, Whittaker, Vaske, & Manfredo 2001; Vaske et al. 2006, Conover, 1997 are a few examples of many that have utilized the Dillman mail survey methodology in determining public values and attitudes toward wildlife with successful results.

A quantitative approach to this study was adopted since quantitative studies use an experimental strategy of inquiry and are used to pre-test and posttest measures of

attitudes (Creswell, 2003). A quantitative methodology is often used in conducting surveys and experiments since it collects data on predetermined instruments, in this case, a mail survey, that yield statistic results (Creswell, 2003).

A sample size of 4000 was calculated based on the population size of the GWA and based on 99% confidence level and a+/- 3% sampling error (Dillman, 2007). The Tailored Design Method was utilized for this research since it identifies each aspect of the mail survey process that may bear on the quality and quantity of response and effectively shapes mail questionnaires in such a way that the best possible responses are obtained. Through adopting the Tailored Design Method, I attempted to increase survey response rate. Mail surveys have received a downward trend in response over the last fifteen years, mainly due to an increasing presence of junk mail in people's mailboxes (Connelly et al., 2003). Following methods established in the Tailored Design Method minimizes the costs of respondents' responding, maximizes respondents' rewards for responding, establishes a trust that these rewards will be delivered to respondents, and appeals to respondents on the basis of their social usefulness.

*Sample*

This broad-based study randomly selected 4000 residents within the GWA whose names, phone numbers, and addresses were purchased from The Conerstone Group of Companies. The Conerstone Group of Companies provided a random computerized selection of GWA residents who have a registered telephone number from the Manitoba Telephone System. The study was designed to survey a broad-based selection of complete representativeness of the GWA residents. To accomplish complete broad based

representativeness, The Cornerstone Group of Companies randomly selected an even number of residents from each of the 36 urban FSA's located within the GWA. Since the desired sample size was 4000 and there are 36 urban FSA's within the GWA, there were 111 residents randomly selected from each urban FSA. Using this methodology, however, it is important to recognize that not all residents within the GWA were represented. The sample frame did not consist of GWA residents who do not have a registered phone number, who have requested privacy restrictions on their information, or those without a private telephone number who are elderly or disabled. These individuals were not included in this broad-based sample. For the purpose of this study, response rate is calculated as follows:

$$\text{Response Rate} = \frac{\text{Number of questionnaires returned}}{\text{Number of questionnaires in the sample} - (\text{non-eligible} + \text{non-reachable})} \times 100$$

*Mail Survey Construction*

A mail survey must act as its own advocate. Over the last decade, mail surveys have received a downward trend in response rate with the increasing presence of junk mail (Connelly et al., 2003). Mail questionnaire construction must be carefully organized and designed to engage, motivate, and reward respondents for their participation. The mail questionnaire must provide immediate and positive answers to concerns over the questionnaire's importance, difficulty, and length. According to the Tailored Design Method, a properly organized and shaped mail questionnaire should achieve good results. By considering 5 elements, the Tailored Design Method has been shown to significantly improve response to mail surveys in most situations. These 5 elements are: respondent-friendly questionnaire; four contacts by first class mail; inclusion of stamped return

envelopes; personalized correspondence; and a token financial incentive (Dillman, 2007). To this end, the careful construction of the questionnaire was a critical feature of this study.

*Questionnaire Construction*

Questionnaire construction and organization are critically important to the success of a mail survey. Each aspect of the design, implementation and organization must be carefully considered in order to yield higher response rates. Consistent with the Tailored Design Method, the questionnaire utilized in this study was formatted in a vertical booklet form (Dillman, 2007). See Appendix 8. The booklets were attractive, well-organized and appear easy to complete. I used Likert 5 point scales in the survey. Likert point scales gave the survey respondents a range to indicate their level of agreement or disagreement with the question or statement. No questions were presented on the front or back cover pages of the questionnaire. The questionnaires were printed on white paper to be consistent with the methodology. Questions were carefully grouped according to topic, and ordered along a descending gradient of social usefulness or importance (Dillman, 1978). Questions were grouped within topics from the most salient to the least salient. Higher response rates of 25% were noted by Connelly et al. 2003, when the survey was highly salient, involving a topic of interest to a specific audience (Connelly et al., 2003). Since questionnaires consist of a variety of topics, some interesting to the respondents, some not, I attempted to start the questionnaire with the more salient questions, questions that would be relevant to a wide range of respondents (Dillman, 2007). Questions were grouped to take advantage of cognitive ties that respondents were likely to make among

groups of questions to build a sense of flow and continuity throughout the questionnaire. Since self-administered surveys are a series of questions that cannot be separated or made independent from one another, they have an effect on each other. Respondents identify the questions as related to one another and may adjust their answers to the second question based on their answers to the first one (Dillman, 2007). "No single question is more crucial than the first one" (Dillman, 2007). The first question will be chosen based on: clarity, relation to study, interesting, usefulness, neutrality, applicability to everyone, and should be easily understood and answer (Dillman, 1978; Dillman, 2007). The questionnaire was designed in careful consideration that respondents comprehend every word and every question. Questionnaire pre-test was designed and conducted to ensure a random selection of participants indeed understood language and question construction. Each complex question added to the survey map potentially decrease response rate by 0.5% (Connelly et al., 2003). As such, the questionnaire was created by carefully considering and simplifying question complexity.

Since using multiple fonts, shapes, brightness, symbols and styles may decrease questionnaire clarity, these were avoided. The font color used throughout the questionnaire is black making it easy to read. The font is standard and large enough that readability was easy for respondents. Increasing font size by one whole increment can improve the response rate by 4% (Connelly et al., 2003). The questionnaire was designed to use bold print for the questions and regular print for the answer choices. This provides a hierarchical gradient of the most to the least brightness that is consistent with the flow of each question and provides a clear and easy way for respondents to distinguish between questions and answers (Dillman, 2007). All answers are listed vertically instead

of horizontally, use simple numbers or boxes, and are placed on the left of the category labels, since the amount of space needed for writing answers varies considerably (Dillman, 2007; Dillman, 1978). Careful attention was given to ensure consistency and simplicity to the verbal and graphical language in the questionnaire (Dillman, 2007). Directions on how to answer each question of the questionnaire are clear and consistent throughout the questionnaire. The directions are placed exactly where the information is needed and not in a separate section of the questionnaire (Dillman, 1978; Dillman, 2007). In addition, only one question is asked at a time, and all questions fit to each page. Objectionable questions are placed near the end of the questionnaire, since a respondent who has invested 5-10 minutes already answering questions is less likely to respond to an objectionable question by quitting. In addition, these "objectionable" questions may seem less objectionable in light of previous questions already answered (Dillman, 2007). Demographic questions are placed at the end of the questionnaire (Dillman, 1978; Dillman, 2007). The front cover design is simple, basic, and attractive, in black and white carefully created to generate a positive first impression and motivate respondents. The front cover includes the study title, a simple, neutral graphic illustration, and the name and address of the University of Manitoba (Dillman, 1978; Dillman, 2007). The back cover is also simple, providing participants with the opportunity to make any additional comments, and offering plenty of white space with a simple note of appreciation at the bottom (Dillman, 1978; Dillman, 2007).

By and large, the questions used in this study were developed by researching human dimensions mail survey questions generated over the past two decades to address public opinion and tolerance in regard to growing urban white-tailed deer populations.

Questions were developed from surveys conducted by the Human Dimensions Research Unit through Cornell University. The survey questions were modeled from the HDRU series: No. 99-1; No. 01-7; No. 07-5; No. 00-8; and No. 08-2 (Human Dimensions Research Unit, Cornell University web pages accessed on March 2, 2008).

This study was approved by the Joint Research Ethics Committee at the University of Manitoba.

*Pre-test*

According to the Tailored Design Method, a pre-test is an important step in effective survey implementation. A pre-test should: evaluate the questionnaire to see if others identify problems; determine if any production mistakes have been made; learn whether people understand the questions; determine if any questions are avoided; and provide active feedback (Dillman, 2007). I conducted a pre-test as a part of my questionnaire design. I dispersed 25 questionnaires to staff employed at the University of Manitoba. These participants had a range of job responsibilities and lived in different areas within my study area. I also dispersed 25 questionnaires to staff employed at Manitoba Conservation. Again, participants' job responsibilities were varied and respondents lived in different areas within my study area. Pre-testing gave me the opportunity to evaluate the questionnaire in terms of my study objectives. It allowed me to determine item non-response questions, question comprehension, and appropriate survey length (Dillman, 1978; Dillman, 2007).

*Survey Implementation*

Implementation procedures have a substantial influence on response rates. The implementation design should convince respondents that a problem of importance exists and that their help is needed to identify a solution (Dillman, 2007). Following Dillman, I attempted to present myself as a person who, in light of the complexity of the problem, is making a reasonable request for help, such help as will contribute to the solution of the problem. I presented myself as an intermediary between the recipient asked to contribute and the steps that might help to solve the important problem (Dillman, 1978). Since multiple contacts are identified as the primary factor influencing response rate, followed only by financial incentives (Dillman, 2007), this study made four contacts to each of the 4000 randomly selected residents. Dillman identified personalization of correspondence and stamped returned envelopes as positively, albeit modestly, affecting response rate (Dillman, 2007). Thus, each envelope was personally addressed, with a postage paid return envelope enclosed. As a financial incentive, participants who completed and returned the questionnaire were able to enter a draw for a weekend for two, valued at $400, at a local Manitoba resort.

*Cover Letter*

I mention the cover letter methodology here, since the design and message of the cover letter are critically important and may affect survey response rates (Dillman, 2007). The cover letter is extremely important as it communicates the appeal with reasonable explanation of the subject of the study, the benefit, and the individual importance of the respondent to the study success (Dillman, 1978). The cover letter used for this study was

kept to one page (Dillman, 1978; Dillman, 2007). The cover letter was printed on University of Manitoba letter head with the personalization of each recipient's address present on each letter. The cover letter was designed to establish personal communication with each respondent. The cover letter was clear and straight-forward. The date on the cover letter was current to the date the letter was mailed. Since I was carrying out a respondent selection process, I was only partially able to personalize each letter. In an attempt to balance the demographic of residents completing the survey, I asked that the adult member of the household whose birthday was next to occur to be the person to fill out the questionnaire. As a result, I was not able to address the cover letter to a specific individual.

The first paragraph of the cover letter outlined the intent of the letter, the objectives of the study and the request for each recipient's participation. This paragraph outlined the approval of the project by the Joint Faculty Research Ethics Board at the University of Manitoba. The second paragraph of the cover letter explained that each recipient's participation was voluntary, emphasized the social usefulness of their response and explained that postage-paid return envelopes were enclosed. The third paragraph described my ethical commitment to each participant not to release the results of the study in a way that would identify any respondents individually. I explained confidentiality in an honest but brief way to avoid any discouragement. I explained the financial incentive offered to those who chose to participate. Each questionnaire was coded with an individual identification number that was printed directly on the front of the questionnaire to ensure that follow up mailings were sent only to non-respondents. I did not attempt to hide this identification number since this is inconsistent with honesty

and inconsistent with an effort to communicate openly with the questionnaire recipients (Dillman, 2007). I briefly explained the identification number located on the front of the survey. The last paragraph of the cover letter explained that respondents may feel free to withdraw from this study at any time. This paragraph provided information on how participants might contact the Human Ethics Secretariat and explained participants may feel free to contact me with any questions (Dillman, 2007). A simple statement of thanks was made. See Appendix 9.

For the second and third contact, a postcard reminder/thank you card was created and mailed to all non-respondents. Postcard thank you and reminder contacts are advantageous since: they ensure these contacts have a unique look and feel compared to the original letter; they may draw a recipient's attention compared to a regular envelope; and they reduce costs by removing the need for purchasing envelopes (Dillman, 2007). These postcards were dated for the date in which they were mailed. This reminder postcard indicated that the person's completed questionnaire had not yet been received and urged the recipient to respond. These two reminder/thank you mailings did not include another copy of the survey nor a postage-paid return envelope. See Appendix 10.

The fourth mailing contact included a cover letter along with another copy of the survey and a postage paid return envelope. The cover letter used for this fourth mailing contact was only slightly modified from this original cover letter. This cover letter was modified to thank all those who had already responded and to act as a reminder to all those who had yet to respond. This letter re-enforced the need and usefulness of their response and the benefits awarded to them for responding. See Appendix 11.

*Mailing Time Line*

The first of the four contacts was sent out on September 2, 2008. The study began in September since researchers such as Connelly et al. 2003 have indicated that study findings suggest spring, holiday and summer months receive lower survey response rates, and that survey response rates can be improved between 3-6% depending on the month in which the survey is sent (Connelly et al., 2003). The initial contact package consisted of an information cover letter, a copy of the questionnaire, and a postage paid return envelope. Two weeks to the day of the initial mailing, on September 15, 2008, a reminder postcard was sent. This reminder was sent to all non-respondents and was dated for the date it was mailed. A second non-respondent reminder was sent 4 weeks after the original mailing, on October 1, 2008 and was again dated for the date it was mailed. This reminder postcard indicated that the person's completed questionnaire had not yet been received, explain the importance of their response to the study, and urge them to complete the questionnaire. The final contact, mailed 8 weeks following the original mailing, consisted of a letter indicating the person's completed questionnaire had not yet been received, a modified version of the original letter, the questionnaire, and a postage paid return envelope. Each contact, created to give a slightly different look and feel, attempted to convey a sense of appropriate renewal of an effort to communicate. The four wave mailing is a modification from Dillman's proposed 5 contacts (Dillman, 2007). I omitted the pre-notice letter due to cost restraints.

*Non-Response Error Follow-up*

In order to address potential non-response error, and to assess whether those who did not respond felt substantially different from those who did, a non-response telephone survey was designed and conducted on 50 random non-respondents upon completion of the survey. Non-response questions were generated by researching other non-respondent surveys conducted over the past two decades. See Appendix 12.

## Analysis

The following discussion of the techniques used to analyze the results of this study is divided into three parts: first, an outline of the methods used to input and store the data received from each returned survey; second, a description of the statistics used to analyze data; third, a review of the spatial distribution of data illustrated by GIS.

*Database*

In order to effectively record response from each returned survey, a relational database was created. The information for the entire sample of 4000 residents was entered, including, for each question, all variables and demographics. For each potential respondent, a code was used to identify if a survey was returned completed, incomplete, or was returned to sender. Once a survey was returned the individuals were found by use of their sequence number or name and the information from the returned survey was recorded. This process was maintained daily to ensure the database was current to the day's mail delivery. On September 10, 2008, September 26, 2008, and October 9, 2008, the database was sent to MDA mail management services. This list contained all names

and addresses of those who had not yet responded. These lists of non-respondents provided MDA with the information on how many packages to print for the corresponding reminder/thank you contact.

Upon the completion of the mailing process, once all returned surveys had been received and entered into the database, queries were created and run for each and every question. The queries summarized the data and presented the overall findings of each question for analysis.

*Statistics*

As the first stage of data analysis, descriptive statistics were used to summarize the data generated from all returned surveys. Frequency tables and pie charts were generated for each and every question. In the process, questions needing further investigation were identified. Relationships that might exist between questions were then investigated. Two by two contingency tables were used to determine whether or not associations between categorical variables exist. These tables contained the number of observations as defined by these two variables. Chi-square tests were then conducted to evaluate whether this is an association between the variables. Logistic regression was used to determine the relationship of a number of variables to one question, or, to determine the effect of the numerous variables to one response variable. Due to the nature of the data of the outcome response variable, where the data represents discrete variables instead of continuous variables, logistic regression was used (Moore, 2000).

*Geographic Information Systems (GIS)*

GIS is a process of analysis that combines relational databases with spatial interpretation and outputs in the form of maps (Government of Canada Industry of Canada web pages accessed on November 28, 2008). Geographical information systems has just emerged as a tool used to spatial represent information generated from human dimensions studies in the wildlife management field. Leong et al. presented on the use of GIS and mail survey response to assist in public participation on planning providing a spatial analysis of wildlife issues in communities near urban parks (Leong et al., 2008). GIS can be an effective tool to spatial represent public opinion in comparison to deer density and deer-vehicle collision hot spots across a defined area. This study used GIS to spatially represent the distribution of resident response and opinion, creating a tool that may visually assist individuals in understanding survey results.

# CHAPTER FOUR
# RESULTS

This chapter presents the results of the study broken down into five sections: the first section presents the results of the pre-test; the second section presents the study response rate, demographics of respondents, and overall findings of the questionnaire; the third section explores the relationships identified between variables from the questionnaire and the results of the statistical analysis; the fourth section presents the spatial distribution of respondents, and the results from the GIS analysis; the final section presents the results from the non-response error follow-up survey.

## Pre-Test

A total of fifty pre-tests were distributed during the month of June and July. Twenty-five surveys were given out to various support staff at the University of Manitoba and the remaining twenty-five surveys were given to various staff employed at Manitoba Conservation. A total of forty-three pre-test surveys were returned by the beginning of August. Three minor changes were made that were identified as necessary in the returned pre-test. One change made was to remove the word "sport" from before hunting. The second change was to better define instructions on how to rank answers to one question. The last change made was to include radio with television as a method of public education. No other changes or revisions were identified as necessary from the returned pre-test surveys.

## Survey Findings

*Response Rate*

Of the 3753 delivered surveys (247 questionnaires were undeliverable), I received 1182 completed. The response rate of this study is 31.5%.

*Demographics*

Of the 1182 respondents, 61% (n=719) were male and 37% (n=442) were female with 2% (n=21) not responding to this question. There were 42.9% (n=508) of respondents between the age range of 51-70, 31.4% (n=371) between the age range of 31-50, and 15.8% (n=187) between the age range of 71-100. Only 5.2% (n=62) of those who responded indicated they were in the youngest age range between 18-30, with 4.6% (n=54) choosing not to respond to this question. Figure 3 illustrates the age breakdown of respondents.

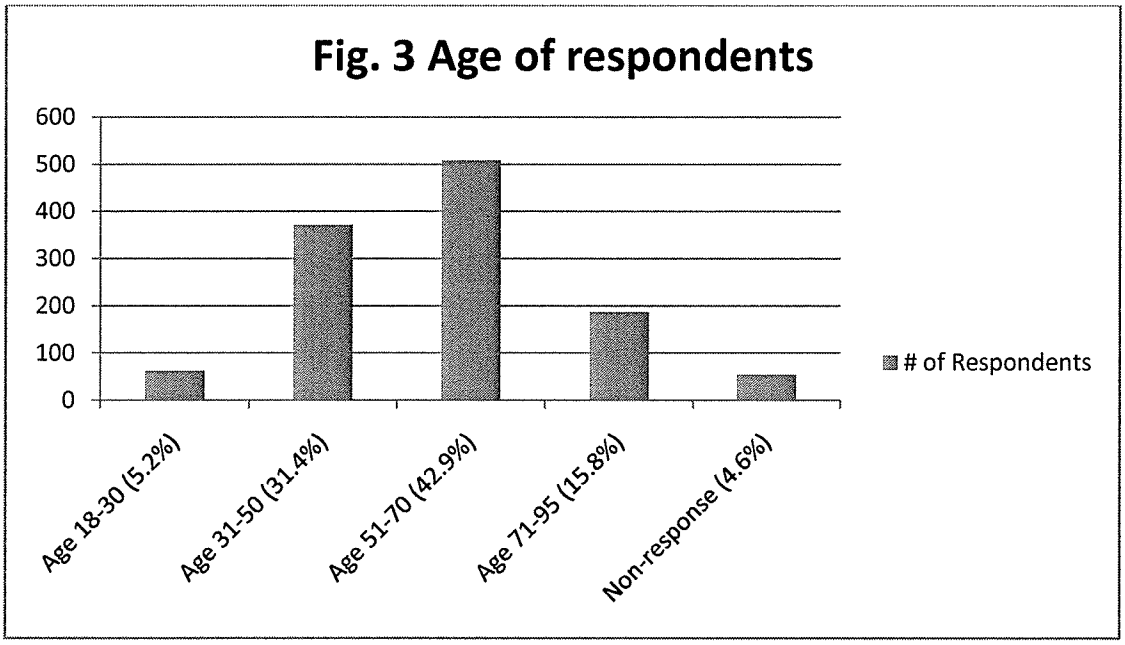


Figure 4 represents respondents' answers when asked about their highest level of education.

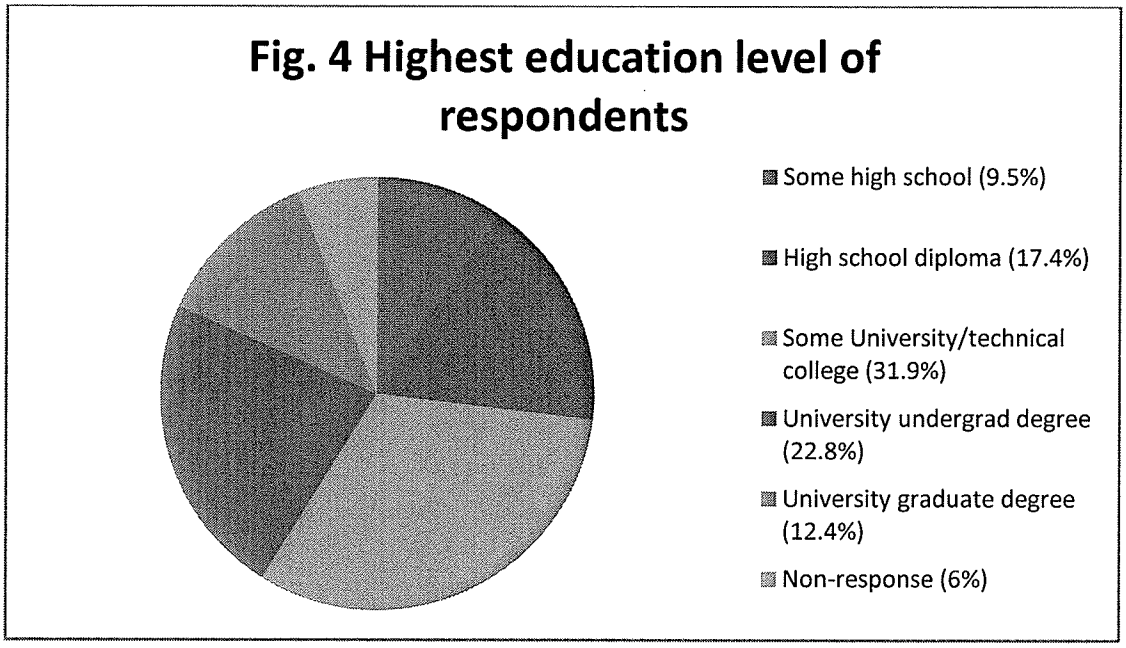



Figure 4 illustrates that 71.4% (n=793) of those who responded indicated they had attended university at some point.

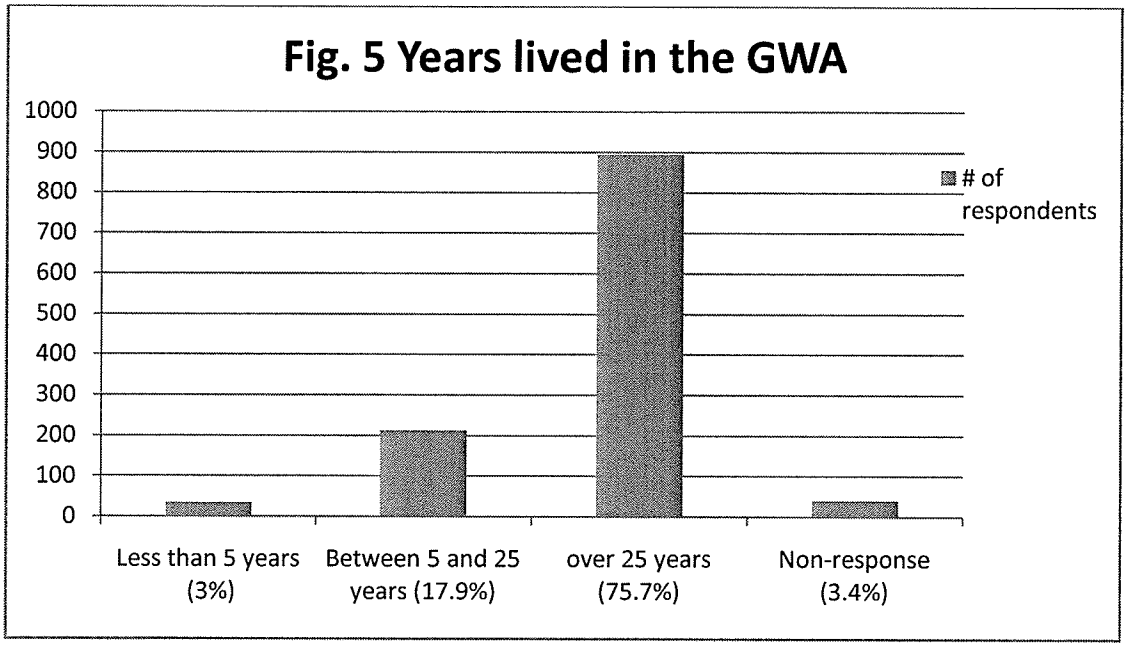
Respondents' marital status results are as follows: 63.5% (n=750) of respondents indicated they were married, 20.5% (n=242) indicated they were single, 8% (n=94) indicated they were divorced, 5% (n=63) indicated they were in a common-law relationship, and 3% (n=33) chose not to answer this question. A majority of respondent households, 38.7% (n=458) had two people living in the household. 18.9% (n=223) of respondents indicated only one person lived in the household, 14% (n=165) indicated three people lived in the household, 18.4% (n=217) indicated four people were living in the household, 7% (n=82) indicted five or more people living in the household, and 3% (n=35) chose not to respond to this question. Respondents were also asked to indicate whether they have any children and if so, how many. Responses to this question are as

follows: a majority of respondents, 33.1% (n=391) indicated having two children, 23% (n=271) indicated they did not have any children, 12.6% (n=149) indicated they had one child, 17.7% (n=209) indicated they had three children, 10.6% (n=127) indicated they had four or more children, and 3% (n=35) did not respond to this question.

*Overall Findings of Questionnaire*

The following section provides the participants responses to the questionnaire. These responses give insight into residents' opinions and tolerances toward the urban white-tailed deer population, and residents' preferences toward potential urban deer management strategies.

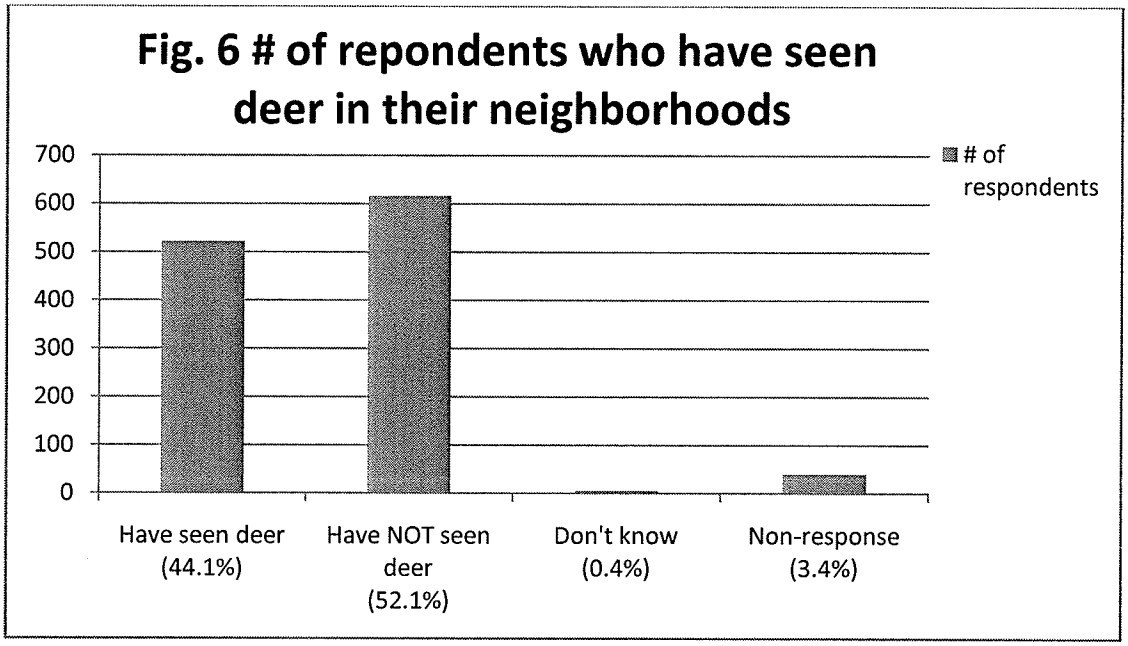
To begin, respondents were asked to indicate the length of time they have lived in the GWA. Figure 5 illustrates the length of time respondents have lived in the GWA.




When asked if respondents had seen a deer in the GWA within the last year, 76.1% (n=900) indicated they had. Of those who had observed deer, the questionnaire

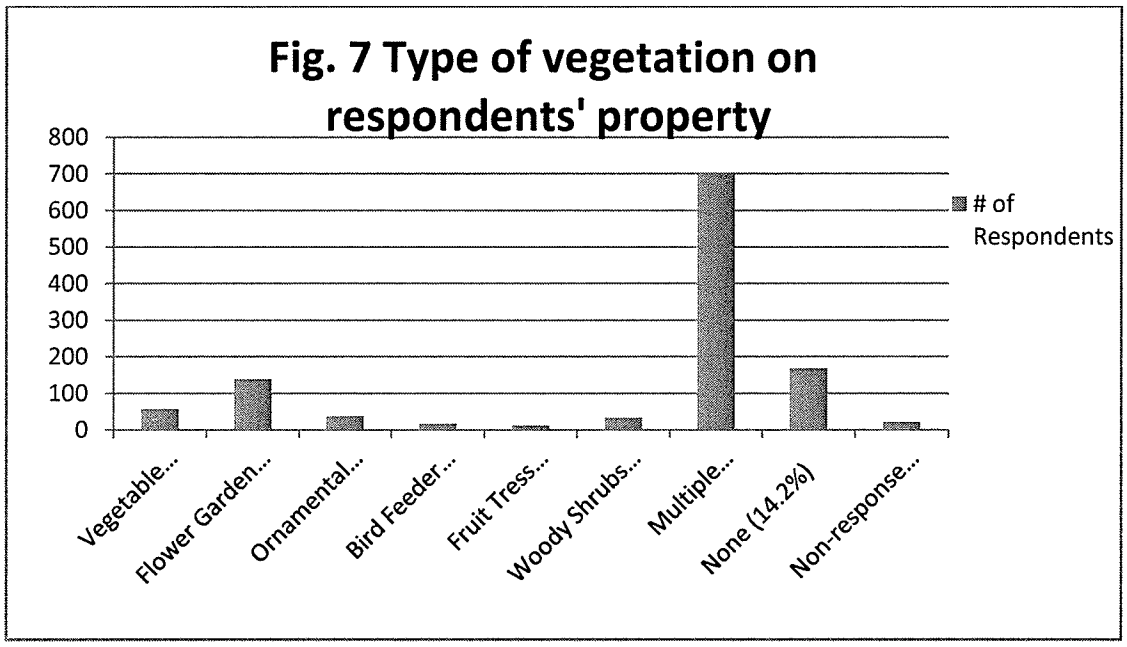
asked them to indicate the season(s) in which they had observed deer. A majority of respondents indicated they had observed deer in all four seasons (32%, n=383), 9.7% (n=115) indicated they had observed deer solely in spring, 14.2% (n=168) observed deer solely in summer, 10.3% (n=122) observed deer solely in fall, and 3% (n=37) observed deer solely in winter.

Figure 6 provides respondents' answers when asked whether they had seen a deer in their neighborhood within the last year.

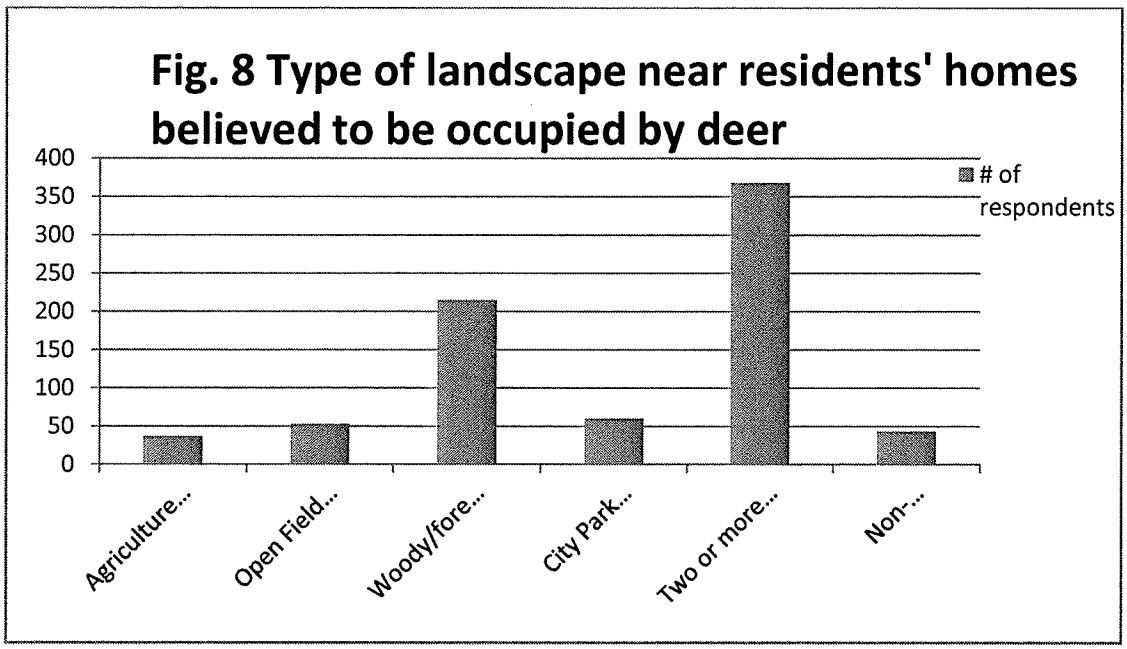



Those who responded that they had observed deer in their neighborhoods were asked to indicate whether they enjoyed having deer in their neighborhood. A total of 34% (n=399) indicated they did enjoy having deer in their neighborhood. Respondents were asked whether they had seen a deer or signs of deer on their property: 20% (n=236) of respondents indicated they had, 78.8% (n=931) indicated they had not, 0.3% (n=4) indicated they did not know, and 0.9% (n=11) did not respond to this question.

Respondents were asked a series of questions about vegetation and landscape on their property and in their community. Respondents were asked to indicate they type of potential deer food sources they had on their property. Figure 7 represents the types of potential deer food sources respondents indicated were present on their property.

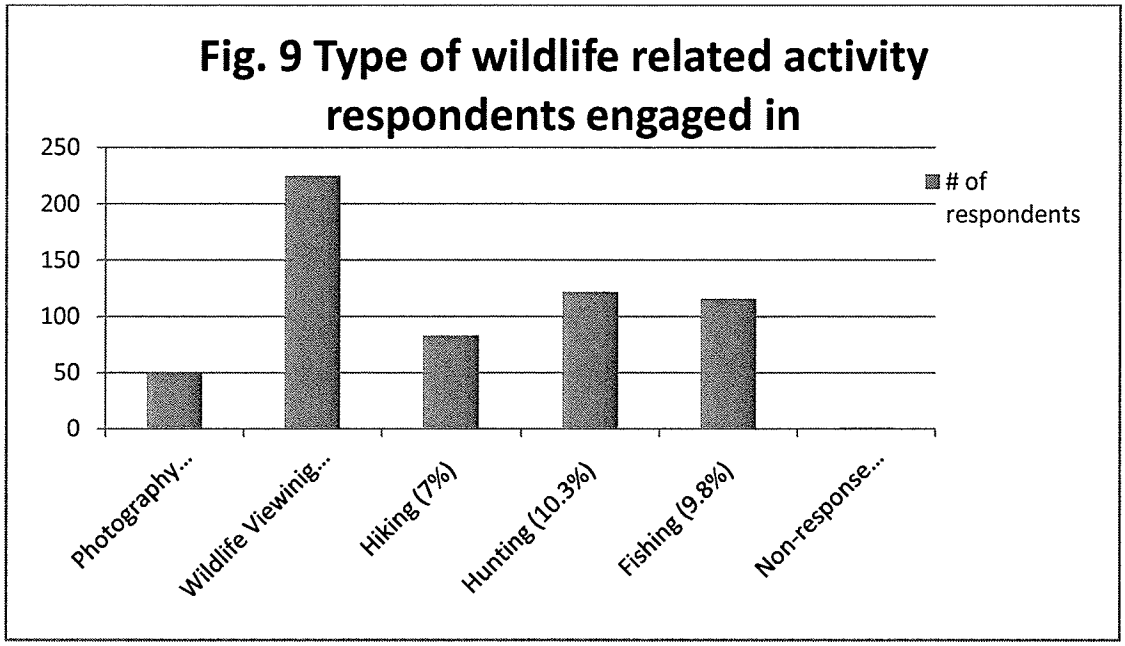



Respondents were asked about the types of landscapes within their communities. When asked whether respondents had parks, woods, or forested/undeveloped lands near their property that they felt might be used by deer, 60.6% (n=716) indicated they did, 33.8% (n=399) indicated they did not, 4.9% (n=58) indicated they did not know, and 0.8% (n=9) did not respond to this question. Of those who indicated they did have such lands near their property, they were asked to identify the type(s) of landscapes(s). Figure 8 represents respondents answers to the types(s) of landscapes(s) located near their homes in which they felt may be used by deer.




Three percent (n=37) indicated there was agriculture near their property, 4.5% (n=58) who indicated there were open fields, 18.2% (n=215) indicated woody areas, 5.1% (n=60) indicated city park(s), 31.1% (n=368) indicated there were two or more of these landscapes near their property, and 3.6% (43) did not respond to this portion of the question.

When asked about wildlife related activities, 49.7% (n=587) indicated they did engage in these activities, 49% (n=581) indicated they did not engage in wildlife related activities, 1% (n=12) indicated they did not know, and 0.2% (n=2) did not respond to this question. Figure 9 represents the wildlife related activities in which respondents indicated they were engaged.




Of those who responded yes, 60.9% (n=358) of the 587 respondents indicated that they do engage in wildlife related activities, and 30.3% of the overall 1182 respondents indicated that they engage in non-consumptive uses of wildlife.

Respondents were asked a series of questions about human-deer related conflicts. When asked whether they had seen a deer killed in Winnipeg in the last year, 46.9% (n=554) of respondents indicated they had, 51.4% (n=608) indicated they had not, 1.5% (n=18) indicated they did not know, and 0.2% (n=2) chose not to respond to this question. When asked if they knew anyone who had been involved in a deer-related vehicle accident in Winnipeg, a majority of respondents, 63.1% (n=745), indicated they did not know anyone, 34.3% (n=405) indicated they did know someone, 2.1% (n=25) indicated they did not know, and 0.6% (n=7) did not respond to this question.

Respondents were asked about the degree of interest they had in a number of deer related activities. Table 1 illustrates respondents' interests in deer in the GWA.

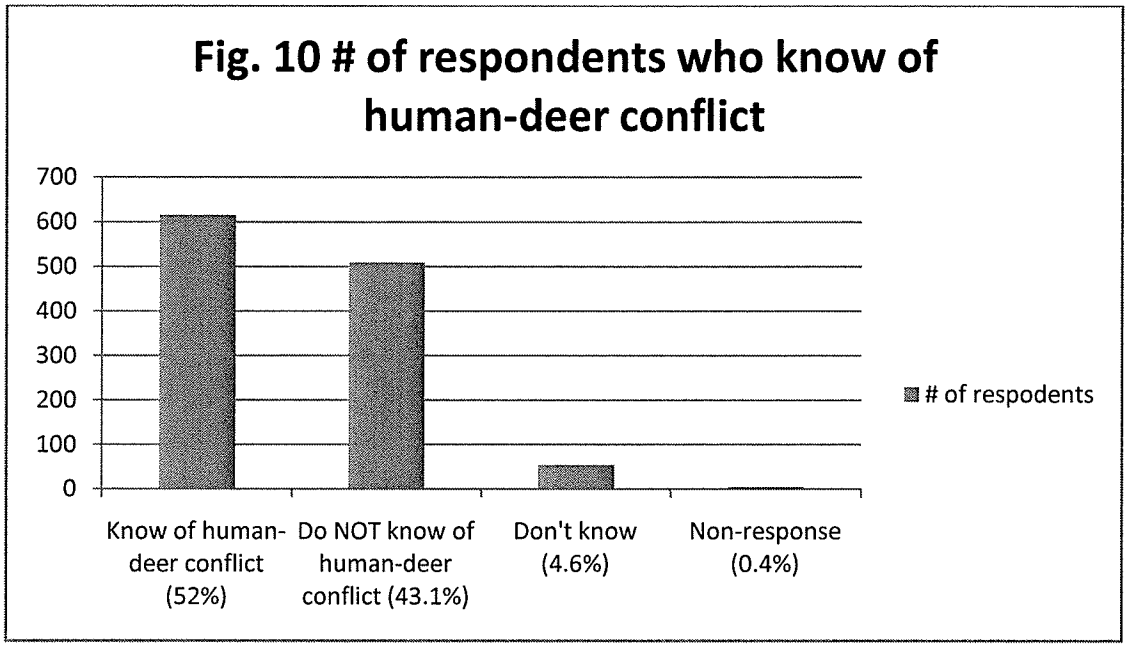
**Table 1: Resident Level of Interest in Various Deer-Related Activities**

| Deer-Related Interest | Mean[2] | % Expressing Level of Interest [1] | | | | | |
|---|---|---|---|---|---|---|---|
| | | Not at all Interested 1 | 2 | 3 | Very Interested 4 | Don't Know | Did Not Respond |
| Learning more about deer | 2.19 | 32 | 25 | 26 | 12 | 2 | 3 |
| Providing input for local deer management decisions | 1.94 | 46 | 18 | 18 | 11 | 3 | 3 |
| Participating in deer management decisions | 1.78 | 56 | 14 | 15 | 9 | 3 | 4 |
| Hunting deer | 1.35 | 81 | 3 | 3 | 8 | 1 | 3 |
| Feeding deer near your home | 1.54 | 65 | 12 | 10 | 6 | 3 | 4 |
| Seeing deer | 2.79 | 17 | 17 | 31 | 31 | 1 | 3 |
| Photographing deer | 2.01 | 46 | 17 | 17 | 15 | 2 | 3 |
| Watching deer near your home | 2.35 | 33 | 17 | 22 | 22 | 3 | 3 |

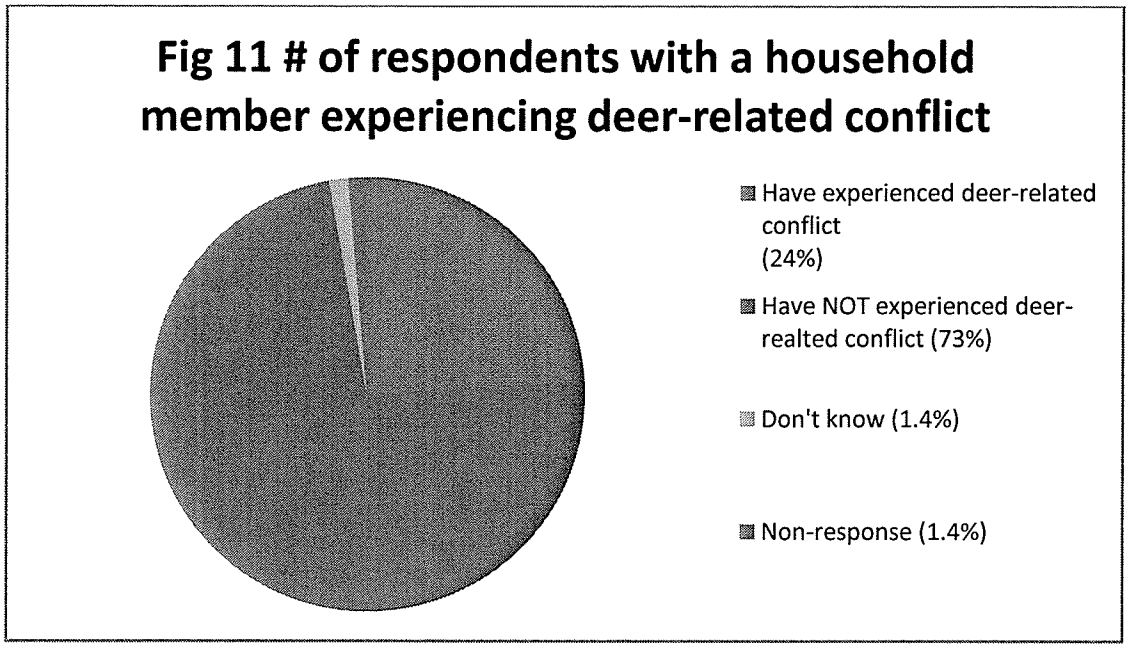
[1] Totals may not equal exactly 100% due to rounding; [2] Based on 1 = Not at all interested through 4 = Very Interested.

Table 1 illustrates that respondents have a high degree of interest in seeing deer, learning more about deer, watching deer near their homes, and photographing deer. Respondents indicated a lower degree of interest for hunting deer and feeding deer near their homes.

Figure 10 represents responses to the question whether participants knew of any human-deer related conflict.

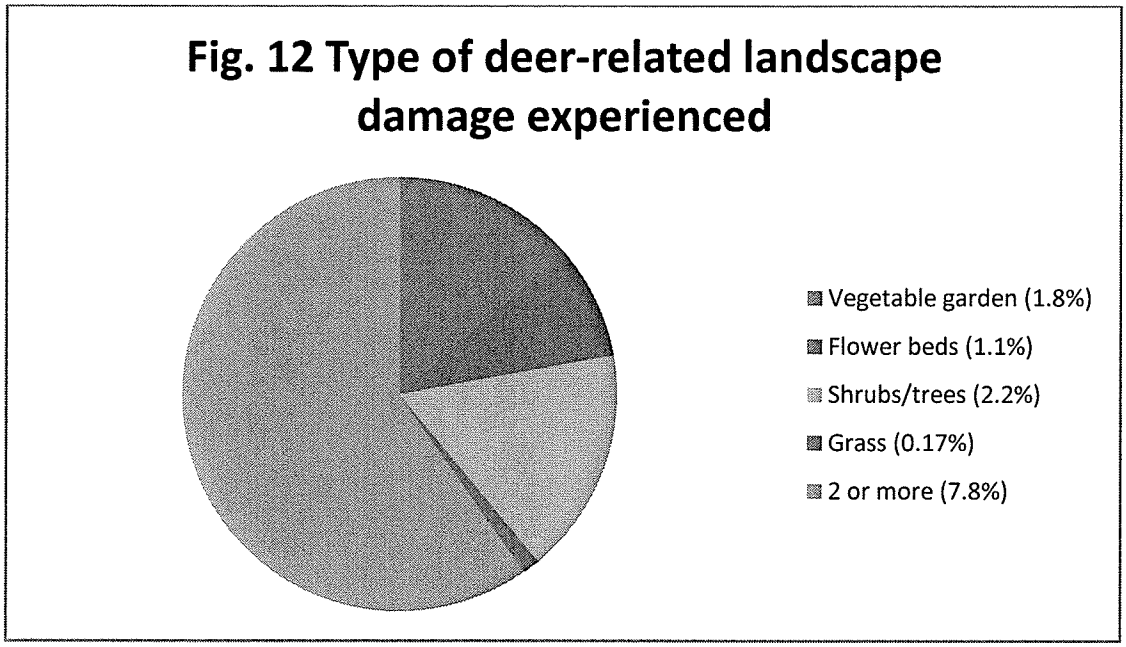



Respondents who indicated they knew of human-deer conflict were asked to indicate the type of human-deer conflict they were aware of. Four percent of respondents (n=49) indicated they were aware of deer overpopulation, 15.2% (n=180) respondents indicated they were aware of deer-vehicle collisions, 0.1% (n=1) indicated awareness of deer disease transmission to humans, 5.2% (n=61) indicated awareness of deer causing private property damage, 0.1% (n=1) indicated awareness of personal injury from deer, 27.5% (n=325) indicated awareness of two or more of these conflicts, and 4.2% (n=50) did not respond. Figure 11 illustrates respondents' answers to the question whether anyone in their household had experienced deer-related conflict.

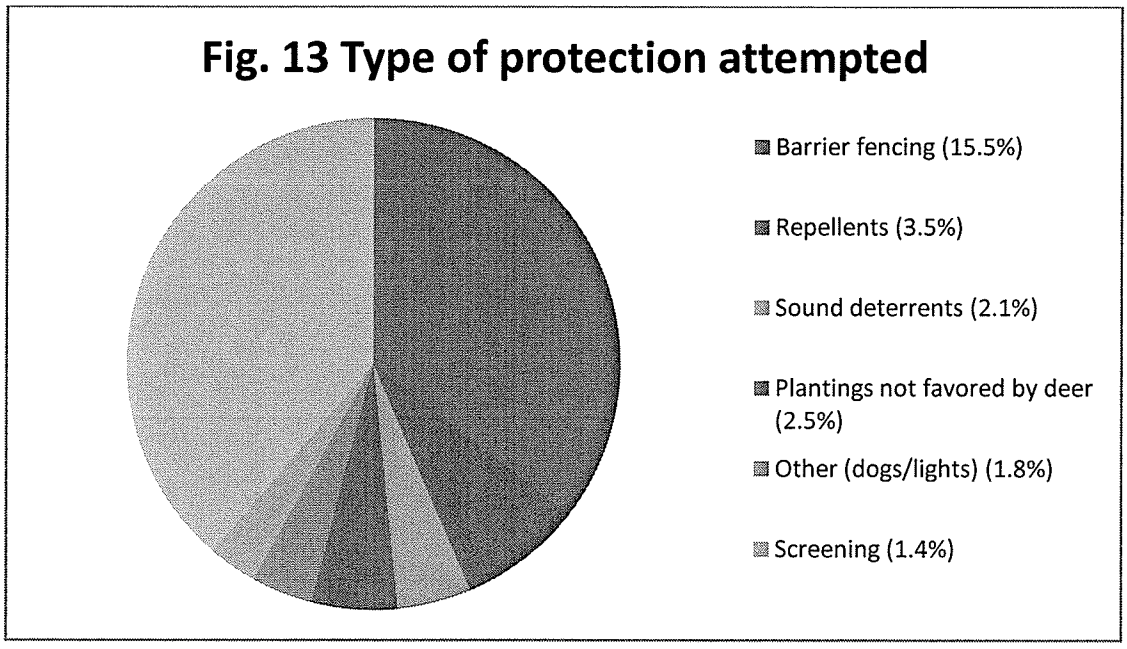



For those who responded that someone in the household had experienced deer-related conflict, participants were asked to indicate the type of conflict experiences. Roughly, 10.8% (n=128) indicated they had experienced a deer-vehicle accident, 7.8% (n=92) indicated they had experienced private property damage, 0.2% indicated they had experienced deer disease transmission, 5% (n=61) indicated they had experienced two types of deer-related conflicts, and only 1 respondent did not answer the question.

The survey probed further to investigate the experiences residents had with deer-related landscape damage. Figure 12 provides a look at the type(s) of property damage respondents indicated they had experienced.

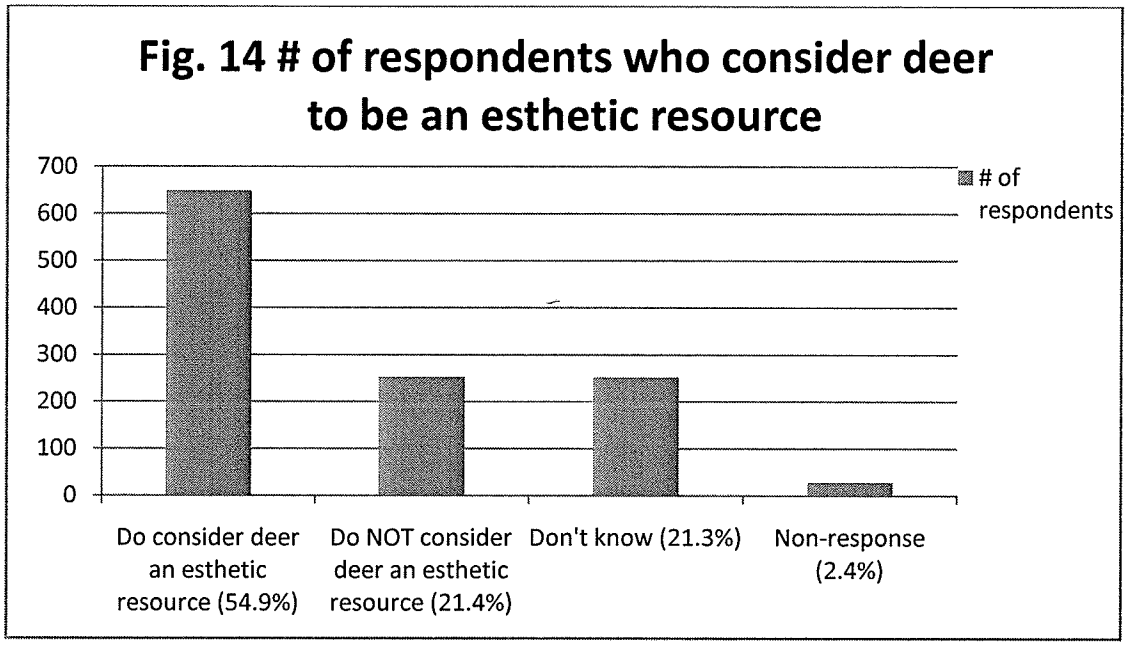



Residents who had experienced deer-related property damage were asked whether they had attempted to protect their property. Forty two percent (n=119) of respondents indicated they had, 48.9% (n=139) indicated they had not, 2.5% (n=7) indicated they did not know, and 6.7 % (n=19) did not respond to the question. Figure 13 represents the type(s) of property protection attempted by residents.

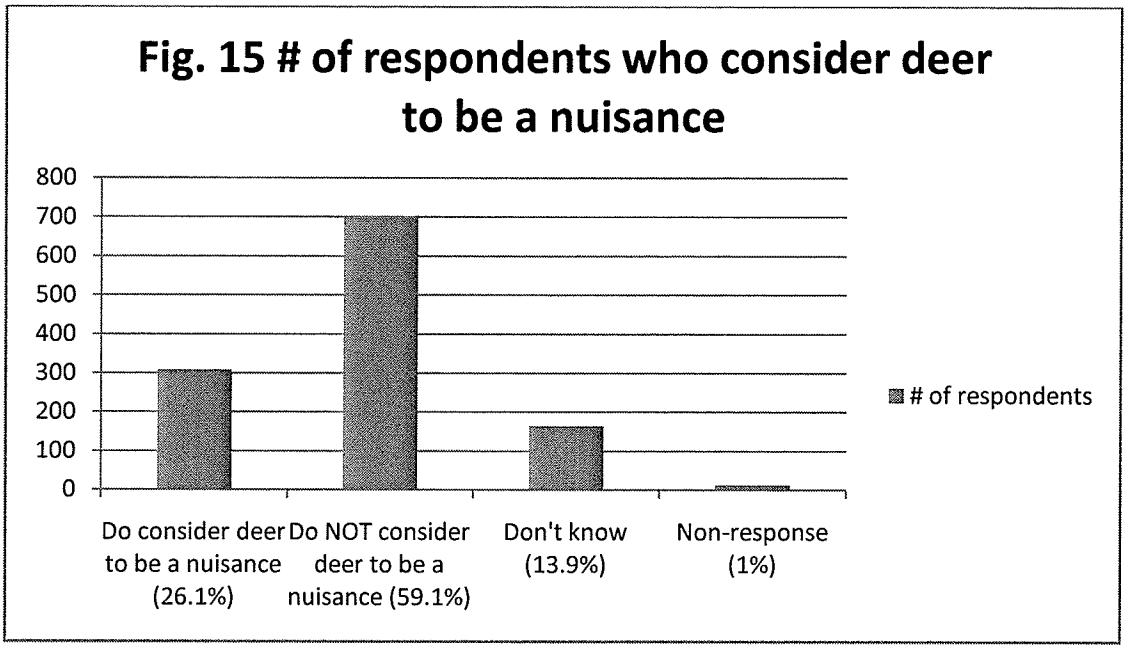


Three respondents indicated they used the presence of a dog in their yard to deter deer, and two indicated they use holiday festive lights on shrubs and trees year round as an effective method employed to deter deer.

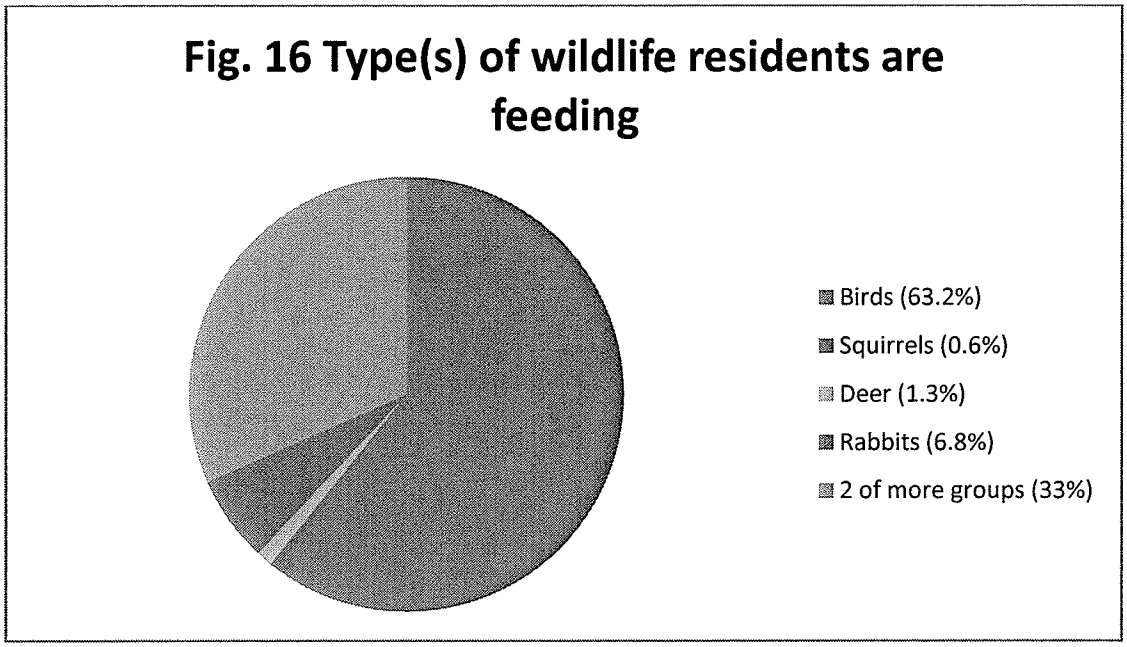
Following this series of questions relating to the human-deer conflict respondents had experienced, respondents were asked whether they consider deer to be an esthetic resource in Winnipeg. A majority of respondents (54.9%, n=649) indicated that they did consider deer an esthetic resource in Winnipeg. Figure 14 illustrates respondents' answers to whether deer are an esthetic resource in the GWA.




Respondents were also asked if they considered deer to be a nuisance in Winnipeg. A majority of respondents (59.1% n=698) indicated they did not feel deer were a nuisance in Winnipeg. Figure 15 illustrates respondents' answers to whether deer are a nuisance in the GWA.




When asked whether the respondents feed deer on their property, 95.8% (n=1133) of the respondents indicated that they do not feed deer. When asked whether their neighbors feed deer, 71.4% (n=844) indicated they did not, 7.1% (n=84) indicated they had neighbors who did feed deer, 20.6% (n=243) indicated they did not know if their neighbors feed deer, and 0.9% (n=11) did not answer this question. When asked whether they feed any wildlife on their property, 57.9% (n=684) indicated they do not and 40% (n=473) indicated they do feed other wildlife on their property. Figure 16 shows the type(s) of wildlife respondents indicate they feed on their property.




Respondents were then asked to indicate their general attitudes toward deer. Table 2 illustrates GWA respondents' attitudes toward the urban deer population.

**Table 2: Resident Attitudes Toward Deer in the GWA**

| Attitude Statement | % Agreeing with Statement |
|---|---|
| I have no particular feelings about deer | 17.2% (n=203) |
| I enjoy the presence of deer AND I do not worry About deer-related conflict | 32.5% (n=384) |
| I enjoy the presence of deer BUT I do worry About deer-related conflict | 42.9% (n=507) |
| I do not enjoy the presence of deer | 6.1% (n=72) |

Respondents were asked about their deer-related concerns. Table 3 illustrates respondents' concerns about deer in the GWA.

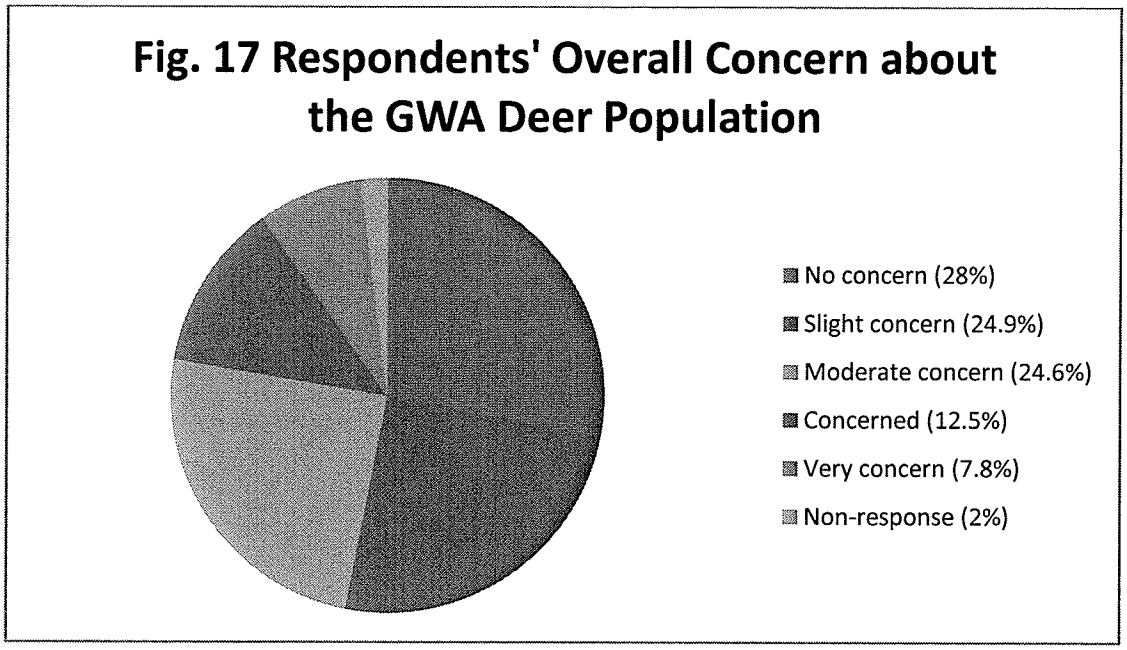
**Table 3: Resident Level of Concern toward Deer-Related Issues**

| Deer-Related Concerns | Mean[2] | % Expressing Level of Concern [1] | | | | | |
|---|---|---|---|---|---|---|---|
| | | Not at all Concerned 1 | 2 | 3 | Very Concerned 4 | Don't Know | Did Not Respond |
| Sick or starving deer | 2.84 | 14 | 19 | 29 | 32 | 3 | 3 |
| Aggressive deer | 2.24 | 35 | 19 | 19 | 19 | 5 | 4 |
| Presence of deer feces | 1.94 | 44 | 19 | 15 | 12 | 6 | 4 |
| Damage to yard plantings | 2.21 | 34 | 24 | 18 | 18 | 3 | 3 |
| Damage to natural plantings | 2.01 | 42 | 23 | 17 | 13 | 3 | 3 |
| Deer in garbage | 2.11 | 41 | 18 | 15 | 18 | 6 | 3 |
| Deer interactions with pets | 1.89 | 47 | 18 | 13 | 12 | 6 | 4 |
| Deer-vehicle collisions | 3.28 | 6 | 13 | 24 | 52 | 3 | 2 |
| Transmission of deer-related diseases to people | 2.44 | 29 | 19 | 15 | 27 | 7 | 3 |
| People's behavior toward deer | 2.64 | 18 | 20 | 30 | 23 | 7 | 3 |

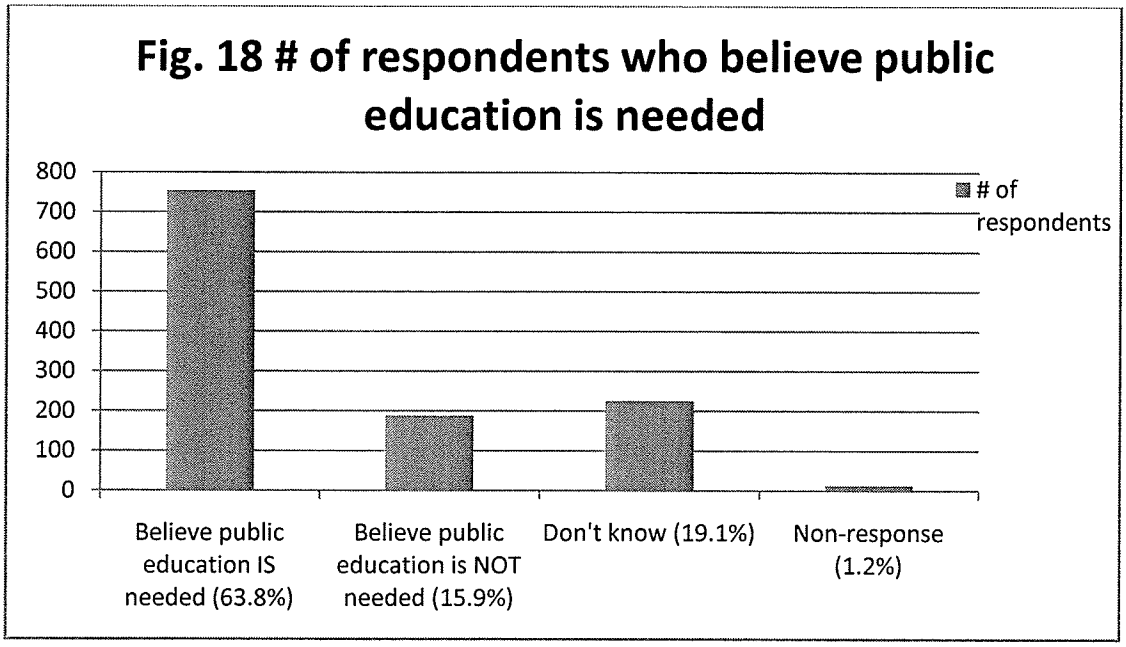
[1] Totals may not equal exactly 100% due to rounding; [2] Based on 1 = Not at all concerned through 4 = Very concerned.

Table 3 shows respondents to have a higher degree of concern for deer-vehicle collisions, sick or starving deer, people's behavior toward deer, and transmission of deer-related diseases. Respondents indicate a lower degree of concern for deer interactions with pets, the presence of deer feces, and deer damage to natural plantings.

Respondents were asked to provide their overall concern about the deer population in Winnipeg on a scale of 1-5 (5 being very concerned and 1 indicating no concern). Figure 17 illustrates their responses to overall concern.

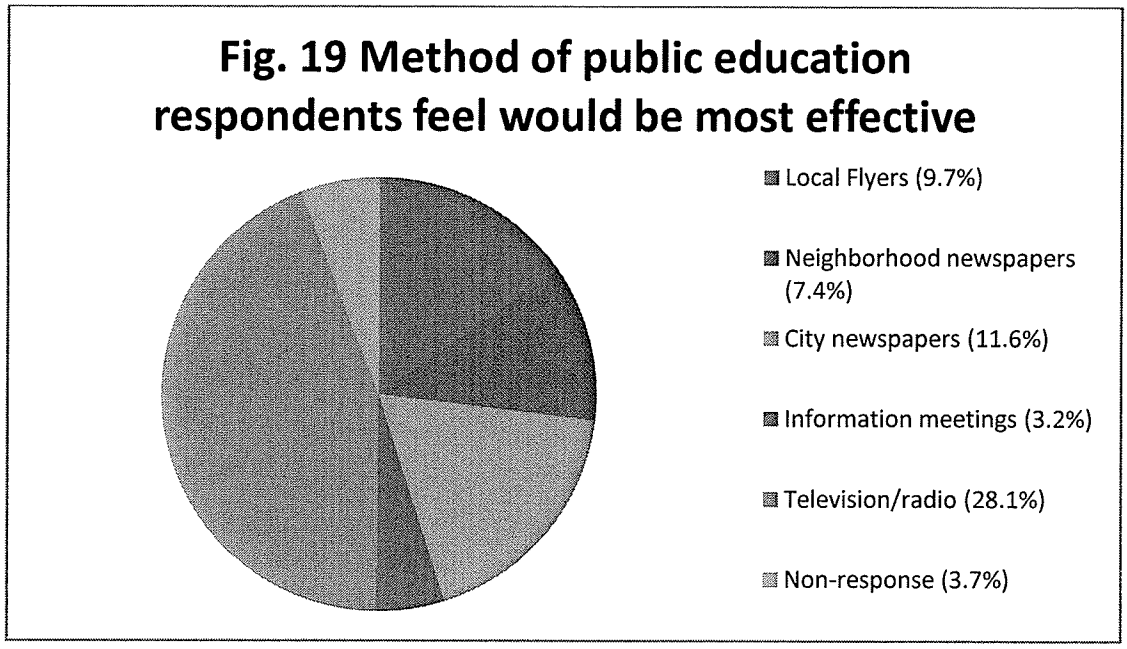



The questionnaire asked respondents to indicate whether they think there is a need for public education to inform Winnipeg residents of: deer biology/ecology; deer related problems; and deer management options. Figure 18 illustrates residents' responses:

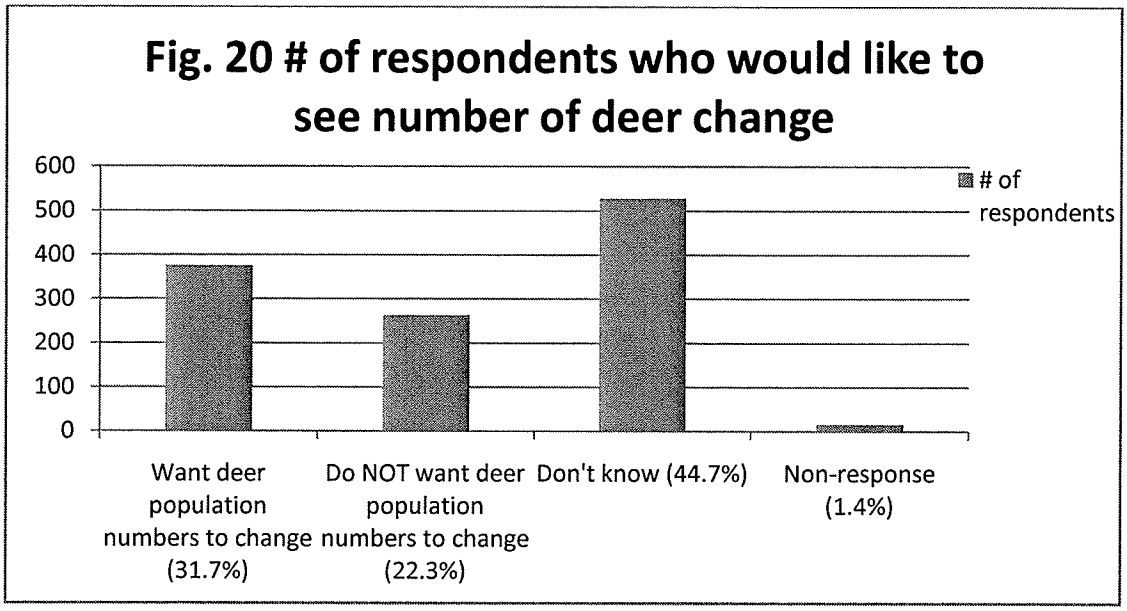



When residents were asked to indicate the method of public education they think would be most effective in delivering deer related information to residents in the GWA, a

large majority indicated that television and radio information spots would be the most effective. Figure 19 shows residents' responses to the question.




The questionnaire asked respondents to indicate whether they think the number of deer in Winnipeg is changing. Forty five percent (n=536) of respondents indicated they felt the number of deer in Winnipeg is changing, only 7.0% (n=94) of respondents indicated the number of deer is not changing, 45.9% (n=542) indicated they do not know, and less than one percent (n=10) did not answer the question. Those who indicated they did feel the number of deer in Winnipeg is changing were asked to indicate their views in regard to the changes taking place. Thirty seven percent (n=442) of respondents indicated the Winnipeg deer population is increasing, 8.1% (n=96) of respondents thought the Winnipeg deer population is decreasing, and 8.9% (n=106) indicated they did not know. Respondents were asked to indicate whether they would like to see the number of deer in Winnipeg change. Figure 20 represents responses to this question.




The respondents who indicated they would like to see the deer population numbers change were asked to indicate the type of deer population size change they would like to see in regard to the Winnipeg deer population size. Figure 21 illustrates the response.

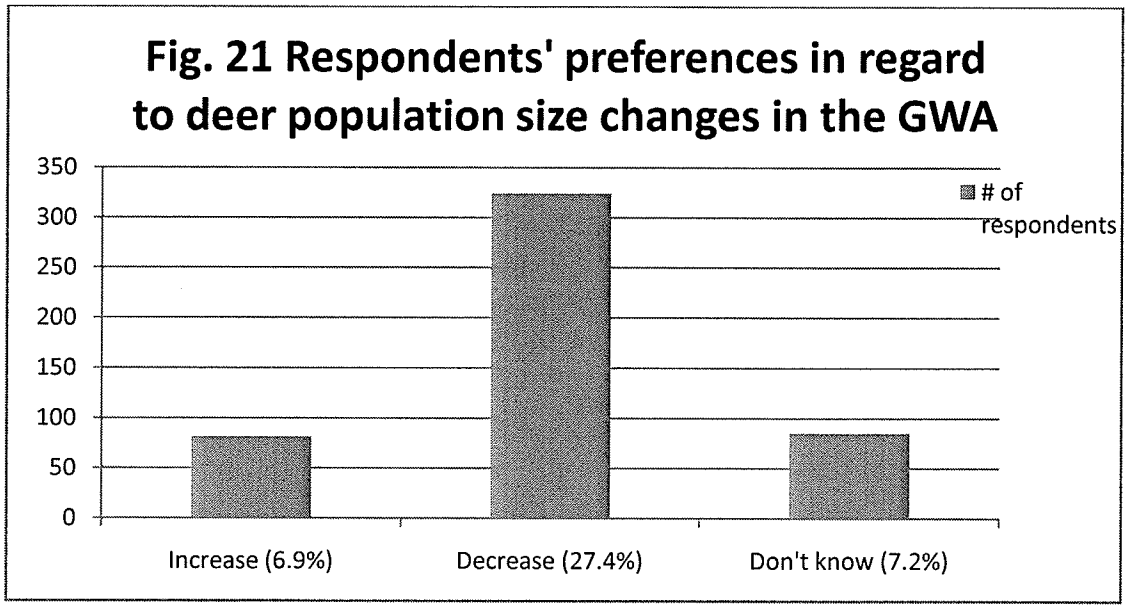


Figure 21 shows that 27.4% (n=324) of respondents would like to see a decrease in the Winnipeg deer population size.

Respondents were asked a series of questions to identify their preferences toward potential urban deer management. Several techniques have been suggested for potentially managing urban deer populations. Residents were asked to indicate how acceptable they personally found each technique. Table 4 represents the degree of acceptability residents' find in each potential management strategy.

## Table 4: Resident Rank of Acceptability of Potential Urban Deer Management

| Deer Management Action | Mean[2] | % Expressing Level of Acceptability[1] | | | | | |
|---|---|---|---|---|---|---|---|
| | | Not At All Acceptable 1 | 2 | 3 | Very Acceptable 4 | Don't Know | Did Not Respond |
| Public Education | 3.41 | 3 | 11 | 23 | 54 | 7 | 3 |
| Use of High Fencing to Protect Property | 2.68 | 17 | 21 | 26 | 26 | 8 | 3 |
| Use of Contraception (birth control) for deer | 2.04 | 36 | 13 | 15 | 12 | 21 | 4 |
| Surgically Sterilize Deer | 1.52 | 58 | 10 | 7 | 6 | 17 | 4 |
| Chemical Repellents | 1.69 | 49 | 16 | 12 | 6 | 12 | 5 |
| Trap and Transfer Deer to Another Location | 2.65 | 18 | 21 | 24 | 26 | 9 | 3 |
| Selectively Cull Deer | 2.22 | 29 | 16 | 16 | 15 | 19 | 4 |
| Sharpshooting Deer at Bait Sites (donate meat to food banks) | 1.93 | 49 | 14 | 13 | 15 | 7 | 3 |
| Regulated Bow and Arrow Hunting within City Limits | 1.74 | 59 | 9 | 8 | 14 | 7 | 3 |
| Trap and Euthanize | 1.36 | 70 | 10 | 5 | 4 | 8 | 4 |
| Controlled Hunting within Designated Areas within City Limits | 1.80 | 55 | 13 | 9 | 14 | 7 | 3 |
| Status Quo (no management) | 2.01 | 35 | 13 | 16 | 10 | 20 | 6 |
| Increase Road Safety Signage | 3.24 | 7 | 12 | 23 | 48 | 7 | 3 |
| Prohibit the Feeding of Deer | 2.87 | 16 | 15 | 20 | 36 | 11 | 3 |
| Barrier Fencing on Troubled Roadways | 3.31 | 6 | 11 | 21 | 51 | 7 | 3 |
| Promote use of Plants on Private Property that Deer are Less Likely to Eat | 3.03 | 10 | 15 | 23 | 38 | 11 | 3 |
| Restrict Development to Preserve Deer Habitat | 2.80 | 16 | 17 | 21 | 32 | 11 | 3 |
| Promote use of Deer Whistles on Vehicles to Keep Deer off Roadways | 3.21 | 7 | 13 | 21 | 45 | 12 | 3 |

[1] Totals may not equal exactly 100% due to rounding; [2] Based on 1 = Not at all acceptable through 4 = Very acceptable.

Respondents were then asked to indicate the degree of effectiveness of each management technique. Table 5 represents their response.

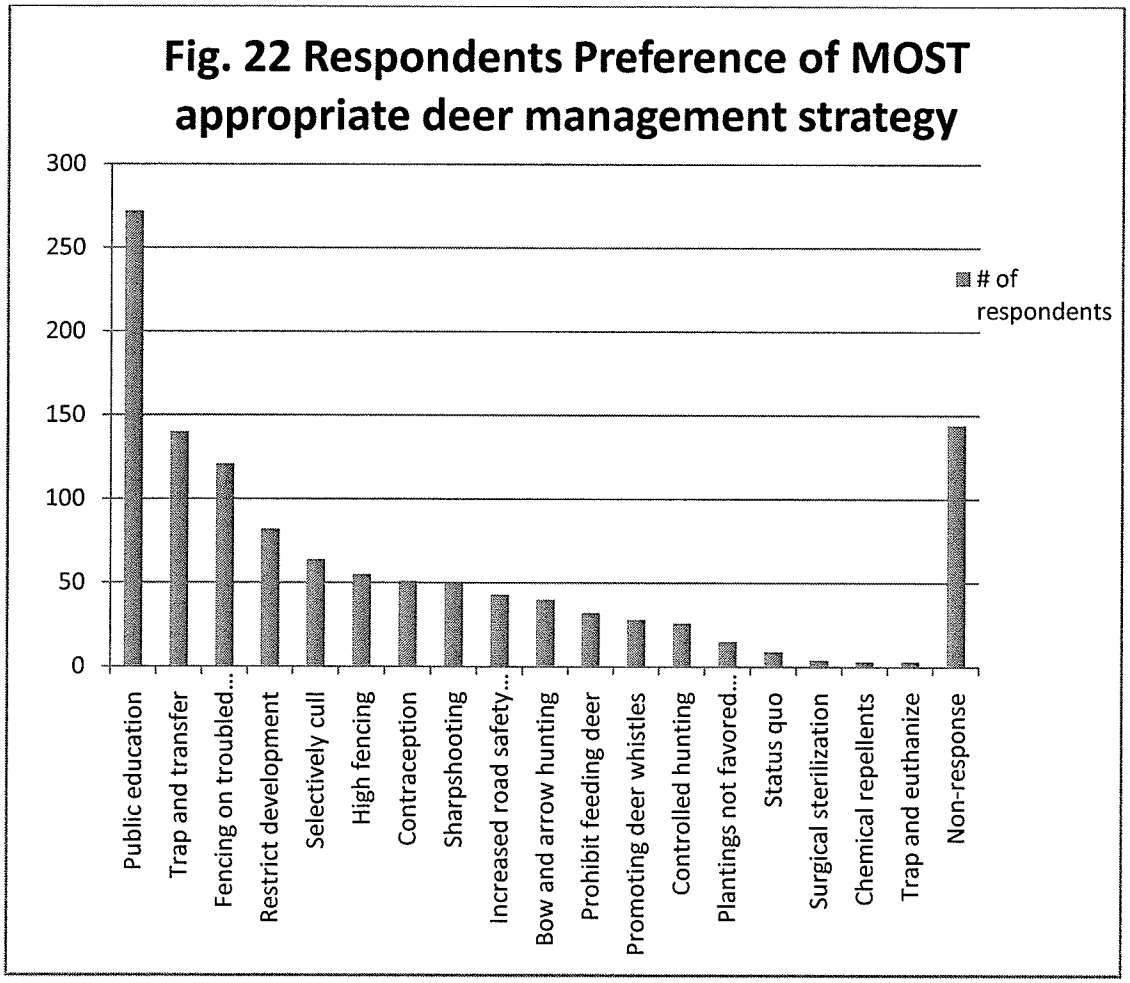
**Table 5: Resident Rank of Effectiveness of Potential Urban Deer Management**

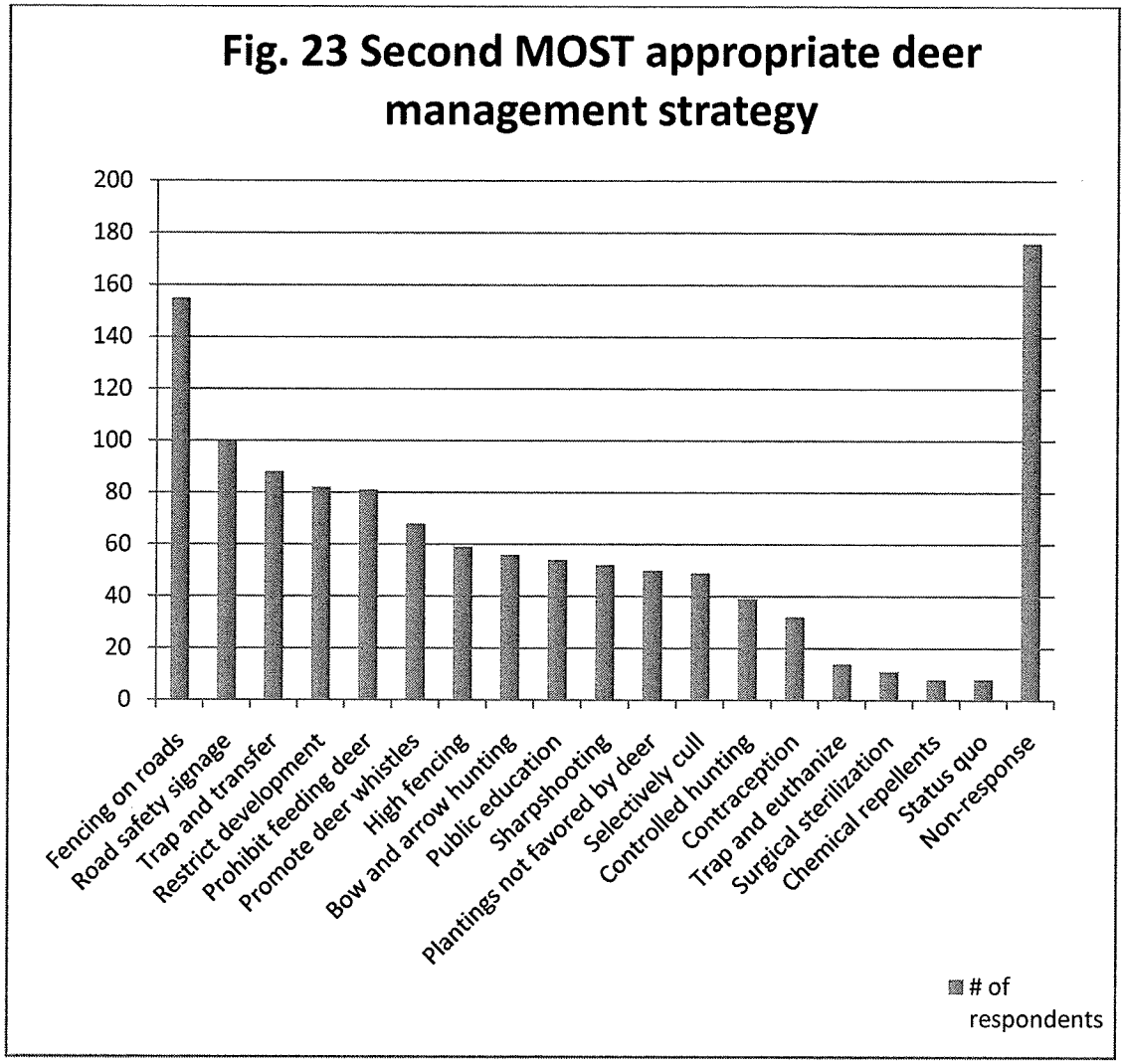
| Deer Management Action | Mean[2] | % Expressing Level of Effectiveness[1] | | | | | |
|---|---|---|---|---|---|---|---|
| | | Not At All Effective 1 | 2 | 3 | Very Effective 4 | Don't Know | Did Not Respond |
| Public Education | 2.78 | 9 | 23 | 34 | 22 | 8 | 4 |
| Use of High Fencing to Protect Property | 2.88 | 9 | 19 | 29 | 27 | 11 | 5 |
| Use of Contraception (birth control) for deer | 2.38 | 19 | 11 | 15 | 13 | 36 | 6 |
| Surgically Sterilize Deer | 2.30 | 24 | 9 | 10 | 16 | 36 | 6 |
| Chemical Repellents | 2.10 | 22 | 15 | 14 | 7 | 35 | 6 |
| Trap and Transfer Deer to Another Location | 2.75 | 13 | 16 | 24 | 23 | 19 | 6 |
| Selectively Cull Deer | 2.73 | 14 | 10 | 18 | 21 | 30 | 7 |
| Sharpshooting Deer at Bait Sites (donate meat) | 2.59 | 21 | 10 | 16 | 23 | 24 | 6 |
| Regulated Bow and Arrow Hunting within City Limits | 2.29 | 27 | 12 | 13 | 17 | 24 | 6 |
| Trap and Euthanize | 2.19 | 30 | 11 | 11 | 16 | 26 | 6 |
| Controlled Hunting within Designated Areas within City Limits | 2.41 | 23 | 13 | 16 | 18 | 23 | 7 |
| Status Quo (no management) | 1.67 | 42 | 9 | 10 | 5 | 27 | 7 |
| Increase Road Safety Signage | 2.80 | 9 | 22 | 27 | 24 | 11 | 6 |
| Prohibit Feeding Deer | 2.64 | 14 | 22 | 23 | 21 | 14 | 6 |
| Barrier Fencing on Troubled Roadways | 3.12 | 6 | 12 | 30 | 34 | 13 | 6 |
| Promote use of Plants on Private Property that Deer are Less Likely to Eat | 2.62 | 12 | 23 | 24 | 18 | 17 | 6 |
| Restrict Development to Preserve Deer Habitat | 2.65 | 15 | 18 | 23 | 21 | 19 | 6 |
| Promote use of Deer Whistles on Vehicles to Keep Deer off Roadways | 2.82 | 9 | 18 | 24 | 23 | 21 | 6 |

[1] Totals may not equal exactly 100% due to rounding; [2] Based on 1 = Not at all effective through 4 = Very effective.

Table 4 illustrates that respondents find public education, barrier fencing on troubled roadways, increased road safety signage and promoting the use of deer whistles as the most appropriate potential urban deer management action. In terms of how effective residents feel each technique is, Table 5 illustrates barrier fencing, high fencing on personal property, promoting use of deer whistles, and increased road safety signage as the most effective potential urban deer management actions.

Based on responses to the above questions on potential deer management techniques, residents were asked to indicate the MOST and the second MOST appropriate strategies for reducing problems people experience with deer in the GWA. Their responses are presented below in Figures 22 & 23.






Conversely, based on response from the questions base on potential deer management techniques, residents were asked to indicate the LEAST and the second LEAST appropriate strategies for reducing problems people experience with deer in the GWA. Their responses are presented below in Figures 24 & 25.

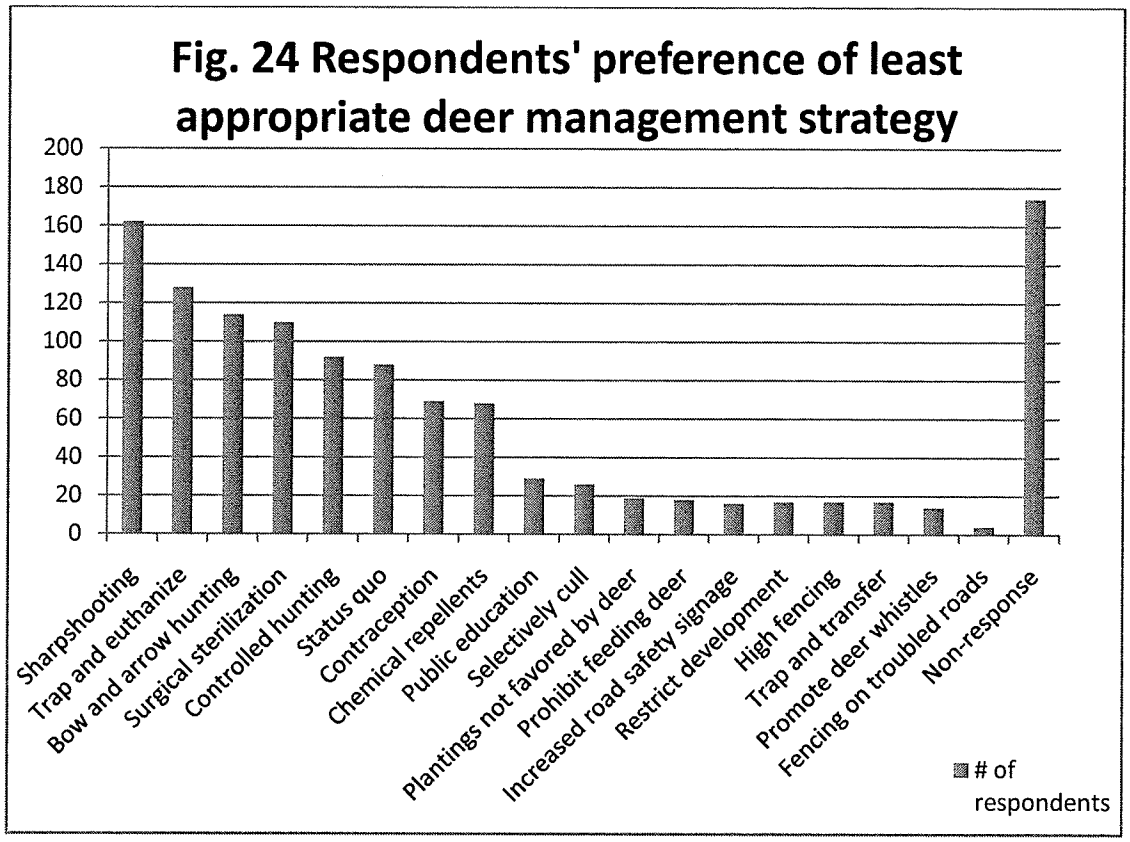


Fig. 24 Respondents' preference of least appropriate deer management strategy
200
180
160
140
120
100
80
60
40
20
0
Sharpshooting
Trap and euthanize
Bow and arrow hunting
Surgical sterilization
Controlled hunting
Status quo
Contraception
Chemical repellents
Public education
Selectively cull
Plantings not favored by deer
Prohibit feeding deer
Increased road safety signage
Restrict development
High fencing
Trap and transfer
Promote deer whistles
Fencing on troubled roads
Non-response
# of respondents

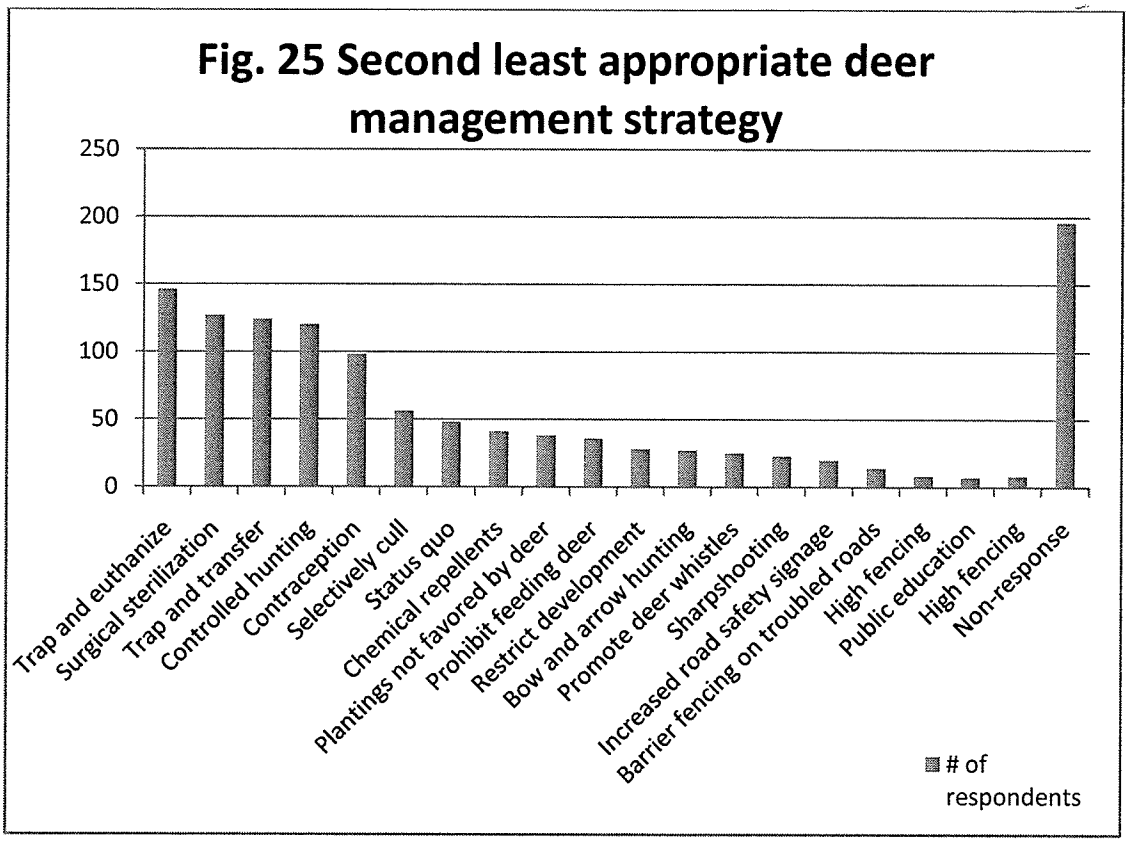


Fig. 25 Second least appropriate deer management strategy
250
200
150
100
50
0
Trap and euthanize
Surgical sterilization
Trap and transfer
Controlled hunting
Contraception
Selectively cull
Status quo
Chemical repellents
Plantings not favored by deer
Prohibit feeding deer
Restrict development
Bow and arrow hunting
Promote deer whistles
Sharpshooting
Increased road safety signage
Barrier fencing on troubled roads
High fencing
Public education
High fencing
Non-response
# of respondents

Figure 22 illustrates that the potential deer management actions residents find the most appropriate are non-lethal methods of action. The methods of management identified as the most appropriate are: public education (23%); trap and transfer (11.8%); barrier fencing on troubled roadways (10.2%); and restricting development to preserve deer habitat (6.9%). The lethal method of management identified as most appropriate is selectively culling. Selectively culling is the fifth most appropriate management action identified at 5.4%. Figure 24 illustrate that the lethal methods of management identified as the least appropriate methods of management action are: sharpshooting (13.7%), trap and euthanize (10.8%), bow and arrow hunting within city limits (9.6%). The non-lethal method of action identified as the least appropriate is surgical sterilization. Surgical sterilization is the fourth least appropriate management action identified at 9.3%. Respondents were asked whether they felt the GWA deer population needs to be managed. Figure 26 represents resident response.

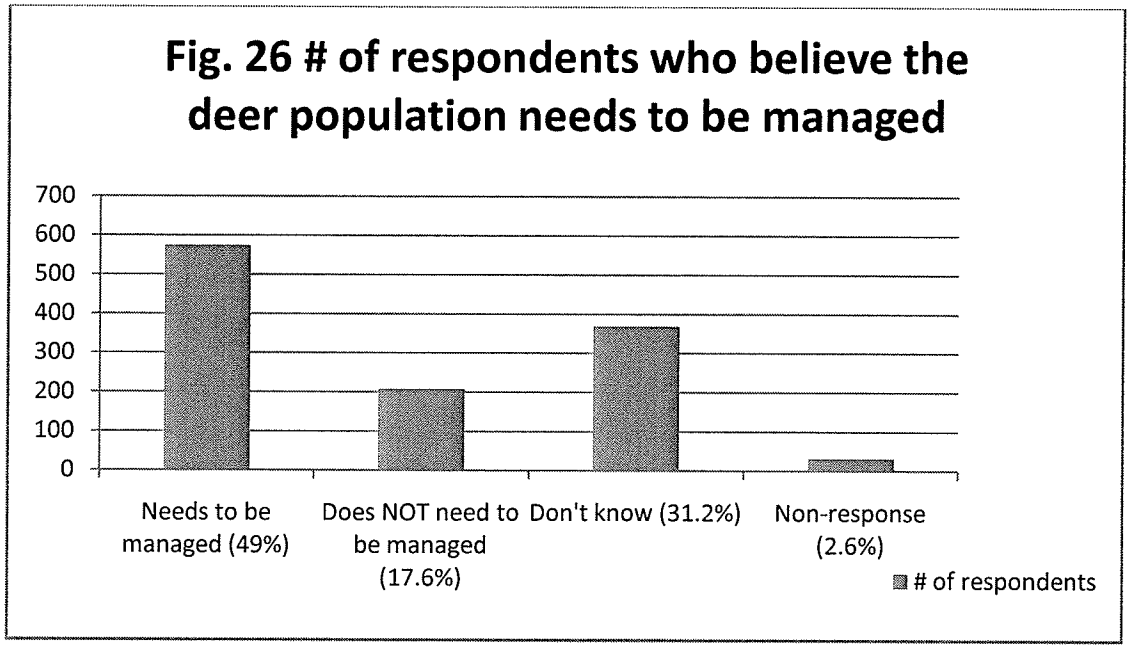


Figure 26 illustrates that 49% of those that responded think that the GWA does need to be managed. In order to better understand why residents felt one strategy more or less appropriate than another, I asked residents to indicate the degree of importance various aspects of the management plan had for them. Table 6 illustrates the varying degree of importance residents place on aspects of the management action.

**Table 6: Resident Rank of Importance of Aspects of Urban Deer Management**

| Reasons for Support | Mean[2] | % Expressing Level of Importance [1] | | | | | |
|---|---|---|---|---|---|---|---|
| | | Not at all Important 1 | 2 | 3 | Very Important 4 | Don't Know | Did Not Respond |
| Effectiveness at reducing deer-related problems | 3.29 | 4 | 11 | 27 | 44 | 7 | 6 |
| Minimizes deer suffering | 3.72 | 1 | 4 | 14 | 71 | 4 | 5 |
| Minimizes human health and safety risks | 3.52 | 3 | 8 | 18 | 60 | 5 | 6 |
| Proven effective in other cities | 3.21 | 3 | 8 | 27 | 28 | 28 | 6 |
| Does not involve killing deer | 3.14 | 13 | 10 | 14 | 48 | 9 | 6 |
| Is effective at reducing deer population | 3.15 | 8 | 9 | 25 | 37 | 14 | 7 |
| Shorter time to achieve population reduction | 2.50 | 16 | 20 | 23 | 15 | 18 | 8 |
| Minimizes your personal costs | 2.84 | 13 | 17 | 22 | 30 | 12 | 6 |
| Is supported by the public majority | 2.79 | 12 | 16 | 29 | 23 | 13 | 7 |
| Minimizes spending public funds | 2.90 | 9 | 18 | 29 | 28 | 9 | 6 |
| Minimizes disruption of resident's daily lives | 2.91 | 9 | 19 | 29 | 29 | 8 | 6 |
| Minimizes use of firearms within city limits | 3.55 | 6 | 6 | 10 | 66 | 6 | 6 |
| Minimizes use of bow and arrows within city limits | 3.37 | 10 | 7 | 11 | 59 | 7 | 6 |
| Maintains a healthy (sustainable) deer population within city limits | 3.38 | 7 | 6 | 20 | 53 | 8 | 6 |
| Minimizes side effects on deer | 3.48 | 4 | 8 | 17 | 57 | 8 | 6 |
| Does not require an increase in taxes | 3.31 | 5 | 12 | 20 | 49 | 8 | 6 |

[1] Totals may not equal exactly 100% due to rounding; [2] Based on 1 = Not at all important through 4 = Very important.

Table 6 illustrates that residents considered it highly important that the potential urban deer management action minimizes deer suffering, minimizes the use of firearms within city limits, minimizes human health and safety risks, and minimizes the side

effects on deer. Other aspects residents thought it important to consider in a potential urban deer management plan are: that the management plan maintains a healthy (sustainable) urban deer population, that it minimizes the use of bow and arrows within the city, is proven effective, does not require and increase in taxes, and does not involve killing deer.

Resident response to whom they believe should create the GWA urban deer management plan are represented in Figure 27.

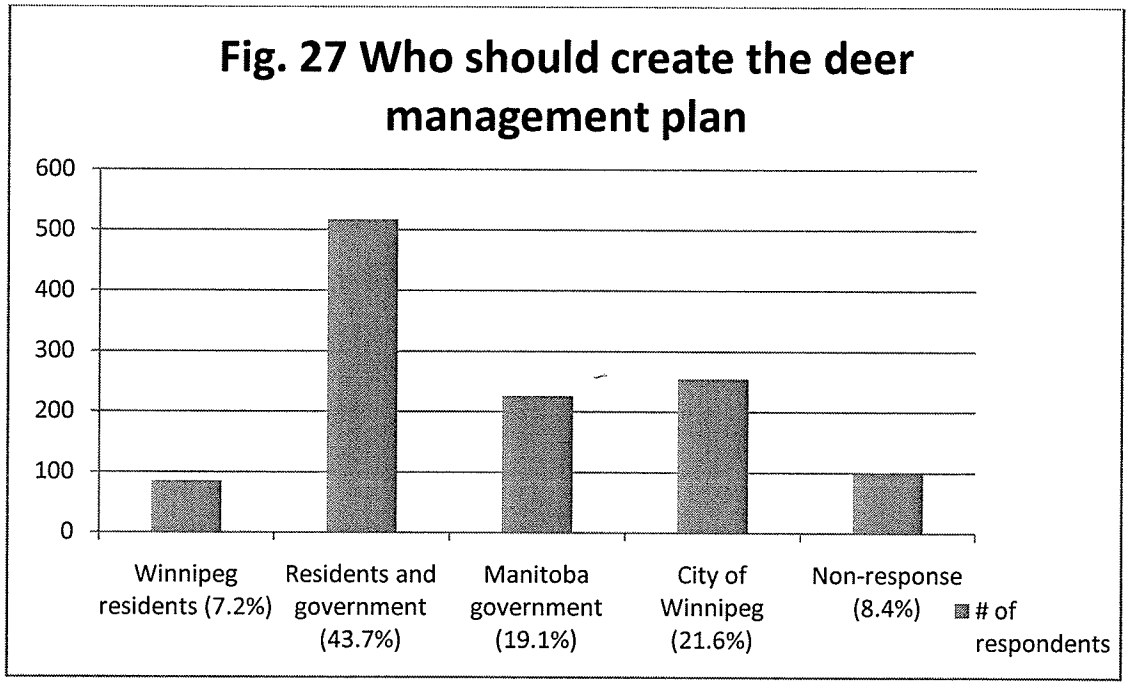



Figure 27 illustrates that the majority of respondents (43.7%) indicate that residents and government together should create the management plan. Table 7 illustrates respondents' rank of effectiveness for a number of methods of potentially engaging public in potential deer management decisions.

**Table 7: Resident Rank of Effectiveness of Methods to Gather Public Input**

| Method of Gathering Input | Mean[2] | % Expressing Level of Effectiveness [1] | | | | | |
|---|---|---|---|---|---|---|---|
| | | Not at all Effective 1 | 2 | 3 | 4 | Very Effective 5 | Did Not Respond |
| Open public meetings | 3.43 | 9 | 17 | 17 | 20 | 27 | 12 |
| Citizen committees representing various interest groups | 3.34 | 7 | 14 | 24 | 26 | 16 | 13 |
| Scientific telephone and mail survey | 3.02 | 10 | 24 | 22 | 16 | 15 | 13 |
| Meetings open to select groups and invited individuals | 2.94 | 8 | 28 | 23 | 17 | 11 | 13 |
| No public input | 1.57 | 66 | 6 | 6 | 4 | 5 | 14 |

[1] Totals may not equal exactly 100% due to rounding; [2] Based on 1 = Not at all effective through 5 = Very Effective.

Residents indicate, as identified in table 7, that citizen committees and open public meetings are the most effective methods of gathering public input. Residents also indicate that they find gathering no public input toward management decisions the least effective.

## Statistical Relationships

*Chi Square Testing*

Chi square testing was conducted on a number of question variables to determine whether any difference or associations exist between variables.

*Gender*

A highly statistically significant difference ($p<.0001$) was identified when chi-square testing was conducted on gender in comparison to residents identifying lethal versus non-lethal methods of action as most appropriate. A higher percentage of males identify

lethal methods as the most appropriate method of management (23%) compared to females (9%). Chi-square testing conducted on gender relative to the second most appropriate management action confirms the statistically significant difference between males and females again, with a higher percentage of males indicating lethal methods as the most appropriate. Repeating these testing procedures to look at the difference between gender and least appropriate management action confirms a highly statistically significant difference ($p<.0008$) exists between males and females in comparison to the least appropriate methods of management where a higher percentage of females find lethal methods of management the least appropriate (59%) compared to males (47%). A highly statistically significant difference ($p<.0001$) resulted from testing gender to the second least appropriate management action confirming again that a higher percentage of females (64%) find lethal methods of action the least appropriate compared to males (45%).

Chi-square testing conducted on gender compared to how important they feel about the management plan not involving the killing of deer, testing confirms a highly ($p<.0001$) significant statistical difference between males and females where a higher percentage of females (78%) find it moderately or very important that the management plan does not involve killing deer compared to males (59%).

Chi-square testing conducted on gender relative to how important residents feel it is for a management plan to minimize the use of firearms within city limits, confirms a highly significant statistical difference ($p<.0001$). A higher percentage of females (87%) feel it is moderate or very important that the management plan minimizes the use of firearms within the city compared to males (76%).

Similarly, chi-square testing on gender relative to how important residents feel it is for a management plan to minimize the use of bow and arrows within city limits, confirms a highly significant statistical difference ($p<.0001$). A higher percentage of females (85%) feel it is moderate or very important that the management plan minimizes the use of bows and arrows within the city compared to males (68%).

Chi-square testing conducted on gender compared to how important residents feel it is that the management plan maintains a healthy deer population, identifies a highly statistical difference. A higher percentage of males (59%) found it moderately or very important that the management plan maintained a healthy deer population compared to females (41%).

Chi-square testing conducted on gender compared to how important residents feel it is that the management plan minimizes side effects on deer, identifies high statistical difference. A higher percentage of females (85%) compared to males (76%) found it moderately, or very, important that the management plan minimized side effects on deer.

Adjusting for multiple comparisons using a Bonferroni correction identifies all of these results remain significant.

*Age*

Age groups compared to residents identifying lethal methods of management as most appropriate did not show any significant statistical differences between groups. Checking these results by testing again but against lethal methods of management as the second most appropriate management action confirms no substantial statistical difference exists. Chi-square testing for age of residents who find it very important that the management

plan does not involve killing deer also did not show any significant statistical difference between age groups. Chi-square testing for age of residents who find it very important that the management plan minimizes the use of firearms within city limits did show a significant statistical difference. The age group of 31-50 years of age had a higher tendency to indicate that it was very important to them that the urban deer management plan minimizes the use of firearms within the city.

*Education*

Testing education categories compared to lethal methods as the most appropriate methods of action did not show any significant statistical difference between categories. Chi-square testing of education categories of residents who find it very important that the management plan does not involve killing deer did not show any statistically significant difference between categories. Similarly, chi-square testing of education categories of residents who find it very important that the management plan minimizes the use of firearms within city limits did not show any statistically significant difference.

*Other*

Testing for those who said they did want to see a decrease in the urban deer population compared to residents finding lethal methods the most appropriate management action, identified a highly significance statistical difference ($p<.0001$). Of those residents finding lethal methods the most appropriate, 87.5% were individuals who wanted to see an urban deer population reduction. Chi-square testing on residents with signs of deer on their property, and on residents who know someone who has been involved in a deer-

vehicle collision, and residents who have experiences deer-related conflict compared to residents finding lethal methods of action the most appropriate, all show a highly significant statistical difference. Those who have had signs of deer, those who know someone involved in a deer-vehicle collision, and those who have experienced conflict all have a higher tolerance for lethal methods of action compared to those without these experiences. Chi-square testing of FSA areas of low population density, medium population density, and higher population density compared to residents finding lethal methods of action the most appropriate did not show any substantial statistical difference. Chi-square testing of FSA areas of low deer population density, medium deer population density, and high deer population density compared to residents finding lethal methods of action as most appropriate did show a statistically significant difference. There were 23% of residents living in high deer density FSA areas that indicated a lethal method of management as most appropriate compared to only 15% and 16% of residents indicating a lethal method of management as most appropriate in the medium and low deer density areas respectively.

Adjusting for multiple comparisons using a Bonferroni correction identifies all of these results remain significant except for the results observed in the low, medium, and high deer density areas no longer show statistically significant differences.

*Logistic Regression*

Logistic regression was used to determine the relationship of a number of variables to one question to determine the effect of the numerous variables to that one response variable.

Table 8 illustrates, with the use of SAS, the logistic regression of age, gender, and education compared to lethal methods as the most appropriate method of management.

**Table 8: Age, Gender, and Education in Relation to Lethal Methods of Management**

| Parameter | DF | Estimate | Standard Error | Wald Chi-square | Pr > Chisq |
|---|---|---|---|---|---|
| Intercept | 1 | -2.7462 | 0.3924 | 48.9761 | <.0001 |
| Age group 18-30 | 1 | 0.0977 | 0.5093 | 0.0368 | 0.8479 |
| Age group 31-50 | 1 | 0.678 | 0.3296 | 4.2317 | 0.0397 |
| Age group 51-70 | 1 | 0.3642 | 0.3214 | 1.2842 | 0.2571 |
| sex 0 | 1 | 1.1656 | 0.2105 | 30.6615 | <.0001 |
| Education some H.S. | 1 | -0.1439 | 0.3995 | 0.1297 | 0.7187 |
| Education H.S. | 1 | -0.2855 | 0.3215 | 0.7885 | 0.3746 |
| Education some Univ. | 1 | 0.0609 | 0.2691 | 0.0513 | 0.8208 |
| Education Undergrad | 1 | -0.1519 | 0.2891 | 0.2763 | 0.5992 |

The logistic Regression in table 8 shows gender and one age group showing some statistical substantiated difference. The logistic regression illustrates that those respondents 31-50 years of age are more accepting of lethal methods of management than those 71-95 years of age. The logistic regression also illustrates gender differences where males are more accepting of lethal methods of management than females.

Table 9 illustrates logistic regression of the relationship between age, gender and education categories of residents who find it very important that the management plan does not involve killing deer.

**Table 9: Age, Gender, and Education in Relation to Those Opposed to Killing Deer**

| Parameter | DF | Estimate | Standard Error | Wald Chi-square | Pr > Chisq |
|---|---|---|---|---|---|
| Intercept | 1 | 0.782 | 0.2588 | 9.1327 | 0.0025 |
| Age group 18-30 | 1 | -0.0991 | 0.3257 | 0.0926 | 0.7609 |
| Age group 31-50 | 1 | -0.0197 | 0.2122 | 0.0087 | 0.9259 |
| Age group 51-70 | 1 | 0.0781 | 0.1998 | 0.1527 | 0.6959 |
| Sex 0 | 1 | -0.912 | 0.1333 | 46.7808 | <.0001 |
| Education some H.S. | 1 | -0.3596 | 0.2798 | 1.652 | 0.1987 |
| Education H.S. | 1 | -0.1891 | 0.2348 | 0.6485 | 0.4207 |
| Education some Univ. | 1 | -0.1676 | 0.2098 | 0.6384 | 0.4243 |
| Education Undergrad | 1 | -0.1991 | 0.2205 | 0.8158 | 0.3664 |

Table 9 illustrates that a substantial statistical difference does exist with gender where males are less likely to indicate it is very important that the urban deer management plan does not involve killing deer.

Table 10 illustrates the logistic regression of the relationship between age, gender and education categories of residents who find it very important that the urban deer management minimizes the use of firearms within city limits.

**Table 10: Age, Gender, and Education in Relation to Those Wanting Minimal use of Firearms within City Limits**

| Parameter | DF | Estimate | Standard Error | Wald Chi-square | Pr > Chisq |
|---|---|---|---|---|---|
| Intercept | 1 | 1.5216 | 0.286 | 28.3078 | <.0001 |
| Age group 18-30 | 1 | -0.2084 | 0.3361 | 0.3846 | 0.5351 |
| Age group 31-50 | 1 | 0.226 | 0.2202 | 1.0539 | 0.3046 |
| Age group 51-70 | 1 | 0.5236 | 0.2087 | 6.2933 | 0.0121 |
| sex 0 | 1 | -0.8658 | 0.1534 | 31.8662 | <.0001 |
| Education some H.S. | 1 | -0.6959 | 0.3034 | 5.2618 | 0.0218 |
| Education H.S. | 1 | -0.6053 | 0.2643 | 5.2438 | 0.022 |
| Education some Univ. | 1 | -0.3397 | 0.242 | 1.9698 | 0.1605 |
| Education Undergrad | 1 | -0.314 | 0.2536 | 1.5328 | 0.2157 |

There are a number of categories in table 10 that indicate statistical significance. The age categories of 31-50 and 51-70 years of age shows a positive estimate, suggesting that it is very important to them that the urban deer management plan minimizes the use of firearms within city limits. The age category 51-70 shows a statistically substantial difference from the 71-90 control age group suggesting they are more likely to indicate it is very important to them that the management plan minimizes the use of firearms within the city limits. With respect to the education categories, there is a gradient present. The lowest education category of some high school educated respondents shows a negative estimate, suggesting they are less likely to find it important that the urban deer management plan minimizes the use of firearms within the city limits. With increasing education, the estimate becomes less negative and therefore with higher education, the more likely residents are to indicate the importance to them that the management plan minimizes the use of firearms within the city.

Table 11 illustrates the logistic regression of age, gender, and education categories of residents indicating they want to see an urban deer population reduction.

**Table 11: Age, Gender, and Education in Relation to Population Decrease**

| Parameter | DF | Estimate | Standard Error | Wald Chi-square | Pr > Chisq |
|---|---|---|---|---|---|
| Intercept | 1 | -1.9712 | 0.6696 | 8.6647 | 0.0032 |
| Age group 18-30 | 1 | 2.4417 | 0.7321 | 11.1239 | 0.0009 |
| Age group 31-50 | 1 | 1.2079 | 0.5993 | 4.0622 | 0.0439 |
| Age group 51-70 | 1 | 0.5323 | 0.5805 | 0.8409 | 0.3591 |
| sex 0 | 1 | 0.0734 | 0.3081 | 0.0567 | 0.8118 |
| Education some H.S. | 1 | -0.918 | 0.7549 | 1.4788 | 0.224 |
| Education H.S. | 1 | 0.0114 | 0.5168 | 0.0005 | 0.9825 |
| Education some Univ. | 1 | -0.5484 | 0.4783 | 1.3147 | 0.2515 |
| Education Undergrad | 1 | -0.5636 | 0.5281 | 1.1391 | 0.2858 |

Table 11 illustrates that the younger age categories of 18-30 years of age and 31-50 years of age are less likely to want a population decrease and more likely to say they would like to see the urban deer population increase. Using the variables in table 11 but including residents favoring lethal methods of management as most appropriate, we find that those who want to see an urban deer population reduction are more likely to favor lethal methods of action. This logistic regression is represented in table 12.

**Table 12: Age, Gender, and Education in Relation to Two Variables**

| Parameter | DF | Estimate | Standard Error | Wald Chi-square | Pr > Chisq |
|---|---|---|---|---|---|
| Intercept | 1 | -3.8268 | 0.8023 | 22.7494 | <.0001 |
| Q24Bgroup | 1 | 2.2849 | 0.5152 | 19.6658 | <.0001 |
| agegrp 18-30 | 1 | 1.0735 | 0.7573 | 2.0095 | 0.1563 |
| agegrp 31-50 | 1 | 1.1247 | 0.5008 | 5.0434 | 0.0247 |
| agegrp 51-70 | 1 | 0.2818 | 0.4721 | 0.3561 | 0.5507 |
| sex 0 | 1 | 1.4403 | 0.3206 | 20.1883 | <.0001 |
| Education some H.S. | 1 | -0.6971 | 0.6475 | 1.1591 | 0.2817 |
| Education H.S. | 1 | -0.4713 | 0.5317 | 0.7855 | 0.3755 |
| Education some Univ. | 1 | -0.5195 | 0.47 | 1.2219 | 0.269 |
| Education Undergrad | 1 | -0.6299 | 0.5114 | 1.5167 | 0.2181 |

## GIS Analysis

GIS can be an effective tool to spatial represent public opinion across a defined area.

### *Spatial Distribution of Response*

Appendix 13 represents the number of respondents for each FSA. Since there were 4000 surveys sent, and 36 FSA's in the GWA, there was an even distribution of 111 surveys mailed to each FSA. In total, 1182 questionnaires were returned completed. If an even distribution of surveys were returned, we would except to see 33 surveys returned for

each FSA. Appendix 13 illustrates that a lower number of surveys were returned from FSA's located near city center. Appendix 14 represents the number of respondents for each FSA compared to the deer numbers from the 2006 aerial survey conducted over the GWA. Interestingly, the FSA's near city center with the lower number of returned surveys occurs in FSA areas with little to no deer activity. Conversely, the FSA areas with a larger number of returned surveys received occurs in areas with a larger number of deer.

*Spatial Distribution of Management Preference*

Appendix 15 represents the percentage of respondents who find lethal methods of action the most appropriate in comparison to the 2006 deer numbers. The dark red on the image represents the FSA with the highest percentage of respondents indicating a lethal method of action as the most appropriate. The pale pink represents the FSA areas with the least number of respondents indicating a lethal method of management as the most appropriate. The spatial distribution shows that areas with higher deer numbers are more likely to have a higher percentage of respondents indicate a lethal method of action as most appropriate. It is important to note, however, that even in the areas with the highest level of support for lethal methods of action there are only 23-28% of respondents indicating a lethal method of action as most appropriate out of all residents who responded from within that FSA.

Conversely, Appendix 16 represents the percentage of respondents who find non-lethal methods of action the most appropriate in comparison to the 2006 deer numbers. The dark red on the image represents the higher percentage of residents indicating non-

lethal methods of action as the most appropriate. The image shows that FSA areas with higher numbers of deer have a lower percentage of residents, indicating a non-lethal method of action as most appropriate. It is again important to note that over 72% of all residents who responded in each FSA indicate non-lethal methods of action as the most appropriate.

Statistically significant differences were noted between male and female responses on the methods of action they considered most appropriate. Appendix 17 represents female respondents who find non-lethal methods of action as the most appropriate compared to the 2006 deer numbers. The dark red shading indicates the FSA's with a higher percentage of respondents indicating a non-lethal method of action as the most appropriate. Interestingly, the image is almost entirely dark red. Conversely, Appendix 18, represents the mapping of male respondents who find non-lethal methods of action the most appropriate compared to the 2006 deer numbers. The significantly lighter red shading on this map compared to the Appendix 17 illustrates the difference between male and female responses. Appendix 18 shows that fewer males indicated a non-lethal method of action as the most appropriate.

Appendix 19 represents the percentage of respondents indicating that they believe the urban deer population needs to be managed relative to the 2006 deer numbers. The image shows that over 50% of respondents indicated they believe there is a need for urban deer management in all FSA's. Interestingly, the image illustrates the FSA's with the highest percentage of respondents indicating they believe there is a need for urban deer management are from inner city FSA with little to no deer activity. This result may be due to the fewer number of respondents from these FSA's.

Residents were asked to indicate how important they felt it is that the urban deer management plan minimized the killing of deer. Residents were asked to indicate the degree of importance based on: not important (1), slightly important (2), moderately important (3), and very important (4). Appendix 20 represents how these responses distribute spatially compared to the 2006 deer numbers. All but six FSA's indicated an average importance between "moderately important" and "very important" that the management plan minimized the killing of deer. Several FSA's, placing high importance on the minimizing of killing deer, are FSA's with high deer numbers.

Residents were also asked to indicate how important they thought it is that the urban deer management plan minimized the use of firearms within the city limits. Using the same four point scale, Appendix 21 represents how these responses distribute spatially compared to the 2006 deer numbers. Responses in all FSA's show residents indicating an average importance between "moderately important" and "very important" that the management plan minimized the use of firearms within city limits. Resident responses from FSA's that have higher deer numbers still indicate a high degree of importance that the management plan minimizes the use of firearms within the city.

**Non-Response Bias Follow-Up**

A total of fifty non-response bias follow up interviews were conducted by telephone between November 15th and December 1st, 2008. Of the fifty interviews, only one resident indicated irritation over the survey process indicating he do not fill out surveys and did not want to be contacted again. Of the remaining residents, five (10%) indicated that English is a second language and they were unable to fill out the survey. One

resident (0.02%) indicated he forgot to fill it out, one resident (0.02%) indicated it was addressed to her daughter who since moved and therefore she never opened the envelope, and nine residents (18%) indicated they were incredibly busy and did not have the time to fill out the survey. Sixteen residents (32%) indicated they were not aware of deer in the city and did not know, or have an opinion, and therefore did not fill out the survey. Four residents (8%) indicated they did not recall being contacted. The remaining thirteen residents indicated they were either too elderly, had difficulty due to health problems, or that the survey was addressed to someone in the home who had passed away and as a result, they did not respond. Answers to the non-response interviews did not show any unusual trends compared to the responses from the original survey. The non-response, similar to those who responded originally, shows non-lethal management is preferred over lethal methods. The top three most appropriate methods of management were indicated as public education, trap and transfer, and barrier fencing on troubled roadways. These are the same methods of management indicated as most appropriate by the original respondents. The top three least appropriate deer management strategies were indicated as trap and euthanize sharpshooting, and bow and arrow hunting within city limits. These results are consistent with the original survey responses. Chi-square testing of original response and non-response in relation to preferences of lethal and non-lethal methods of management shows no significant difference between these two groups. The non-response interviews show 69% of those interviewed believe there is a need for public education, that 43%, a majority, indicate the need for management of the urban deer herd, 47% indicate they want to see residents and government together create the urban deer management plan, and that 16% of those who were interviewed indicated they wanted to

see the urban deer population reduced. Conducting chi-square testing on original response and non-response in relation to: those wanting public education; those wanting an urban deer population reduction; those wanting the urban deer herd to be managed; and all deer-related concerns, show results that are not statistically significant. These chi-square tests confirm non-response is consistent with the original responses from the completed surveys.

# CHAPTER FIVE

# DISCUSSION AND CONCLUSION

This chapter presents a discussion on the survey findings and study objectives divided into four sections. The first section of this chapter reviews the limitations of the type of study I have conducted; the second section discusses the GWA residents' opinions and tolerances toward the urban deer population and their preferences regarding potential urban deer management; the third section considers the implications these findings have for urban deer management; the fourth section deliberates whether a feasible urban deer management plan can be created that balances residents' safety with the conservation of an urban white-tailed deer population. The thesis concludes with a suggested management plan.

## Study Limitations

A major limitation of a mail survey of resident opinion is that the results of the survey provide managers with information based on resident opinion at a certain point in time. There are many complex and changing variables that may change resident opinion at any given moment, and many possible variables that might significantly modify public opinion toward urban deer management. Since Manitoba is located at the northern limiting range for white-tailed deer, severe weather may drastically alter deer population size, which may in turn dramatically change resident opinion, tolerance and preference toward deer management. Deer disease introduction could incite fear and modify residents' views. A devastating deer-vehicle collision could result in a change in resident opinion. These scenarios are but a few examples of the many potential changes that may

have a significant impact on resident opinion, tolerance, and preferences toward management. The results of this study provide a "snap shot" of resident opinions, tolerances, and preferences at a given point in time, then; additional human dimensions research will need to be conducted should wildlife managers desire to integrate resident opinions into future management.

Another limitation of the study is that the results reflect resident opinion before a public education initiative has taken place. Resident opinion might be different following presentation to residents of detailed accurate information on deer biology and ecology, the advantages and disadvantages of each potential management action, the impact decisions have on the ecosystem, and the financial costs involved.

**GWA Residents' Opinions, Tolerances and Management Preferences**

One objective of the study is to gain a better understanding of GWA residents' opinion and tolerances toward the urban deer population. GWA residents indicate overall that they do enjoy white-tailed deer as a part of the urban landscape. Resident response indicates the majority of residents find deer to be an esthetic resource, and a majority of residents indicate they do not consider deer a nuisance. Seventy six percent of the respondents indicate that they enjoy the presence of deer, even the 42.9% who say that they do worry about deer-related conflict. Residents continue to enjoy deer in their urban landscape despite the numerous concerns they have. Residents indicate greatest concern for deer-related vehicle accidents; their second and third top concerns - pertaining to sick and starving deer and people's behavior toward deer - have to do with deer well-being rather than concerns for human health and safety. Forty five percent of residents indicate

moderate or greater concern for the GWA deer population. A large majority of residents indicate that they think public education is needed. In regard to tolerance, 31.7% of residents indicate they want to see a change in the urban deer population. Twenty seven percent (324 of the 1182 residents who responded) indicate they want to see a population reduction. The remaining 858 (72.6%) of respondents indicate they do not want to see a reduction in the urban deer population; however, 49% of respondents indicate a need for the deer population to be managed.

Another objective of the study is to determine GWA residents' preferences toward potential urban deer management. The GWA residents' indicate the management techniques they prefer are non-lethal methods of management. The management actions residents most prefer are public education, trap and transfer, fencing on troubled roadways and restricting development to preserve deer habitat. Their preference for non-lethal methods of action is confirmed in the follow up question of preference and again when they are asked the management action they find least appropriate. Residents indicate that the management actions they least prefer are lethal methods of action. Sharpshooting, trap and euthanize, bow and arrow hunting are the lethal methods of action for which residents indicate the lowest preference. Resident opposition to lethal methods of action is confirmed in the follow-up question asking residents to indicate the second least appropriate deer management strategy. Residents were asked to indicate the importance underlying their preference for one management strategy over another. This information is conducive to a better understanding of resident preference regarding management action. Residents indicate that it is important to them that the management plan minimizes both deer suffering and the side effects on deer. Residents also place a

high level of importance on a plan that minimizes killing deer. Residents indicate it is important to them that the management plan maintains a healthy deer population within city limits. These responses are consistent with residents' earlier response indicating high concern for deer well being. Residents also indicate that it is important to them that the management plan chosen minimizes the use of firearms and bow and arrows within city limits. Residents indicate that it is important that the management plan minimizes human health and safety risks, that management action is effective, and that it does not require an increase in residents' taxes.

A majority of residents think that residents and government should work together to create the GWA urban deer management plan. Citizen committee groups representing various interest groups and open public meetings are rated as the most effective methods for gathering public input. Scientific surveys and meetings open to selected groups of invited individuals also rank close to the others as effective methods of gathering input.

**Implications for Urban Deer Management**

Based on the presumption that residents' opinions (human dimensions) matter, that is, that resident opinion should be incorporated into the process of creating an urban deer management plan, the study has implications for managers. The study suggests that there is a strong consensus on the need for management, public education and involving residents in management decisions. When determining what management action should be considered, there is strong resident resistance to lethal methods of management. Granted, there are variables here such as gender, in some instances age, and residents' direct experiences with human-deer conflict; it still remains the case, however, based on

the 1182 respondents analyzed here, that management action is desired. It is also clear that there is resistance to lethal action. This presents a significant challenge for managers who are called upon to reduce human health and safety risks in an environment where opposition exists to lethal methods of action, and to the use of firearms within city limits. In addition, residents indicate that they would like to see public education, fencing on troubled roadways, and increased road safety signage; yet they say it is important to them that the management plan does not result in an increase in taxes.

It may be that, with increasing deer numbers in years to come, we will see an increase in the number of people who have direct experience with human-deer conflict such as deer-vehicle collisions and, as a result, that tolerance for acceptance of lethal methods of action increases, along with the willingness to pay for such programs. On this matter, we can only hypothesize at this point. However, there is, undeniably, a societal shift occurring that places pressure on lethal methods of action; a protectionist movement, within urban centers, where attitudes toward wildlife are concerned. These are the challenges – both practical and philosophical - that wildlife managers face in the twenty-first century.

**Potential Urban Deer Management Plan**

Another objective of the study is to assess whether a GWA urban deer management strategy can be created that pays heed to the preferences of urban residents, that is at the same time feasible, and that balances residents' safety with conservation of an urban white-tailed deer population.

On this point, there are five main conclusions to my study:

1. GWA residents want an urban deer management plan.

2. GWA residents substantially prefer non-lethal methods of management.

3. GWA residents residing in high deer density areas, and GWA residents who have experienced direct human-deer conflict, show the highest support for lethal methods of action.

4. Male and female GWA residents show significant statistical differences in relation to their acceptance of lethal methods of action, and the use of firearms within city limits.

5. GWA residents believe residents and government together should create an urban deer management strategy.

In conclusion, there are a number of recommendations I offer community leaders and managers based on the findings of this research:

**1. Establish a public education initiative.** An increase in urban white-tailed deer population may continue. GWA residents indicate in this study that their concern is for the well-being of deer. Educating the public on deer biology and ecology may assist residents in gaining a better understanding of how best to assist in the conservation of a sustainable, healthy urban deer population. Educating the public on human-deer conflict, and ways in which residents may modify their behavior to reduce potential human-deer conflict, could well contribute to a decrease in human-deer conflict cases. Educating the public on the advantages and disadvantages of a number of potential methods of management may also assist residents in attaining a better understanding of each method and the implications it involves. A variety of media may be used strategically, and cost

effectively, throughout the year. GWA residents indicate in this study that they consider television and radio to be the most effective tools for educating the public. Television and radio could be used during late summer and fall months when deer-vehicle collisions are the greatest risk, and a combination of newspaper, both community and city, and brochures could be used throughout the remainder of the year. Integrating residents into the creation of management plans is also an effective means of educating the public. Surveys, such as this one, and public meetings are effective ways of educating the public.

**2. Integrate human dimension into the process of creating an urban deer management plan and continue human dimensions research.**

Results of this study indicate that GWA residents think residents and government should be involved in the creation of the urban deer management plan. Government agencies should promote residents' involvement in the creation of the management strategy through the use of citizen task force groups, open public meetings, and continued efforts to research GWA human dimensions. Efforts should be underway to educate wildlife managers on the importance of human dimensions, and to train them in the skills needed for effective facilitation of human dimensions work.

**3. Create a management plan that is systematically revisited, adaptive and multidimensional.**

In the interests of long-term success, an acceptable plan for management of the urban deer population will need to be adaptive. In order for a management plan to be truly adaptive, funding must be allocated to research the impacts of management actions on

white-tailed deer populations, on the ecosystem, and on any changing variables that may impact the management plan. With accurate information, systematic re-visitation will allow for modifications to the management plan to be considered and if necessary, made. A multi-dimensional management plan will be an effective way to integrate a number of strategies to assist in the reduction on human-deer conflict.

**4. Prohibit feeding deer.**

A ban prohibiting the intentional feeding of deer should be put in place, promoted and enforced. Here is an opportunity to educate GWA residents on the implications of feeding deer.

**5. Increase road safety signage, barrier fencing/modifications on troubled roadways.** Deer-vehicle collisions are increasing in the GWA each year. GWA residents indicate that deer-vehicle collisions are the human-deer conflict of top concern. GWA residents also indicate, however, that they do not find lethal methods of management acceptable. Assuming resident opinion is to be considered and respected, other efforts should be underway to attempt to mitigate the occurrence of deer-vehicle collisions. Public education, as mentioned, may be an effective strategy. In addition, increased road safety signage, and fencing or habitat modification along troubled roadways, should be considered. Increased lighting and re-structuring of ditches along troubled roadways may provide earlier detection of deer and increasing time for motorists to react. Removal of trees and shrubs would increase deer visibility; however, may receive public resistance.

**6. Selectively cull injured deer.**

The lethal method of action indicated by GWA residents as the most appropriate is selectively culling deer. GWA residents indicated a high concern for the well being of deer. Several residents, living in high deer density areas, indicated they did not like seeing injured or obviously dying deer on their property. Trained professionals should be hired to selectively cull injured/obviously sick or dying deer.

**7. Create task force to address long term city planning.**

It is difficult to determine whether the urban white-tailed deer population will continue to grow. Global warming may result in a reduction in the duration and severity of winters, which may contribute to increasing white-tailed deer populations in this range. Given the societal movement toward a protectionist attitude toward animals, and the increasing interest society has for the health of the environment, city planners should consider species co-existence when planning future expansion. To this end, funding for research should be allocated to better understanding urban species such as white-tailed deer, to research their use of urban spaces, and movement. Effective planning should be addressed when considering the construction of major roadways and the implications construction has on both human and non-human species. Habitat corridors, riparian habitat, and connectivity between fragmented remnant habitat patches should be integrated into urban expansion.

## WORKS CITED


Adams, Clark, E., Kieran J. Lindsey, Sara J. Ash, *Urban Wildlife Management.* Boca Raton, London, and New York: CRC Press, 2006.

American Lyme Disease Foundation web pages: http://www.aldf.com/deerTickecology.shtml

Applegate, James, E., "Attitudes Toward Deer Hunting in New Jersey: A Decline in Opposition." *Wildlife Society Bulletin* 7, 2 (1979): 127-129.

Baker, Rollin, H., "Origin, Classification and Distribution." In *White-Tailed Deer and Management.* Ed. Lowell K. Halls. Harrisburg, PA: Stackpole Books, 1984. 1-18.

Beier, Paul, Dale R. McCullough, "Factors Influencing White-Tailed Deer Activity Patterns and Habitat Use." *Wildlife Monographs* 54, 2 (April 1990): 1-51.

Bradley, Robert, D., Fred C. Bryant, Lisa C. Bradley, Michelle L. Haynie, Robert J. Baker, "Implications of Hybridization between White-Tailed Deer and Mule Deer." *The Southwestern Naturalist* 48, 4 (December 2003): 654-660.

Brinkman, Todd, J., Christopher S. Deperno, Jonathan A. Jenks, Brian S. Haroldson, Richard G. Osborn, "Movement of Female White-Tailed Deer: Effects of Climate and Intensive Row-Crop Agriculture." *The Journal of Wildlife Management* 69, 3 (July 2005): 1099-1111.

Brown, Robert, D., Susan, M. Cooper, "The Nutritional, Ecological, and Ethical Arguments against Baiting and Feeding White-Tailed Deer." *Wildlife Society Bulletin* 34, 2 (June 2006): 519-524.

Brown, Tommy, L., Daniel J. Decker, Shawn J. Riley, Jody W. Enck, T. Bruce Lauber, Paul D. Curtis, George F. Mattfeld, "The Future of Hunting as a Mechanism to Control White-Tailed Deer Populations." *Wildlife Society Bulletin* 28, 4 (2000): 797-807.

Bulloch, D.M., "An Assessment of Effects of Urban Land Development on the Winnipeg Deer Herd." MNRM Practicum, University of Manitoba, 1987.

Canadian Education Association web page http://www.cea-ace.ca/pub.cfm?subsection=edu&page=arc&subpage=sum03

Canada Post web pages: http://www.canadapost.ca/tools/pg/fsamaps/pdf/Canada.pdf

Canada Safety Council web pages: http://www.safety-council.org/info/traffic/roadkill.html#Anchor-Collision-58212

Caslick, J. W., Daniel J. Decker, "Economic Feasibility of a Deer-Proof Fence for Apple Orchards." Wildlife Society Bulletin 7, 3 (1979): 173-175.

Champ, Joseph, "A Culturalist-Qualitative Investigation of Wildlife Media and Value Orientations." *Human Dimensions of Wildlife* 7, 4 (2002): 273-286.

Chase, Lisa, C., William F. Siemer, Daniel J. Decker, "Deer Management in the Village of Cayuga Heights, New York: Preliminary Situation Analysis from a Survey of Residents." Human Dimensions Research Unit, Department of Cornell University, Ithaca, N.Y. 14853, March 1999, HDRU Series No. 99-1 web pages: http://www.dnr.cornell.edu/hdru/PUBS/HDRUReport99-1.pdf

City of Winnipeg web pages: http://www.winnipeg.ca/cao/media/news/nr_2006/nr_20060503b.stm

City of Winnipeg By-Laws web pages: http://www.winnipeg.ca/clkdmis/DocExt/BL_Default.asp?DocumentTypeId=1

Connelly, Nancy A., Tommy L. Brown, Daniel J. Decker, "Factors Affecting Response Rates to Natural Resource-Focused Mail Surveys: Empirical Evidence of Declining Rates Over Time." *Society & Natural Resources* 16, 6 (July 2003), 541-549.

Conover, Michael, *Resolving Human-Wildlife Conflicts: The Science of Wildlife Damage Management.* Boca Raton, London, New York, Washington D.C.: CRC Press LLC, 2002.

Conover, Michael, R., "Wildlife Management by Metropolitan Residents in the United States: Practices, Perceptions, Costs, and Values." *Wildlife Society Bulletin* 25, 2 (1997): 306-311.

Conover, Michael, R., "Monetary and Intangible Valuation of Deer in the United States." *Wildlife Society Bulletin* 25, 2 (1997): 298-305.

Conover, Michael, R., William C. Pitt, Kimberly K. Kessler, Tami J. Dubow, Wendy A. Sanborn,"Review of Human Injuries, illnesses and economic losses caused by wildlife in the United States." *Wildlife Society Bulletin* 23, 3 (1995): 407-414.

Cornell University, Human Dimensions Research Unit. *Assessing Deer Impacts and Management Options at a Landscape Scale: A Survey of Landowners in the Towns of Caroline and Venice.* Human Dimensions Research Unit Series No. 08-2, February 2008 web page: http://www.dnr.cornell.edu/hdru/PUBS/HDRUReport08-2.pdf

Cornell University, Human Dimensions Research Unit. *Community Attitudes About Deer Management In the Village of Cayuga Heights, New York.* Human Dimensions Research Unit Series No. 01-7, May 2001 web page: http://www.dnr.cornell.edu/hdru/PUBS/HDRUReport01-7.pdf

Cornell University, Human Dimensions Research Unit. *Cornell Lands, Deer and East Hill Communities 2006 Survey of Community Residents.* Human Dimensions Research Unit Series No. 07-5, April 2007 web page: http://www.dnr.cornell.edu/hdru/PUBS/HDRUReport07-5.pdf

Cornell University, Human Dimensions Research Unit. *Tailoring Communications about Suburban Deer Management to Stakeholders' Concerns.* Human Dimensions Research Unit Series No. 00-8, July 2000 web page: http://www.dnr.cornell.edu/hdru/PUBS/HDRUReport00-8.pdf

Creswell, John, W., *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches; Second Edition.* Thousand Oaks, London, New Delhi: Sage Publications, 2003.

Cunningham, Andrew A., "Disease Risks of Wildlife Translocations." *Conservation Biology* 10, 2 (1996): 349-353.

Deblinger, Robert D., David W. Rimmer, Jerry J. Vaske, Garry M. Vecellio, "Efficiency of Controlled, Limited Hunting at the Crane Reservation in Ipswich, Massachusetts." In *Urban Deer: A Manageable Resource? Proc. Of the 1993 Symposium of the North Central Section, The Wildlife Society.* Ed. J.B. McAninch, 1995. 82-86.

Decker, Daniel J., Thomas A. Gavin, "Public Attitudes toward a Suburban Deer Herd." *Wildlife Society Bulletin* 15, 2 (1987): 173-180.

Decker, Daniel J., Tommy L. Brown, William F. Siemer, *Human Dimensions of Wildlife Management in North America.* Bethesda, Maryland: The Wildlife Society, 2001.

Decker, Daniel J., Ken G. Purdy, "Toward a Concept of Wildlife Acceptance Capacity in Wildlife Management." *Wildlife Society Bulletin* 16, 1 (1988): 53-57.
DeNicola, Anthony, J., R. K. Swihart, "Capture-Induced Stress in White-Tailed Deer." *Wildlife Society Bulletin* 25, 2 (1997): 500-503.
DeNicola, Anthony, J., Steven J. Weber, Charles A. Bridges, Judy L. Stokes, "Nontraditional Techniques for Management of Overabundant Deer Populations." *Wildlife Society Bulletin* 25, 2 (1997): 494-499.
DeNicola, Anthony, J., Kurt C. VerCauteren, Paul D. Curtis, Scott E. Hygnstrom, *Managing White-Tailed Deer in Suburban Environments: A Technical Guide.* Ithaca, New York: Cornell Cooperative Extension Publications, 2000.
Dillman, Don A., *Mail and Telephone Surveys: The Total Design Method.* New York: John Wiley & Sons, 1978.
Dillman, Don A., *Mail and Internet Surveys: The Tailored Design Method.* New Jersey: John Wiley & Sons, 2007.
Doenier, P. B., G. D. DelGiudice, M. R. Riggs, "Effects of Winter Supplemental Feeding on Browse Consumption by White-Tailed Deer." *Wildlife Society Bulletin* 25, 2 (1997): 235-243.
Doerr, Michelle, L., Jay B. McAninch, Ernie P. Wiggers, "Comparison of 4 Methods to Reduce White-Tailed Deer Abundance in an Urban Community." *Wildlife Society Bulletin* 29, 4 (2001): 1105-1113.
Enck, Jody, W., Daniel J. Decker, Shawn J. Riley, John F. Organ, Len H. Carpenter, William F. Siemer, "Integrating Ecological and Human Dimensions in Adaptive Management of Wildlife-Related Impacts." *Wildlife Society Bulletin* 34, 3 (October 2006): 698-705.
Environment Canada web pages: http://www.ec.gc.ca/nature/highlights/a3.htm
Forsyth, Adrian, *Mammals of North America: Temperate and Arctic Regions.* Buffalo, New York: Firefly Books, 1999.
Gehring, Thomas, M., Bradly A. Potter, "Wolf Habitat Analysis in Michigan: An Example of the Need for Proactive Land Management of Carnivore Species." *Wildlife Society Bulletin* 33, 4 (2005): 1237-1244.
Gilbert, Frederick, F., "Reproductive Logic and the Effects of Meningeal Worms: A Comment." *The Journal of Wildlife Management* 56, 3 (July 1992): 614-616.
Gogan, Peter, J., P., Reginald H. Barrett, William W. Shook, Thomas E. Kucera, "Control of Ungulate Numbers in a Protected Area." *Wildlife Society Bulletin* 29, 4 (2001): 1075-1088.
Goulden, Herb, *The White-Tailed Deer in Manitoba.* Manitoba Natural Resources: 1981.
Government of Canada, Industry of Canada web pages: http://www.ic.gc.ca/epic/site/trm-crt.nsf/en/rm00196e.html
Government of Manitoba web pages: http://www.gov.mb.ca/asset_library/en/statistics/winnipeg.pdf
Government of Manitoba Community Profile web pages: http://www.communityprofiles.mb.ca/cgi-bin/csd/overview.cgi?id=4611040
Government of Manitoba Geography web pages: http://www.gov.mb.ca/ctt/invest/busfacts/overviews/geography.html
Government of Manitoba Map for New Comers web pages:

http://www2.immigratemanitoba.com/asset_library/en/settlement/pdf/newcomers_map.pdf
Government of Manitoba new release web pages: http://news.gov.mb.ca/news/index.print.html?archive=&item=3694.
Government of the United States Lyme Disease web pages: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5010al.htm
Green, Deborah, Glen R. Askins, Phillip D. West, "Public Opinion: Obstacle or aid to Sound Deer Management?" *Wildlife Society Bulletin* 25, 2 (1997): 367-370.
Hagglund, Brian, "Big Game Aerial Survey Report: City of Winnipeg (GHA 38) and Surrounding Area". Manitoba Conservation, February 2006, Unpublished.
Heberlein, Thomas, A., "Wildlife Caretaking vs. Wildlife Management: A Short Lesson in Swedish." *Wildlife Society Bulletin* 33, 1 (2005): 378-380.
Heberlein, Thomas, A., "Changing Attitudes and Funding for Wildlife: Preserving the Sport Hunter." *Wildlife Society Bulletin* 19, 4 (1991): 528-534.
Hernandez, Saul, Shawn L. Locke, Matthew W. Cook, Louis A. Harveson, Donald S. Davis, Roel R. Lopez, Nova J. Silvy, Mark A. Fraker, "Effects of SpayVac® on Urban Female White-Tailed Deer Movements." *Wildlife Society Bulletin* 34, 5 (December 2006): 1430-1434.
Hesselton, William, T., RuthAnn Monson Hesselton, "White-Tailed Deer." In *Wild Mammals of North America: Biology, Management and Economics.* Ed. Joseph A. Chapman, George A. Feldhamer. Baltimore and London: The Johns Hopkins University Press, 1982. 878-901.
Humane Society of the United States web pages: http://www.hsus.org/about_us/
Kilpatrick, Howard, J., Andrew M. Labonte, John S. Barclay, "Acceptance of Deer Management Strategies by Suburban Homeowners and Bowhunters." *Journal of Wildlife Management* 71, 6 (2007): 2095-2101.
Kilpatrick, Howard, J., Wade A. Stober, "Effects of Temporary Bait Sites on Movements of Suburban White-Tailed Deer." *Wildlife Society Bulletin* 30, 3 (2002): 760-766.
Kilpatrick, H. J., W. D. Walter, "A Controlled Archery Deer Hunt in a Residential Community: Cost, Effectiveness, and Deer Recovery Rates." *Wildlife Society Bulletin* 27, 1 (1999): 115-123.
Kreyling, Christine, "Not-So-Wild Things: Coping with Wild Animals-and Vice Versa." *Planning* 67, 10 (2001): 18-23.
Lauber, T., Bruce, Barbara A. Knuth, James A. Tantillo, Paul D. Curtis, "The Role of Ethical Judgments Related to Wildlife Fertility Control." *Society & Natural Resources* 20, 2 (February 2007): 119-133.
Leong, K.M., D.M. Theobald, D.J. Decker. Poster presentation on *Using GIS and mail surveys to assist in public participation planning: spatial analysis of wildlife issues in communities near urban parks.* 15th Annual The Wildlife Society Conference, Miami, FL. 8-12 Nov. 2008.
Leuthold, Walter, *African Ungulates: A Comparative Review of their Ecology and Behavioral Ecology.* New York: Springer-Verlag Berlin Heidelberg, 1977: 260-294.
Locker, Cynthia, A., Daniel J. Decker, Steven J. Schwager, "Social Acceptability of Wildlife Management Actions in Suburban Areas: 3 Cases from New York." *Wildlife Society Bulletin* 27, 1 (1999): 152-159.

Manfredo, Michael, *Who Cares About Wildlife? Social Science Concepts for Exploring Human-Wildlife Relationships and Conservation Issues.* New York: Springer, 2008.

Manfredo, J., Michael, Jerry J. Vaske, Perry J. Brown, Daniel J. Decker, and Ester A. Duke, *Wildlife and Society: The Science of Human Dimensions.* Washington, Covelo, and London: Island Press, 2009.

Manfredo, Michael, J., Tara L. Teel, Alan D. Bright, "Why Are Public Values Toward Wildlife Changing?" *Human Dimensions of Wildlife* 8, 4 (June 2003): 287-306.

Manfredo, Michael, J., "Human Dimensions of Wildlife Management." Wildlife Society Bulletin 17, 4 (1989): 447-449

Manitoba Conservation, Deer Management Strategy Draft 5, November 29, 2007.

Manitoba Conservation web pages: http://web2.gov.mb.ca/conservation/cdc/species/fieldguide.php?elcode=AMALC02020&action=Search&search_type=ET_Common#life_history

Manitoba Bureau of Statistics web pages: http://www.gov.mb.ca/asset_library/en/statistics/demographics/mbs2008_prelim_projections.pdf

Marchinton, Larry, R., David H. Hirth, "Behavior." In *White-Tailed Deer Ecology and Management.* Ed. Lowell K. Halls. Harrisburg, PA: Stackpole Books, 1984. 129-168.

Mayer, Kenneth E., Joseph E. DiDonato, Dale R. McCullough, "California Urban Deer Management: Two Case Studies." *In Urban Deer A Manageable Resource? Proc. Of the 1993 Symposium of the North Central Section, The Wildlife Society.* Ed. Jay B. McAninch, 1995. 51-57.

McCabe, Richard, E., Thomas R. McCabe, "Of Slings and Arrows: An Historical Retrospection." In *White-Tailed Deer Ecology and Management.* Ed. Lowell K. Halls. Harrisburg, PA: Stackpole Books, 1984. 19-72.

McCullough, D. R., K. W. Jennings, N.B. Gates, B. G. Elliot and J. E. Didonato, "Overabundant Deer Populations in California." *Wildlife Society Bulletin* 25, 2 (1997): 478-483.

McDonald, John, E., Jr., Daniel E. Clark, William A. Woytek, "Reduction and Maintenance of a White-Tailed Deer Herd in Central Massachusetts." *The Journal of Wildlife Management* 71, 5 (2007): 1585-1593.

Merrill, John, A., Evan G. Cooch, Paul D. Curtis, "Managing an Overabundant Deer Population by Sterilization: Effects of Immigration, Stochasticity and the Capture Process." *The Journal of Wildlife Management* 70, 1 (2006): 268-277.

Messmer, Terry, A., Louis Cornicelli, Daniel J. Decker, David G. Hewitt, "Stakeholder acceptance of Urban Deer Management Techniques." *Wildlife Society Bulletin* 25, 2 (1997): 360-366.

Miller, Karl, V., "Considering Social Behavior in the Management of Overabundant White-Tailed Deer Populations." *Wildlife Society Bulletin* 25, 2 (1997): 279-281.

Moore, David S., *The Basic Practice of Statistics: Second Edition.* New York: W.H. Freeman and Company, 2000.

Morriss, John, "Agriculture in Manitoba" in *The Encyclopedia of Manitoba.* Winnipeg, Manitoba: Great Plains Publications, 2007: 7-10.

Nielsen, Clayton, K., Gary Anderson, Marrett D. Grund, "Landscape Influences on Deer-

Vehicle Accident Areas in an Urban Environment." *The Journal of Wildlife Management* 67, 1 (January 2003): 46-51.
Nielsen, Clayton, K., William F. Porter, H. Brian Underwood, "An Adaptive Management Approach to Controlling Suburban Deer." *Wildlife Society Bulletin* 25, 2 (1997): 470-477.
Porter, William, F., "Ignorance, Arrogance, and the Process of Managing Overabundant Deer." *Wildlife Society Bulletin* 25, 2 (1997): 408-412.
Porter, William, F., H. Brian Underwood, Jennifer L. Woodard, "Movement Behavior, Dispersal, and the Potential for Localized Management of Deer in a Suburban Environment." *The Journal of Wildlife Management* 68, 2 (2004): 247-256.
Raik, Daniela, B., Daniel J. Decker, William F. Siemer, "Dimensions of Capacity in Community-Based Suburban Deer Management: The Managers' Perspective." *Wildlife Society Bulletin* 31, 3 (2003): 854-864.
Riley, Shawn, J., Daniel J. Decker, Len H. Carpenter, John F. Organ, William F. Siemer, George F. Mattfeld, Gary Parsons, "The Essence of Wildlife Management." *Wildlife Society Bulletin* 30, 2 (2002): 585-593.
Romin, Laura A., Larry B. Dalton, "Lack of Response by Mule Deer to Wildlife Warning Whistles." *Wildlife Society Bulletin* 20, 4 (1992): 382-384.
San Julian, Gary, J., "The Future of Wildlife Damage Control in an Urban Environment." In *Eastern Wildlife Damage Control Conference.* University of Nebraska: Lincoln, 1987.
Sauer, Peggy, R., "Physical Characteristics." In *White-Tailed Deer Ecology and Management.* Ed. Lowell K. Halls. Harrisburg, PA: Stackpole Books, 1984. 73-90.
Schwartz, Jennifer, A., Robert J. Warren, David W. Henderson, David A. Osborn, Darrel J. Kesler, "Captive and Field Tests of a Method for Immobilization and Euthanasia of Urban Deer." *Wildlife Society Bulletin* 25, 2 (1997): 532-541.
Scott, Geoff, "Ecoclimatic Regions" in *The Encyclopedia of Manitoba.* Winnipeg, Manitoba: Great Plains Publications, 2007: 185-187.
Shaw, Jonathan, C., Richard A. Lancia, Mark C. Conner, Christopher S. Rosenberry, "Effect of Population Demographics and Social Pressures on White-Tailed Deer Dispersal Ecology." *The Journal of Wildlife Management* 70, 5 (2006): 1293-1301.
Shoesmith, M. W., L. J. Bidlake, *The Movements of White-Tailed Deer in Southwestern Manitoba and the Implications Toward Management.* Manitoba Wildlife Research: 1978.
Shoesmith, M.W., W.H. Koonz, The *Maintenance of an Urban Deer Herd in Winnipeg, Manitoba.* Manitoba Wildlife Research: 1977.
Smith, Michael, H., Hilburn O. Hillestad, Ramone Baccus, Michael N. Manlove, "Population Genetics." In *White-Tailed Deer Ecology and Management.* Ed. Lowell K. Halls. Harrisburg, PA: Stackpole Books, 1984. 119-128.
Soprovich, Daniel, W., *Reproductive Performance and Fetal Development of White-Tailed Deer (Odocoileus virgianus) in Southwestern Manitoba.* Manitoba Natural Resources: 1991.
Stout, Rebecca, J., Daniel J. Decker, Barbara A. Knuth, John C. Proud, David H. Nelson,

"Comparison of Three Public-Involvement Approaches for Stakeholder Input into Deer Management Decisions: A Case Study." *Wildlife Society Bulletin* 24, 2 (1996): 312-317.

Stewart, Kelley, M., Timothy E. Fulbright, D. Lynn Drawe, "White-Tailed Deer Use of Clearings Relative to Forage Availability." *The Journal of Wildlife Management* 64, 3 (July 2000): 733-741.

Swilhart, Robert, K., Peter M. Picone, "Selection of Mature Growth Stages of Coniferous Browse in Temperate Forests by White-Tailed Deer (*Odocoileus virgianus*)." *American Midland Naturalist* 139, 2 (April 1998): 269-274.

Trenaman, Joel, "Birds Hill Provincial Park" in *The Encyclopedia of Manitoba.* Winnipeg, Manitoba: Great Plains Publications, 2007: 68.

Toronto Star Media Kit web pages: http://www.mediakit.thestar.ca/details.asp

Turner, John, W., Jr., Jay F. Kirkpatrick, Irwin K. M. Liu, "Effectiveness, Reversibility, and Serum Antibody Titers Associated with Immunocontraception in Captive White-Tailed Deer." *The Journal of Wildlife Management* 60, 1 (1996): 45-51.

University of Saskatchewan web pages: http://www.usask.ca/wcvm/herdmed/specialstock/elk/diseases/Ptenuis.html

Vaske Jerry J., Mark D. Needham, Peter Newman, Michael J. Manfredo, and Jordan Petchenik, "Potential for Conflict Index: Hunter's Responses to Chronic Wasting Disease." *Wildlife Society Bulletin* 34, 1 (March 2006): 44-50.

VerCauteren, Kurt, C., John A. Shivik, Michael J. Lavelle, "Efficacy of an Animal-Activated Frightening Device on Urban Elk and Mule Deer." *Wildlife Society Bulletin* 33, 4 (2005): 1282-1287.

VerCuteren, Kurt, C., Michael J. Lavelle, Nathan W. Seward, Justin W. Fischer, Gregory E. Phillips, "Fence-Line Contact between Wild and Farmed White-Tailed Deer in Michigan: Potential for Disease Transmission." *Journal of Wildlife Management* 1, 5 (2007): 1603-1606.

Verme, Louis, J., Duane E. Ullrey, "Physiology and Nutrition." In *White-Tailed Deer Ecology and Management.* Ed. Lowell K. Halls. Harrisburg, PA: Stackpole Books, 1984. 91-118.

Waller, Donald, M., William S. Alverson, "The White-Tailed Deer: A Keystone Herbivore." *Wildlife Society Bulletin* 25, 2 (1997): 217-226.

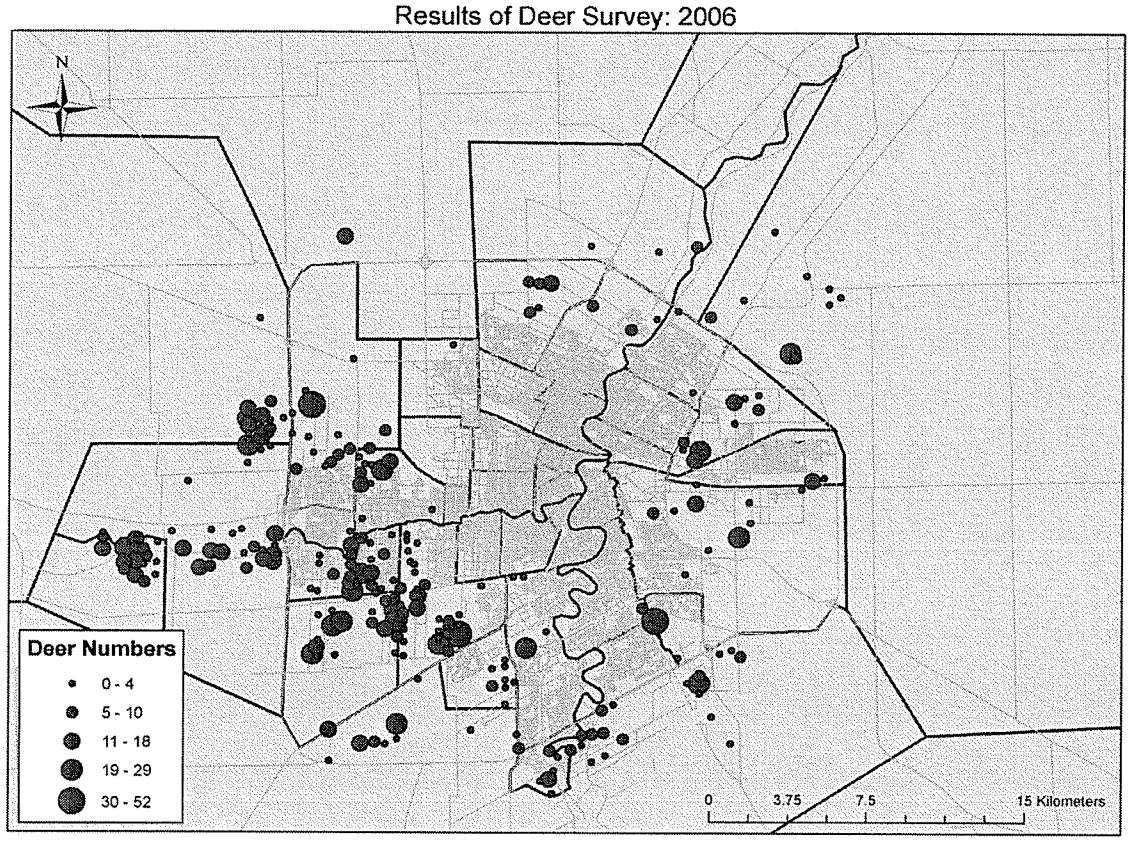
Whittaker, Doug, Michael J. Manfredo, Peter J. Fix, Rick Sinnott, SuzAnne Miller, Jerry J. Vaske, "Understanding Beliefs and Attitudes about an Urban Wildlife Hunt near Anchorage, Alaska." *Wildlife Society Bulletin* 29, 4 (2001): 1114-1124.

Who's Who web pages: http://www.hww.ca/hww2.asp?id=106&cid=8

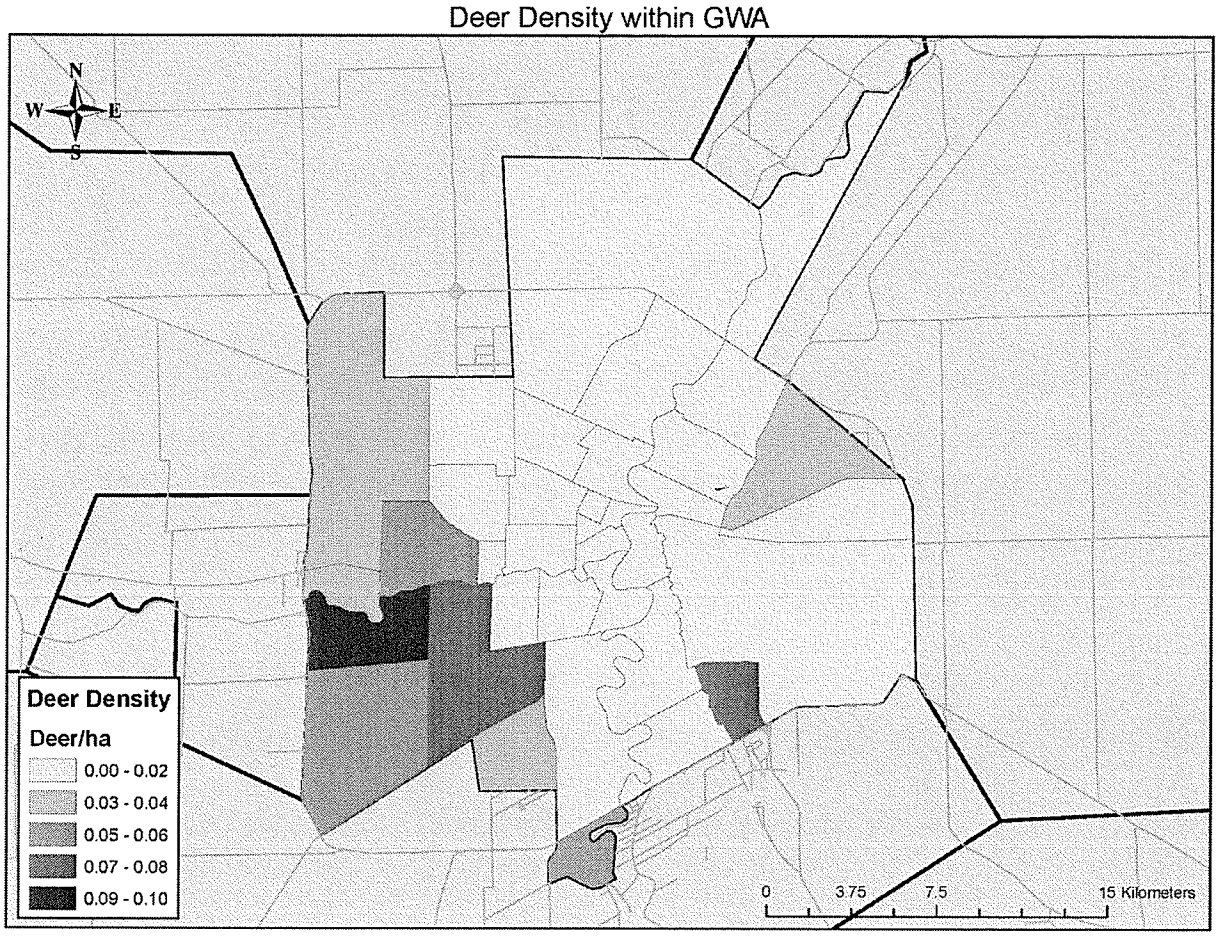
Wildlife Control web pages: http://wildlifecontrol.info/ccevdmp/Publications/Deer-factsheet.pdf

World Deer web pages: http://www.worlddeer.org/whitetaildeer.html

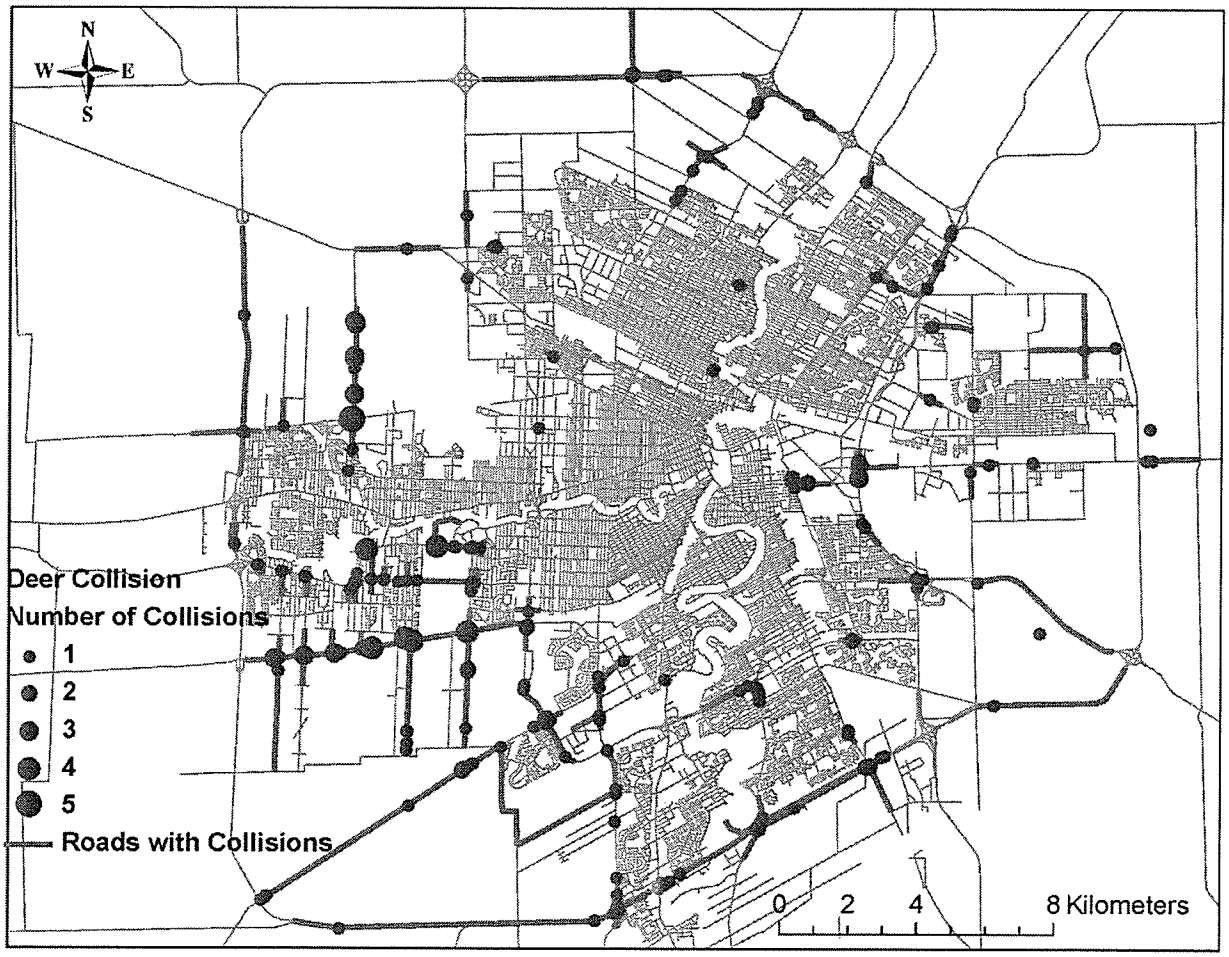
Appendix 1: Map of 2006 Deer Numbers from Aerial Survey Conducted by Manitoba Conservation



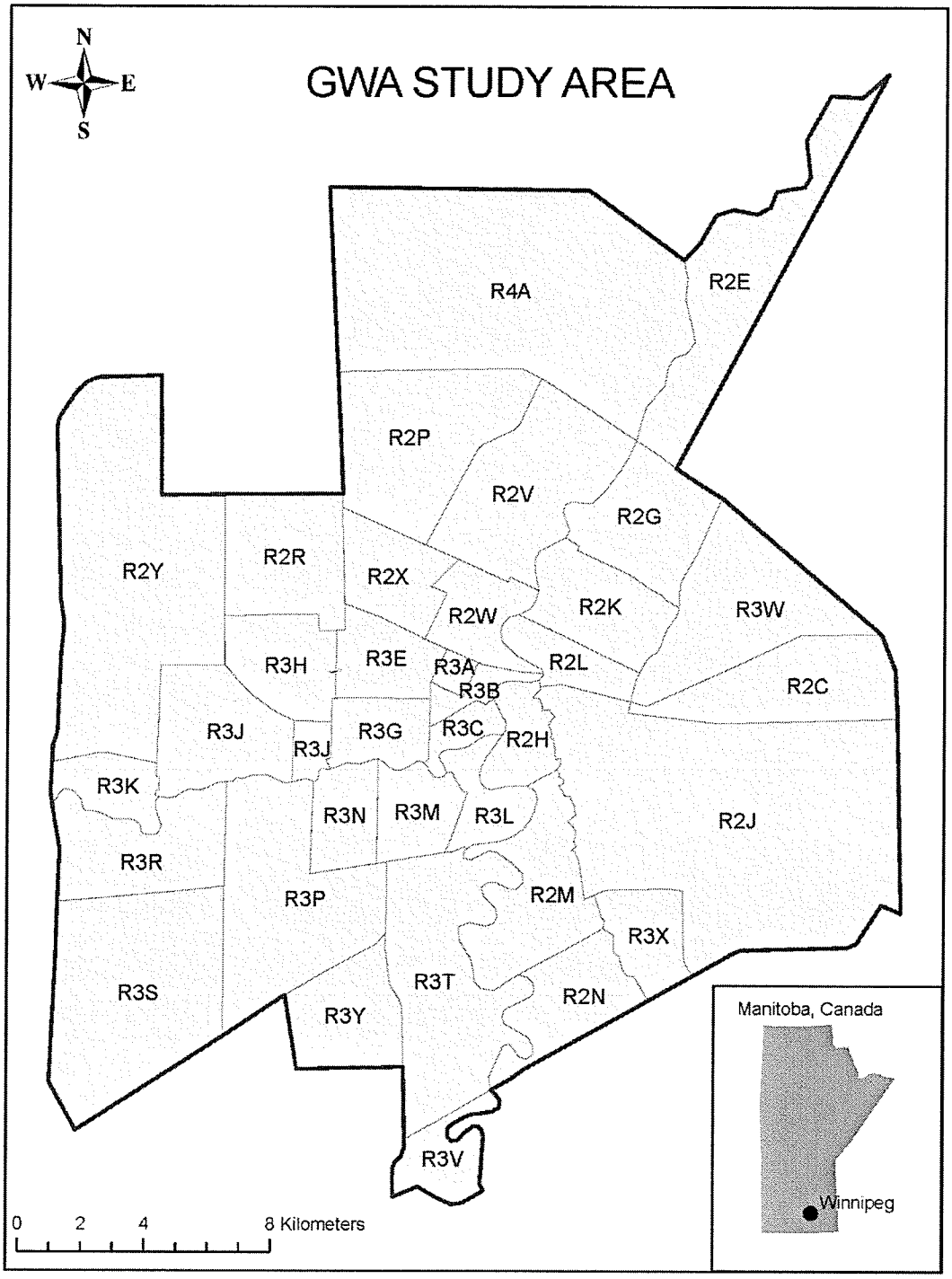
Appendix 2: GWA Deer Density Map Per FSA



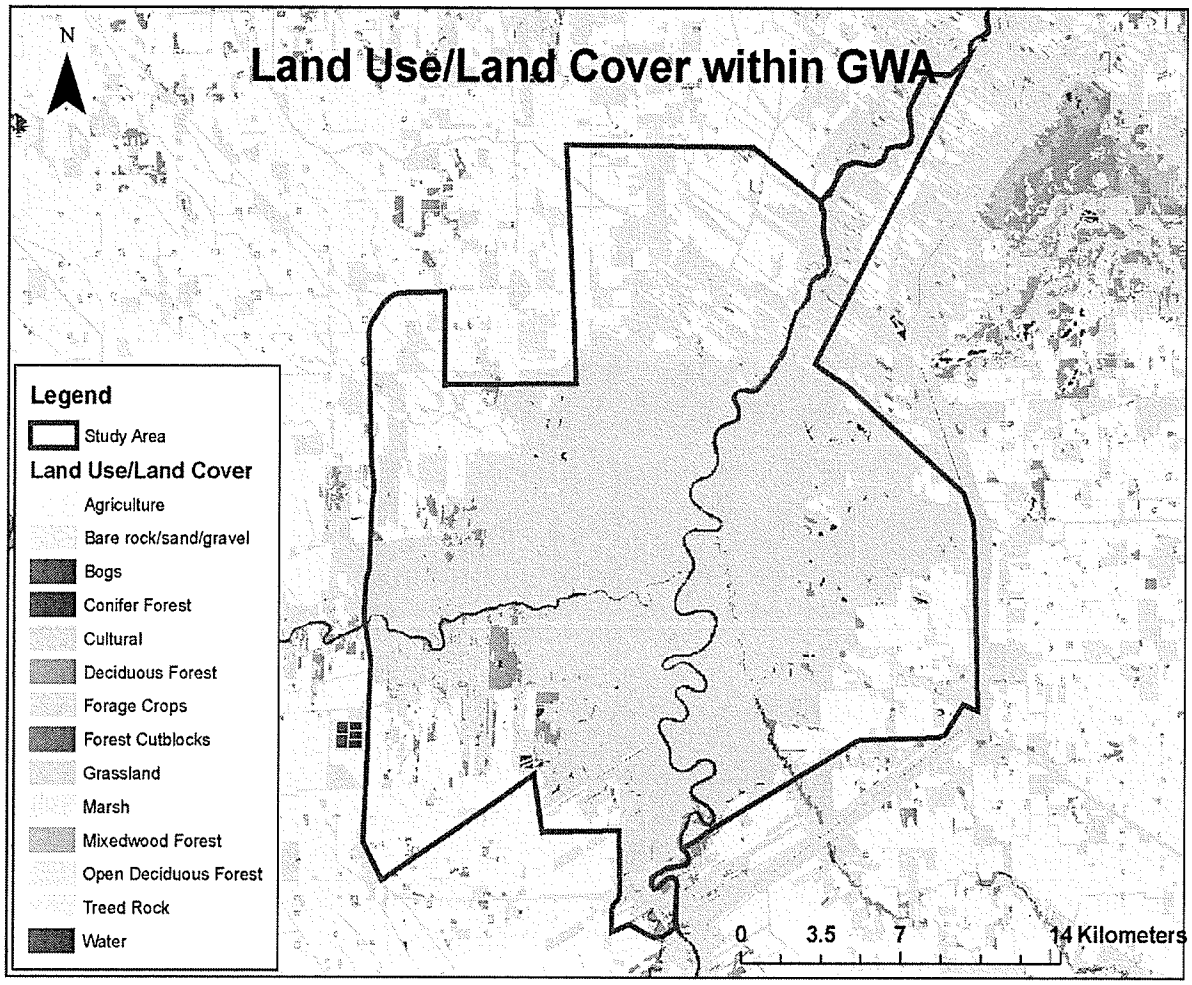
Appendix 3: Map of 2005 GWA Reported Deer-Vehicle Collisions



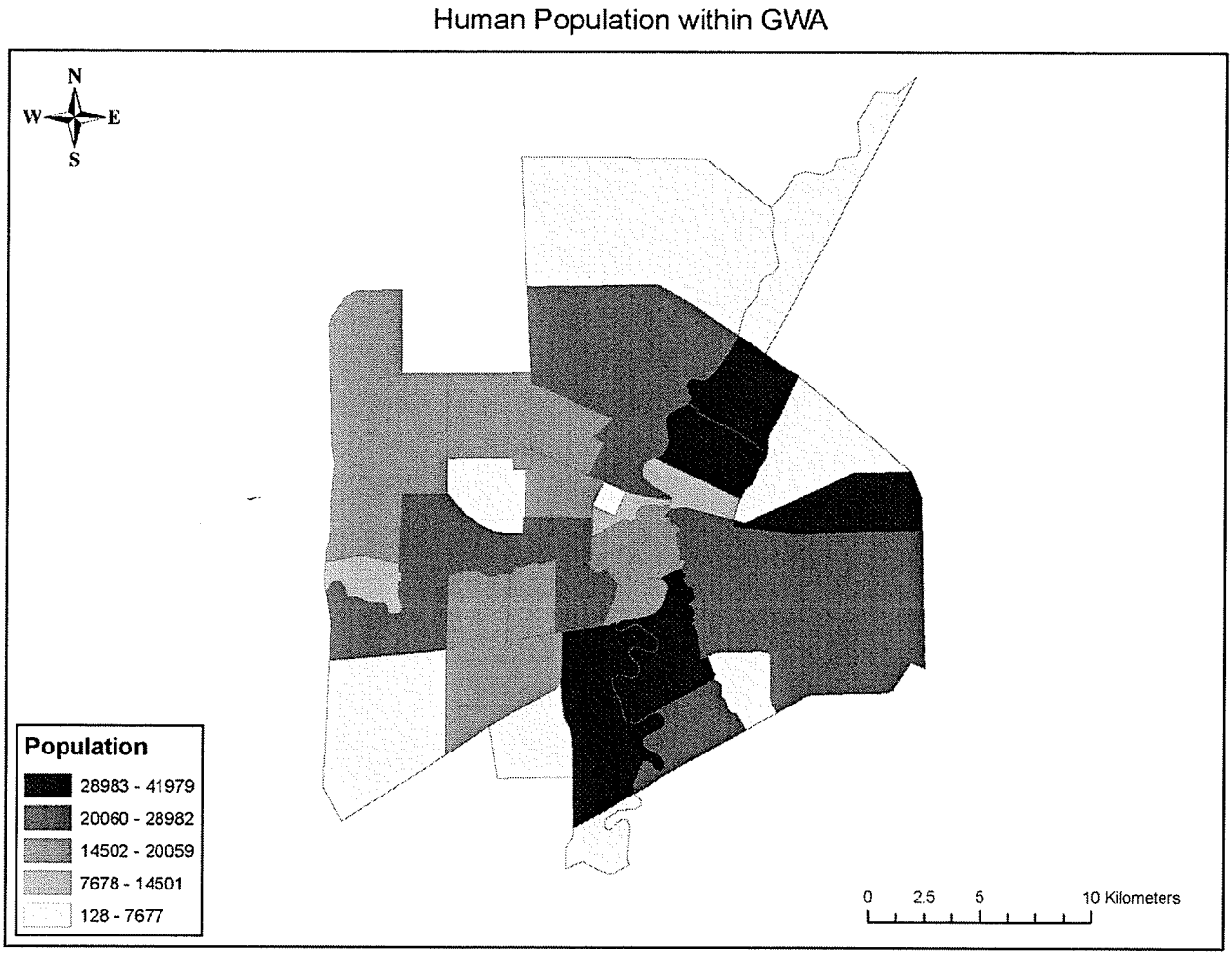
Appendix 4: Map of Study Area



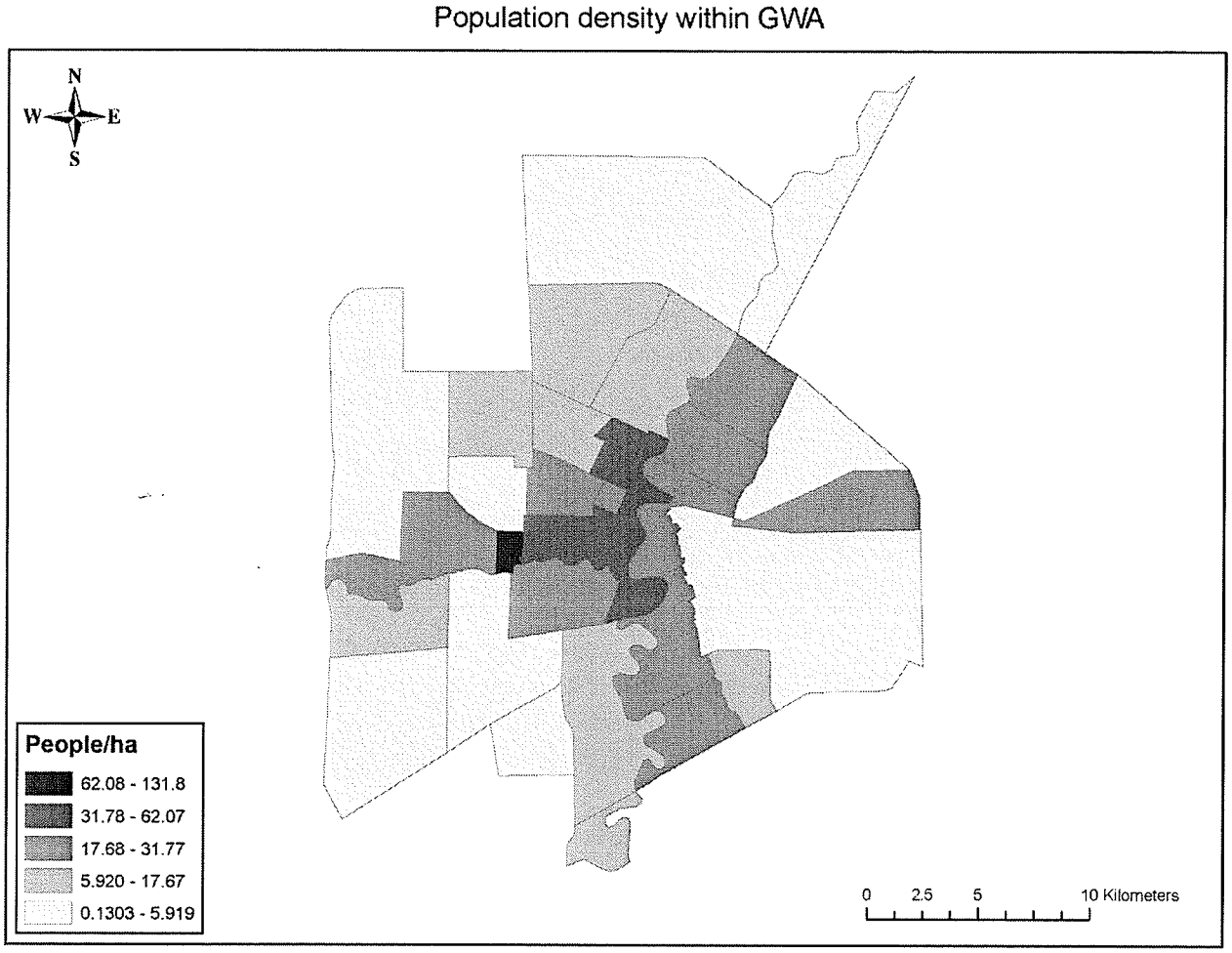
Appendix 5: GWA Land Use and Land Cover Map



Appendix 6: Map of the GWA Human Population Based on the 2006 Statistics Canada Census



Appendix 7: Map of the GWA Population Density Based on the 2006 Statistics Canada Census



Appendix 8: Survey

UNIVERSITY OF MANITOBA

# A Greater Winnipeg Area Human-Dimensions Urban Deer Management Study

Erin McCance
Department of Environment and Geography
211 Isbister Building, University of Manitoba, R3T 2N2

## ❶ START HERE:

1) **How long have you lived in Winnipeg?**
*(Please place a ✓ beside your answer)*

- ☐ Less than 5 years
- ☐ Between 5 and 25 years
- ☐ Longer than 25 years

2) **Have you seen a deer in Winnipeg in the last year?**
*(Please place a ✓ beside your answer)*

- ☐ Yes
- ☐ No
- ☐ Don't know

**If Yes, Please indicate the season in which you observed deer in Winnipeg** *(Please write out the season(s) on the space provided below: spring, summer, winter, fall)*

_____

3) **Have you seen a deer in your neighborhood in the last year?**
*(Please place a ✓ beside your answer)*

- ☐ Yes
- ☐ No
- ☐ Don't know

**If you answered yes, do you enjoy having deer in your neighborhood?**
*(Please place a ✓ beside your answer)*

- ☐ Yes
- ☐ No
- ☐ Don't know

4) **Have you seen a deer or signs of deer on your property in the last year?** *(Please place a ✓ beside your answer)*

- ☐ Yes
- ☐ No
- ☐ Don't know

5) **Do you have any of the following on your property?**
*(Please place a ✓ beside your answer(s))*

- ☐ Vegetable garden
- ☐ Flower garden
- ☐ Ornamental (managed) shrubs
- ☐ Bird feeder
- ☐ Fruit trees
- ☐ Woody shrubs
- ☐ No, I have none of these

6) **Are there parks, woods, or forested/undeveloped lands near your property that you believe are used by deer?**
*(Please place a ✓ beside your answer)*

- ☐ Yes
- ☐ No
- ☐ Don't know

**If yes, please indicate below what type(s) of landscape(s) near your home you believe is/are occupied by deer.**
*(Please place a ✓ beside your answer)*

- ☐ Agriculture
- ☐ Open field
- ☐ Woody/forested area
- ☐ City Park

7) **Do you engage in wildlife related activities?**
*(Please place a ✓ beside your answer)*

- ☐ Yes
- ☐ No
- ☐ Don't know

**If yes, please place a ✓ beside the wildlife related activity(s) you engage in below. If other, please place a ✓ beside other and indicate which wildlife related activities you engage in the space provided.**

- ☐ Photography
- ☐ Wildlife viewing
- ☐ Hiking
- ☐ Hunting
- ☐ Fishing
- ☐ Other _____

_____

8) **Have you seen a deer that has been killed by a vehicle in Winnipeg in the last year?** *(Please place a ✓ beside your answer)*

- ☐ Yes
- ☐ No
- ☐ Don't know

9) **Do you know anyone who has been involved in a deer-related vehicle accident in Winnipeg?** *(Please place a ✓ beside your answer)*

- ☐ Yes
- ☐ No
- ☐ Don't know

**10) Please indicate below your degree of interest in the following activities.** *(Please place a ✓ beside your answer)*

| Rate Questions on a scale of 1 to 5 | Not Interested | Slightly Interested | Moderately Interested | Very Interested | Don't Know |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| a. Learning more about deer | ☐ | ☐ | ☐ | ☐ | ☐ |
| b. Providing input for local deer management decisions | ☐ | ☐ | ☐ | ☐ | ☐ |
| c. Participating in deer management decisions | ☐ | ☐ | ☐ | ☐ | ☐ |
| d. Hunting deer | ☐ | ☐ | ☐ | ☐ | ☐ |
| e. Feeding deer near your home | ☐ | ☐ | ☐ | ☐ | ☐ |
| f. Seeing deer | ☐ | ☐ | ☐ | ☐ | ☐ |
| g. Photographing deer | ☐ | ☐ | ☐ | ☐ | ☐ |
| h. Watching deer near your home | ☐ | ☐ | ☐ | ☐ | ☐ |

**11) Do you know of any human-deer related conflict such as: deer overpopulation; deer-vehicle collisions; private property damage; or disease transmission in Winnipeg?**

*(Please place a ✓ beside your answer)*

☐ Yes
☐ No
☐ Don't know

**If yes, please place a ✓ beside the conflicts you are aware of.**

☐ Deer overpopulation
☐ Deer-vehicle collisions
☐ Deer disease transmission to humans and domestic pets
☐ Private property damage
☐ Personal Injury

12) **Have you or anyone in your household experienced any deer related conflict?** *(Please place a ✓ beside your answer)*

☐ Yes
☐ No
☐ Don't know

**If you answered no, please proceed to question 14. If yes, please place a ✓ beside the conflict(s) experienced. If others were experienced, please place a ✓ beside other and indicate the conflict in the space provided.**

☐ Deer related vehicle accident
☐ Private property landscape damage (flower beds, shrubs, vegetable garden, lawn damage)
☐ Deer disease transmission to humans and domestic pets
☐ Personal injury
☐ Other _____

_____

**If you have experience deer-related landscape damage, please place a ✓ beside the type of plants damaged on your property.** *(If you have not experienced any deer-related landscape damage, please proceed to the next question)*

☐ Vegetable garden
☐ Flower beds
☐ Shrubs/trees
☐ Grass
☐ Other (please specify any other deer-related landscape damage you experienced on your property in the space provide)

_____

_____

13) **Have you attempted to protect your property?** *(If you have experienced no deer-related damage on your property, please proceed to the next question, otherwise please place a ✓ beside your answer.)*

☐ Yes
☐ No
☐ Don't know

**If yes, please place a ✓ beside the type of protection you have attempted.**

☐ Barrier fencing
☐ Repellents
☐ Sound deterrents
☐ Plantings not favored by deer
☐ Screening
☐ Other (Please specify in the space provided any other types of protection you have attempted on your property)

_____

_____

14) **Do you consider deer in Winnipeg to be an esthetic resource?** *(Please place a ✓ beside your answer)*

☐ Yes
☐ No
☐ Don't know

15) **Do you consider the deer in Winnipeg to be a nuisance?** *(Please place a ✓ beside your answer)*

☐ Yes
☐ No
☐ Don't know

16) **Do you feed deer on your property?** *(Please place a ✓ beside your answer)*

- ☐ Yes
- ☐ No
- ☐ Don't know

17) **Do any of your neighbors feed deer?** *(Please place a ✓ beside your answer)*

- ☐ Yes
- ☐ No
- ☐ Don't know

18) **Do you feed any wildlife on your property?** *(Please place a ✓ beside your answer)*

- ☐ Yes
- ☐ No
- ☐ Don't know

**If yes, please place a ✓ beside the wildlife you feed on your property. If other, please place a ✓ beside other and indicate the wildlife you feed on your property in the space provided.**

- ☐ Birds
- ☐ Squirrels
- ☐ Deer
- ☐ Rabbits
- ☐ Other _____

_____

19) **Generally, how do you feel about deer in Winnipeg and in your community?** *(Please place a ✓ beside your answer)*

☐ I have no particular feelings about deer
☐ I enjoy the presence of deer AND I do not worry about deer-related conflict
☐ I enjoy the presence of deer, BUT I do worry about deer-related conflict
☐ I do not enjoy the presence of deer

20) **Please indicate below if you are concerned or not concerned about any of the following deer-related conflicts.**
*(Please place a ✓ beside your answer)*

| Rate Questions on a scale of 1 to 5 | Not Concerned | Slightly Concerned | Moderately Concerned | Very Concerned | Don't Know |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| a. Starving deer | ☐ | ☐ | ☐ | ☐ | ☑ |
| b. Aggressive deer | ☐ | ☐ | ☐ | ☐ | ☐ |
| c. Presence of deer feces | ☐ | ☐ | ☐ | ☐ | ☐ |
| d. Damage to yard plantings (i.e. flowers, shrubs, trees, vegetables) | ☐ | ☐ | ☐ | ☐ | ☐ |
| e. Damage to natural plantings (natural flowers, natural shrubs and trees) | ☐ | ☐ | ☐ | ☐ | ☐ |
| f. Deer in garbage | ☐ | ☐ | ☐ | ☐ | ☐ |
| g. Deer interaction with pets | ☐ | ☐ | ☐ | ☐ | ☐ |
| h. Deer-vehicle collisions | ☐ | ☐ | ☐ | ☐ | ☐ |
| i. Transmission of deer related diseases to people | ☐ | ☐ | ☐ | ☐ | ☐ |
| j. People's behavior toward deer | ☐ | ☐ | ☐ | ☐ | ☐ |

21) On a scale of 1-5 (5 being very concerned and 1 indicating no concern), how concerned are you about the deer population in Winnipeg? *(Please place a ✓ beside your answer)*

- ☐ 1 No concern
- ☐ 2 Slight concern
- ☐ 3 Moderate concern
- ☐ 4 Concerned
- ☐ 5 Very concerned

22) Do you believe there is a need for public education to inform Winnipeg residents of: deer biology/ecology; deer related problems; and deer management options?
*(Please place a ✓ beside your answer)*

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, please list in order of 1 being most effective to 5 being least effective method of the public education options below.

- ____ Local flyers
- ____ Neighborhood newspapers
- ____ City newspapers
- ____ Information meetings
- ____ Television information spots
- ____ Radio information spots

23) Do you believe the number of deer in Winnipeg is changing?
*(Please place a ✓ beside your answer)*

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, please place a ✓ beside the option below that best describes your belief in regard to the changes in the Winnipeg deer population size.

- ☐ Increasing
- ☐ Decreasing
- ☐ Don't know

24) Would you like to see the number of deer in Winnipeg change?
*(Please place a ✓ beside your answer)*

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, please indicate your preference below by placing a ✓ beside the deer population size changes you would like to see in regard to the Winnipeg deer population size.

- ☐ Increase
- ☐ Decrease
- ☐ Don't know

25) Several techniques have been identified to manage urban deer populations. For each statement below, ✓ the number that best reflects how acceptable to you personally are each of the following techniques. *(Please place a ✓ beside your answer)*

| Rate Questions on a scale of 1 to 5 | Not Acceptable | Slightly Acceptable | Moderately Acceptable | Very Acceptable | Don't Know |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| a. Public education | ☐ | ☐ | ☐ | ☐ | ☐ |
| b. Use high fencing to protect property | ☐ | ☐ | ☐ | ☐ | ☐ |
| c. Use contraception (birth control) for deer | ☐ | ☐ | ☐ | ☐ | ☐ |
| d. Surgically sterilize deer | ☐ | ☐ | ☐ | ☐ | ☐ |
| e. Chemical repellents | ☐ | ☐ | ☐ | ☐ | ☐ |
| f. Trap and transfer deer to another location | ☐ | ☐ | ☐ | ☐ | ☐ |
| g. Selectively cull deer | ☐ | ☐ | ☐ | ☐ | ☐ |
| h. Sharpshooting deer at bait site (donate meat to food banks) | ☐ | ☐ | ☐ | ☐ | ☐ |
| i. Regulated bow and arrow hunting within city limits | ☐ | ☐ | ☐ | ☐ | ☐ |
| j. Trap and euthanize | ☐ | ☐ | ☐ | ☐ | ☐ |
| k. Controlled hunting within designated areas within city limits | ☐ | ☐ | ☐ | ☐ | ☐ |
| l. Status quo (no management) | ☐ | ☐ | ☐ | ☐ | ☐ |
| m. Increase road safety signage | ☐ | ☐ | ☐ | ☐ | ☐ |
| n. Prohibit the feeding of deer | ☐ | ☐ | ☐ | ☐ | ☐ |
| o. Barrier fencing on troubled roadways | ☐ | ☐ | ☐ | ☐ | ☐ |
| p. Promote use of plants on private property that deer are less likely to eat | ☐ | ☐ | ☐ | ☐ | ☐ |
| q. Restrict development to preserve deer habitat | ☐ | ☐ | ☐ | ☐ | ☐ |
| r. Promote use of deer whistles on vehicles to keep deer off roadways | ☐ | ☐ | ☐ | ☐ | ☐ |

**26) Using the list of techniques from question 25, how effective do you feel each method is for managing the urban deer population? For each statement below, ✓ the number that best reflects how effective you feel each technique is.** *(Please place a ✓ beside your answer)*

| Rate Questions on a scale of 1 to 5 | Not Effective | Slightly Effective | Moderately Effective | Very Effective | Don't Know |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| a. Public education | ☐ | ☐ | ☐ | ☐ | ☐ |
| b. Use high fencing to protect property | ☐ | ☐ | ☐ | ☐ | ☐ |
| c. Use contraception (birth control) for deer | ☐ | ☐ | ☐ | ☐ | ☐ |
| d. Surgically sterilize deer | ☐ | ☐ | ☐ | ☐ | ☐ |
| e. Chemical repellents | ☐ | ☐ | ☐ | ☐ | ☐ |
| f. Trap and transfer deer to another location | ☐ | ☐ | ☐ | ☐ | ☐ |
| g. Selectively cull deer | ☐ | ☐ | ☐ | ☐ | ☐ |
| h. Sharpshooting deer at bait site (donate meat to food banks) | ☐ | ☐ | ☐ | ☐ | ☐ |
| i. Regulated bow and arrow hunting within city limits | ☐ | ☐ | ☐ | ☐ | ☐ |
| j. Trap and euthanize | ☐ | ☐ | ☐ | ☐ | ☐ |
| k. Controlled hunting within designated areas within city limits | ☐ | ☐ | ☐ | ☐ | ☐ |
| l. Status quo (no management) | ☐ | ☐ | ☐ | ☐ | ☐ |
| m. Increase road safety signage | ☐ | ☐ | ☐ | ☐ | ☐ |
| n. Prohibit the feeding of deer | ☐ | ☐ | ☐ | ☐ | ☐ |
| o. Barrier fencing on troubled roadways | ☐ | ☐ | ☐ | ☐ | ☐ |
| p. Promote use of plants on private property that deer are less likely to eat | ☐ | ☐ | ☐ | ☐ | ☐ |
| q. Restrict development to preserve deer habitat | ☐ | ☐ | ☐ | ☐ | ☐ |
| r. Promote use of deer whistles on vehicles to keep deer off roadways | ☐ | ☐ | ☐ | ☐ | ☐ |

27) **Which two deer management strategies in Question 25 do you think are the most appropriate strategies for reducing problems people experience with deer in the Greater Winnipeg Area?**
*(Please place a letter beside your answer)*

_____ Most appropriate deer management strategy
_____ Second most appropriate deer management strategy

28) **Which two deer management strategies in Question 25 do you think are the least appropriate strategies for reducing problems people experience with deer in the Greater Winnipeg Area?**
*(Please place a letter beside your answer)*

_____ Least appropriate deer management strategy
_____ Second least appropriate deer management strategy

29) **Do you believe the deer population in Winnipeg needs to be managed?** *(Please place a ✓ beside your answer)*

☐ Yes
☐ No
☐ Don't know

**If you answered yes, please indicate why?** _____

_____

30) People have a number of reasons for choosing one management strategy over another. Please indicate below how important each of the following reasons is to you when you consider how deer should be managed in the Greater Winnipeg Area.

*(Please place a ✓ beside your answer)*

| Rate Questions on a scale of 1 to 5 | Not Important | Slightly Important | Moderately Important | Very Important | Don't Know |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| a. Effectiveness at reducing deer-related problems | ☐ | ☐ | ☐ | ☐ | ☐ |
| b. Minimizes deer suffering | ☐ | ☐ | ☐ | ☐ | ☐ |
| c. Minimizes human health and safety risks | ☐ | ☐ | ☐ | ☐ | ☐ |
| d. Proven effective in other cities | ☐ | ☐ | ☐ | ☐ | ☐ |
| e. Does not involve killing deer | ☐ | ☐ | ☐ | ☐ | ☐ |
| f. Is effective at reducing deer population | ☐ | ☐ | ☐ | ☐ | ☐ |
| g. Shorter time to achieve population reduction | ☐ | ☐ | ☐ | ☐ | ☐ |
| h. Minimizes your personal costs | ☐ | ☐ | ☐ | ☐ | ☐ |
| j. Is supported by the public majority | ☐ | ☐ | ☐ | ☐ | ☐ |
| j. Minimizes spending public funds | ☐ | ☐ | ☐ | ☐ | ☐ |
| k. Minimizes disruption of resident's daily lives | ☐ | ☐ | ☐ | ☐ | ☐ |
| l. Minimizes use of firearms within city limits | ☐ | ☐ | ☐ | ☐ | ☐ |
| m. Minimizes use of bow and arrows within city limits | ☐ | ☐ | ☐ | ☐ | ☐ |
| n. Maintains a healthy deer population within city limits | ☐ | ☐ | ☐ | ☐ | ☐ |
| o. Minimizes side effects on deer | ☐ | ☐ | ☐ | ☐ | ☐ |
| p. Does not require an increase in taxes | ☐ | ☐ | ☐ | ☐ | ☐ |

31) Please rank in order, using each number only once, the effectiveness of the following methods to gather public input for decisions about deer management in the Greater Winnipeg Area. *(Please place a number beside each method.)*

1= Very effective
2= Effective
3= Moderately effective
4= Slightly effective
5= Not effective

____ Open public meetings
____ Citizen committees representing various interest groups
____ Scientific telephone and mail survey
____ Meetings open to select groups and invited individuals
____ No public input should be used

32) Who do you believe should create the City of Winnipeg urban deer management plan? *(Please place a ✓ beside your answer)*

☐ Winnipeg residents
☐ Residents and government
☐ Manitoba Government
☐ City of Winnipeg
☐ Other

If you answered other, please describe: _____

_____

Background Information:

33) In what year were you born? 19 _____

34) Are you male or female? *(Please place a ✓ beside your answer)*

☐ Male
☐ Female

**35) Please indicate your marital status below.**
*(Please place a ✓ beside your answer)*

- ☐ Single
- ☐ Common-law
- ☐ Married
- ☐ Divorced

**36) How many people in your household?**
*(Please place a ✓ beside your answer)*

- ☐ 1 person
- ☐ 2 people
- ☐ 3 people
- ☐ 4 people
- ☐ 5 or more people

**37) How many children do you have?**
*(Please place a ✓ beside your answer)*

- ☐ No children
- ☐ 1 child
- ☐ 2 children
- ☐ 3 children
- ☐ 4 or more children

**38) What is the highest level of formal education you have completed?**
*(Please place a ✓ beside your answer)*

- ☐ Some high school
- ☐ High school diploma
- ☐ Some University and/or technical school
- ☐ University undergraduate degree (e.g. B.S., B.A.)
- ☐ University graduate degree (e.g. M.S., Ph.D., M.D.)
- ☐ Other (Please specify in the space provided)

_____

_____

39) Would you like to be informed of the summary of the findings of this study by email? Again, this information is strictly confidential and will never be associated with your name.
*(Please mark a ✓ beside your answer)*

☐ Yes
☐ No

If yes, please indicate your email address in the space provided.

Email Address:
_____

Please use the space provided below for any additional comments you may wish to make.

**Thank you for your time and effort!** To return this questionnaire, simply place it within the return envelope, seal it, and drop it in the mail (return postage has been provided).

Appendix 9: First Mail Out Cover Letter

UNIVERSITY OF MANITOBA | Department of Environment and Geography

[illegible] Building
Winnipeg, Manitoba
Canada, R3T 2N2
General Office (204) 474-9867
Fax: 474-7699

September 1, 2008

Hello, I am from the University of Manitoba and I am writing to ask for your participation in a self-administered survey of a random broad-based selection of Greater Winnipeg Area (GWA) residents. This research is being conducted in the hope of learning more about GWA residents' attitudes, concerns, and preferences toward the urban white-tailed deer population and potential urban white-tailed deer management options. This study has been approved by the Joint Faculty Research Ethics Board. Results from this survey will contribute to my Master's thesis. In addition, survey results will provide valuable information to those interested in reducing human-deer conflict and the health and safety of humans and deer. I am asking for your help to better understand what your values are toward urban deer and urban deer management.

Your participation in this survey is voluntary. However, your opinions, and values are extremely important and your participation will help my research very much. The survey will take you approximately 20 minutes to complete. You are under no obligation to participate and you may stop at any time. A postage paid return envelope is provided with this survey. Should you choose to participate, simply complete the survey, fold lengthwise down the center, insert into the return envelope provided, and place in the mail. In order to balance demographics, I am requesting that the respondent to this survey be the individual in the household who is over 18 and whose birthday is next to occur.

**Your responses are confidential.** All records will be kept in a locked filing cabinet and will be released only as study summaries in which no individual responses can be identified. There will be a tracking number on the survey that will allow me to identify the respondent in order to remove you from the mailing list. Once you return your survey, your name will be deleted from the mailing list. Upon completion of the study only raw data will be kept and all contact information will be destroyed. In appreciation, and as a way of saying thank you for your help, all respondents will be placed in a **draw to win a weekend for two at the Radisson Hecla Oasis Resort, valued at $400!** The draw will be conducted November 1, 2008.

Your completion of this survey indicates that you have understood the information regarding your participation in this research study. In completing this survey you in no way waive your legal rights nor release the researcher, sponsor, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time, and/or you may refrain from answering any questions you prefer to omit, without consequence or prejudice. You should feel free to ask for clarification or new information throughout your participation. Should you have any questions or comments about this study, you may contact me via email at emccance@shaw.ca or you may contact the Human Ethics Secretariat at (204) 474-7122 or email Margaret_bowman@umanitoba.ca. I would like to acknowledge the support of the University of Manitoba, Manitoba Conservation, and the Manitoba Wildlife Federation. Thank you for being a part of this important research.

Sincerely, Erin C. McCance, Graduate Researcher

## Appendix 10: Postcard Thank you/Reminder

Two weeks ago a questionnaire seeking your opinions about the Winnipeg urban deer population and potential urban deer management was mailed to you. Your name was randomly generated from a list of Greater Winnipeg Area residents.

If you have already completed and returned the questionnaire, please accept my sincere thanks. If you have not had a chance to complete and return the questionnaire, please do so today. It is only with your help that this research will be successful.

If you did not receive a questionnaire, or if it was misplaced, please email me at emccance@shaw.ca and I will place another copy of the survey into the mail for you today.

Don't forget, in appreciation, and as a way of saying thank you for your help, all respondents will be placed in a **draw to win a weekend for two at the Radisson Hecla Oasis Resort, valued at $400!** The draw will be conducted November 1, 2008.

Sincerely,

Erin McCance

Graduate Researcher

*The Greater Winnipeg Area Human Dimensions Urban Deer Management Study*

*(Recipient's Address)*
*Joe Smith*
*11 Joe Smith Street*
*Winnipeg, MB*
*R3T 3Y1*

Appendix 11: Final Mail Out Cover Letter

UNIVERSITY OF MANITOBA | Department of Environment and Geography

[illegible]
Winnipeg, Manitoba
Canada, R3T 2N2
General Office (204) 474-9867
Fax 474-7699

October 15, 2008

Hello, approximately six weeks ago, I sent out a questionnaire to you that asked for your opinions of the Winnipeg urban deer population and of potential urban deer management options. To the best of my knowledge the survey has not yet been returned. I am writing again because of the importance that your questionnaire has to the overall accuracy of my results. The results of this study will contribute to my Master's thesis and will provide valuable information to those interested in reducing human-deer conflict. I have enclosed another copy of the original survey in case you may have misplaced the original.

Your participation in this survey is voluntary. However, your opinions, and values are extremely important and your participation will help my research very much. The survey will take you approximately 20 minutes to complete. You are under no obligation to participate and you may stop at any time. A postage paid return envelope is provided with this survey. Should you choose to participate, simply complete the survey, fold lengthwise into the return envelope provided, and place in the mail. In order to balance demographics, I am requesting that the respondent to this survey be the individual in the household who is over 18 and whose birthday is next to occur.

**Your responses are confidential.** All records will be kept in a locked filing cabinet and will be released only as study summaries in which no individual responses can be identified. There will be a tracking number on the survey that will allow me to identify the respondent in order to remove you from the mailing list. Once you return your survey, your name will be deleted from the mailing list. Upon completion of the study only raw data will be kept and all contact information will be destroyed. In appreciation, and as a way of saying thank you for your help, all respondents will be placed in a **draw to win a weekend for two at the Radisson Hecla Oasis Resort, valued at $400!** The draw will be conducted November 1, 2008.

Your completion of this survey indicates that you have understood the information regarding your participation in this research study. In completing this survey you in no way waive your legal rights nor release the researcher, sponsor, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time, and/or you may refrain from answering any questions you prefer to omit, without consequence or prejudice. You should feel free to ask for clarification or new information throughout your participation. Should you have any questions or comments about this study, you may contact me via email at emccance@shaw.ca or you may contact the Human Ethics Secretariat at (204) 474-7122 or email Margaret_bowman@umanitoba.ca. I would like to acknowledge the support of the University of Manitoba, Manitoba Conservation, and the Manitoba Wildlife Federation.

I hope you will fill out and return the questionnaire so your values and opinions can be included in this important study. Thank you for being a part of this important research.

Sincerely, Erin C. McCance, Graduate Researcher

Appendix 12: Non-Response Bias Telephone Interview

Non-Response Bias Follow-up Telephone Interview Questions

Good (Morning, Afternoon, Evening):

My name is Erin McCance and I am a graduate student from the University of Manitoba. I am calling you in regard to a survey that was mailed to your household recently asking you for your opinions of the Winnipeg urban deer population and potential urban deer management options.

The survey was mailed to the adult of your household whose birthday is next to occur. Would that be you or someone that I may be able to speak with? *(If this individual is unavailable, I will ask for his/her name and the best time that I can call back)*

I recognize that you may have been too busy to complete the survey that was mailed to you but I want to include the opinions of everyone, even those that may not be interested in urban deer. Would you be willing to answer a few questions from the survey now? This will only take about 5 minutes of your time. *(If no, I will ask if there is a more convenient time that I can call back)*

If Yes:

1) Have you ever experienced any conflict with deer? (e.g. deer-vehicle collision, private property damage such as deer eating flower beds or shrubs on your property)

☐ Yes

☐ No

☐ Don't know

If No, proceed to question 3. If yes, I will ask question 2.

2) What type of conflict have you experienced with deer?

☐ Deer-vehicle collision

☐ Private property damage

☐ Disease transmission to domestic pets or people you know

☐ Personal Injury

☐ Other

3) Do you feed any wildlife on your property?

☐ Yes

☐ No

☐ Don't know

If yes, please indicate what species of wildlife you feed on your property.

_____

**4) I am going to list off a number of possible deer-related concerns. Please indicate if you are concerned or not concerned for each of the following statements:**

a. Sick or starving deer

b. Aggressive deer

c. Presence of deer feces

d. Damage to yard plantings (flowers, shrubs, trees, vegetables)

e. Deer in garbage

f. Deer interaction with pets

h. Deer-vehicle collisions

i. Transmission of deer related diseases

j. People's behavior toward deer

k. the Winnipeg urban deer population overall

**5) Would you like to see the number of urban deer in Winnipeg change?**

☐ Yes

☐ No

☐ Don't know

**If yes, please indicate your preference of the change in deer population size you would like to see. (If no, I will move on to question 6)**

☐ Increase

☐ Decrease

☐ Don't know

6) Do you believe there is a need for public education to inform Winnipeg residents of: deer biology, deer ecology, deer-related problems, and deer management options?

☐ Yes

☐ No

☐ Don't know

If yes, please indicate which of the following options you think is the most effective way to educate the public. (If no, I will move onto question 7)

☐ Local Flyers

☐ Neighborhood newspapers

☐ City newspapers

☐ Information meetings

☐ Television information spots

Which do you think is the least effective method of educating the public from that list?

_____

7) Do you believe the deer population in Winnipeg needs to be managed?

☐ Yes

☐ No

☐ Don't know

**8) There are several techniques that have been suggested for managing urban deer populations. Please indicate whether you find each of the following acceptable or not acceptable. You may say you don't know to any statement below.**

a. Public education

b. Use of high fencing to protect property

c. Use contraception (birth control) for deer

d. Surgically sterilize deer

e. Chemical repellents

f. Trap and transfer deer to a new location

g. Selectively cull deer

h. Sharpshooting deer at bait sites (donate meat to food banks)

i. Regulated bow and arrow hunting within city limits

j. Trap and Euthanize deer

k. Controlled hunting within designated areas within city limits

l. Status quo (no management)

m. Increase road safety signage

n. Prohibit the feeding of deer

o. Barrier fencing on troubled roadways

p. Promote the use of plants on private property that deer are less likely to eat

q. Restrict development to preserve deer habitat

r. Promote the use of deer whistles on vehicles to keep deer off roadways

**9) Who do you believe should create the urban deer management plan?**

☐ Winnipeg residents

☐ Residents and government

☐ Manitoba Government

☐ City of Winnipeg

**10) How many years have you lived in Winnipeg?**

_____

**11) What year were you born?**

_____

**12) Do you have any children? If so, how many?**

_____

**13) What is your highest level of formal education?**

☐ Some high school

☐ High School diploma

☐ Some University and/or technical college

☐ University degree (e.g. B.S., B. A.)

☐ University graduate degree (e.g. M.S. Ph.D., M.D.)

☐ Other

Do you have any comments you wish to add?

Thank you for taking the time to speak with me today! (End of interview)

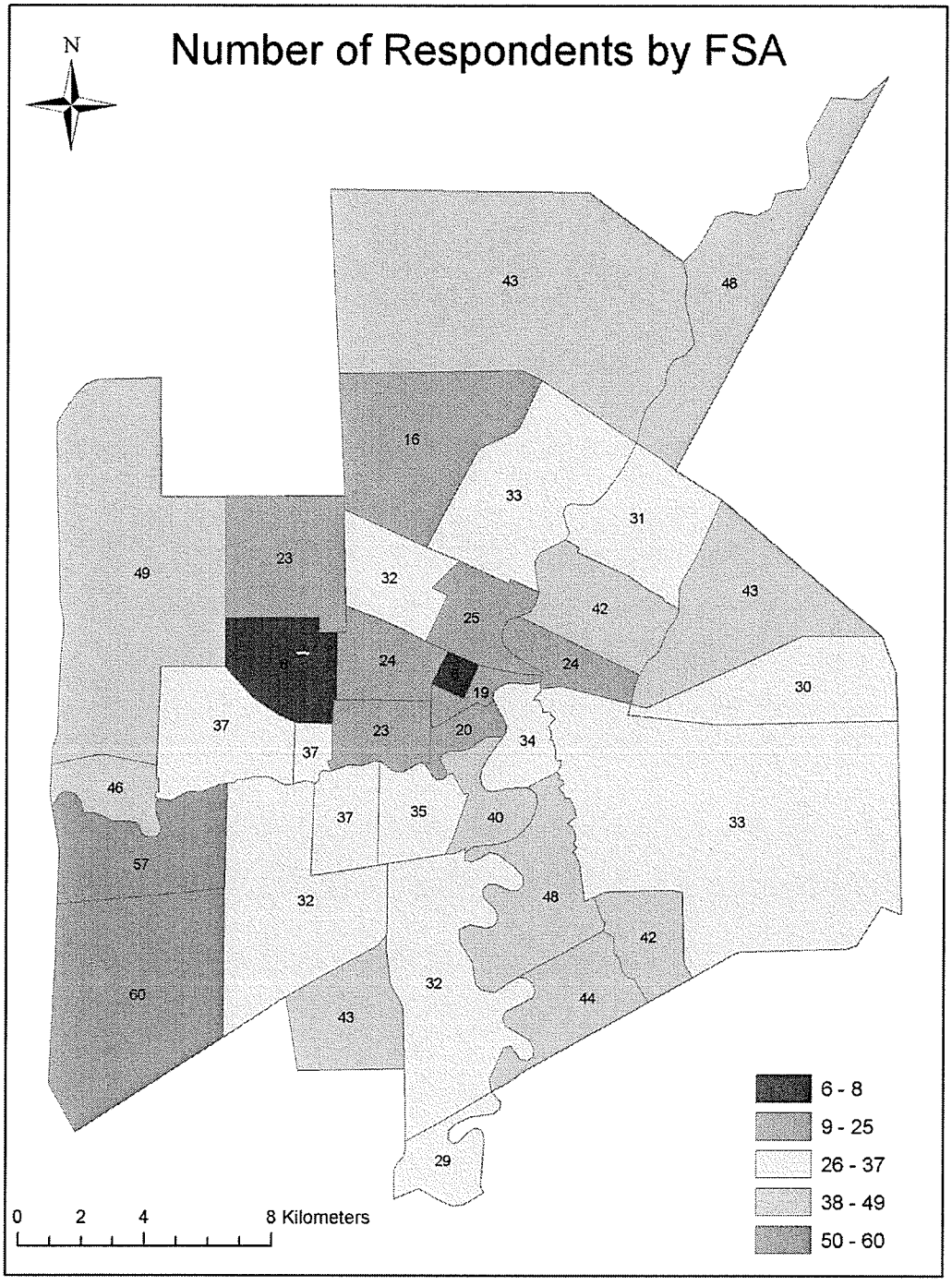
14) Enter in the sex of the respondent

☐ Male

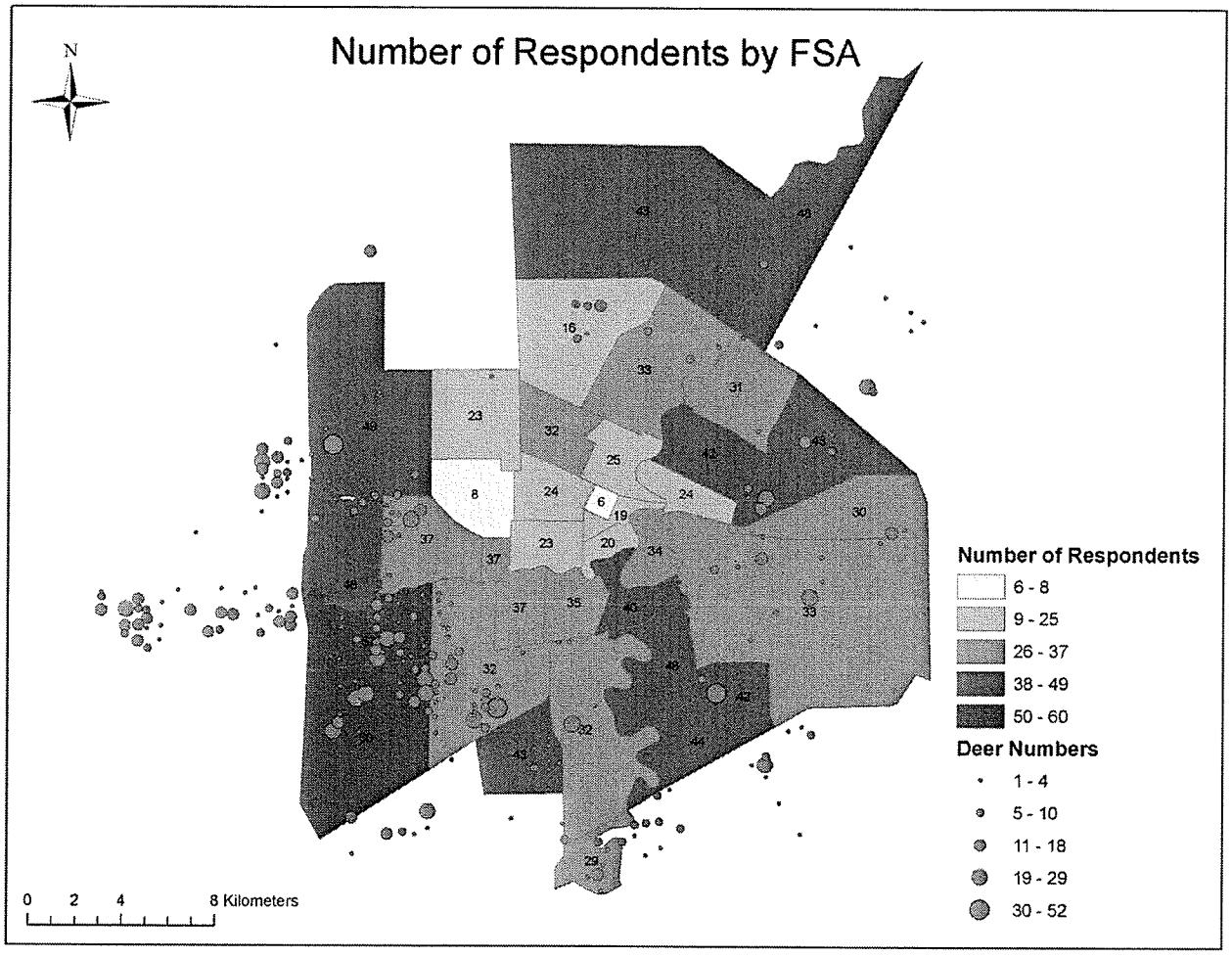
☐ Female

☐ Unsure

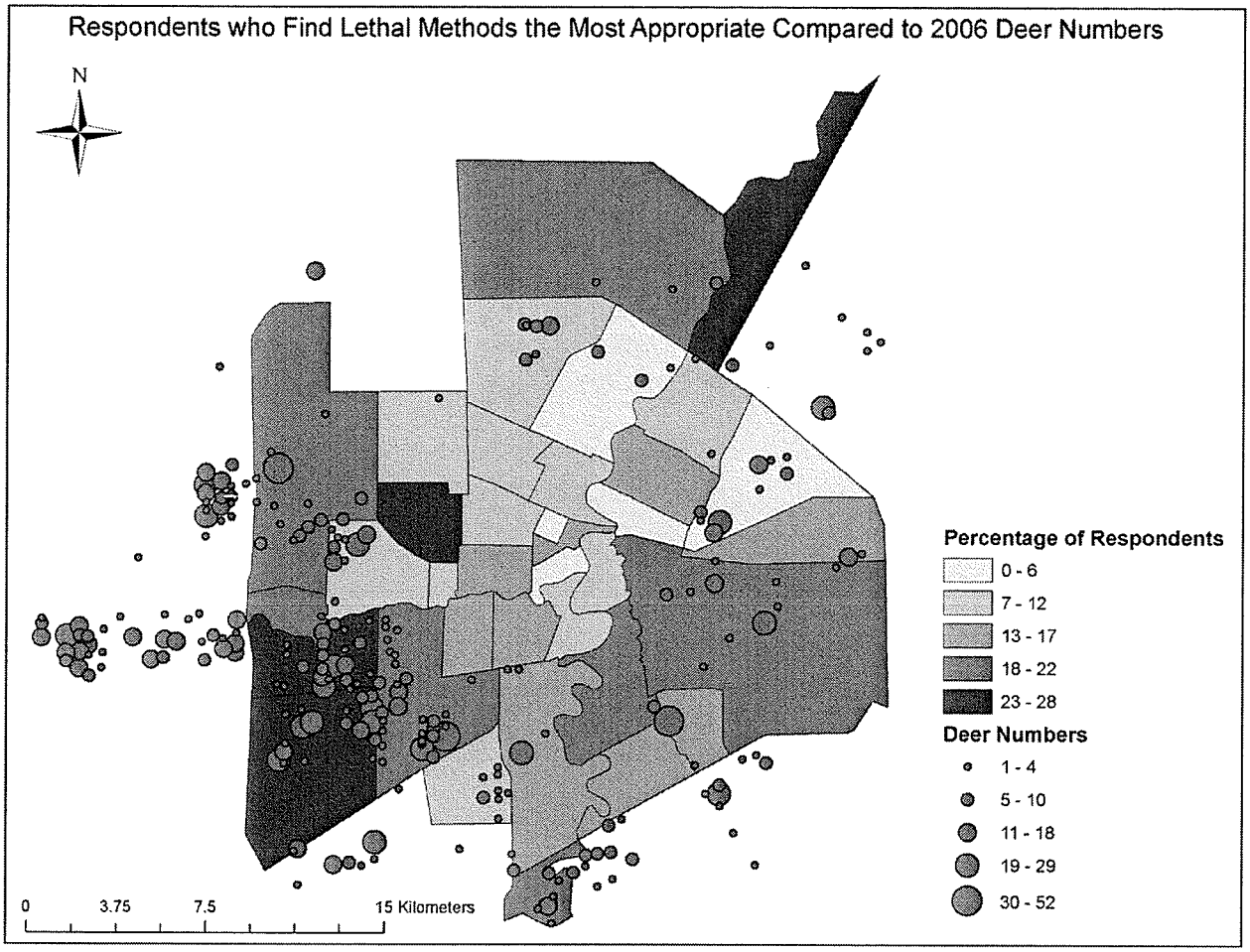
Appendix 13: Number of Respondents by FSA



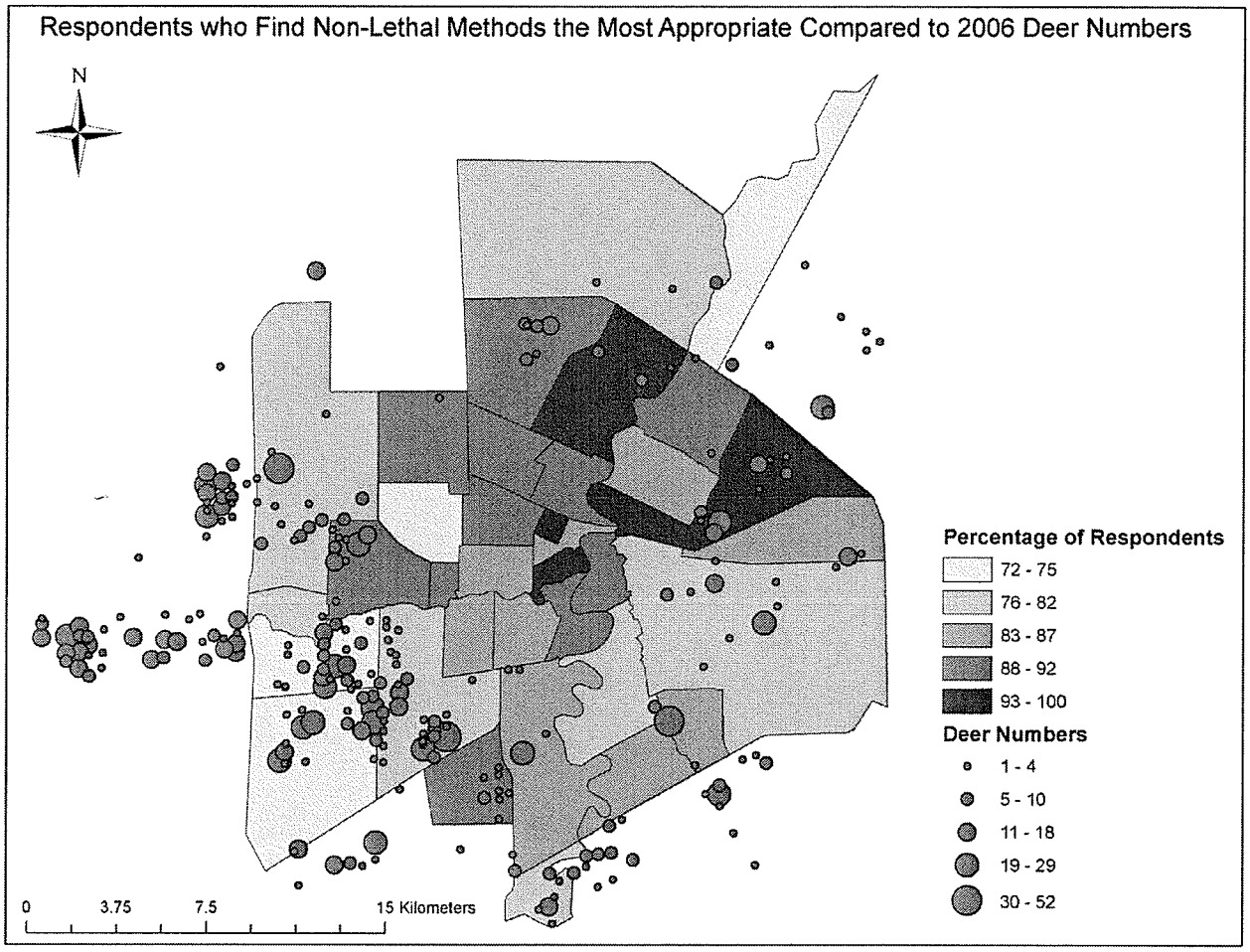
Appendix 14: Number of Respondents by FSA Compared to 2006 Deer Numbers



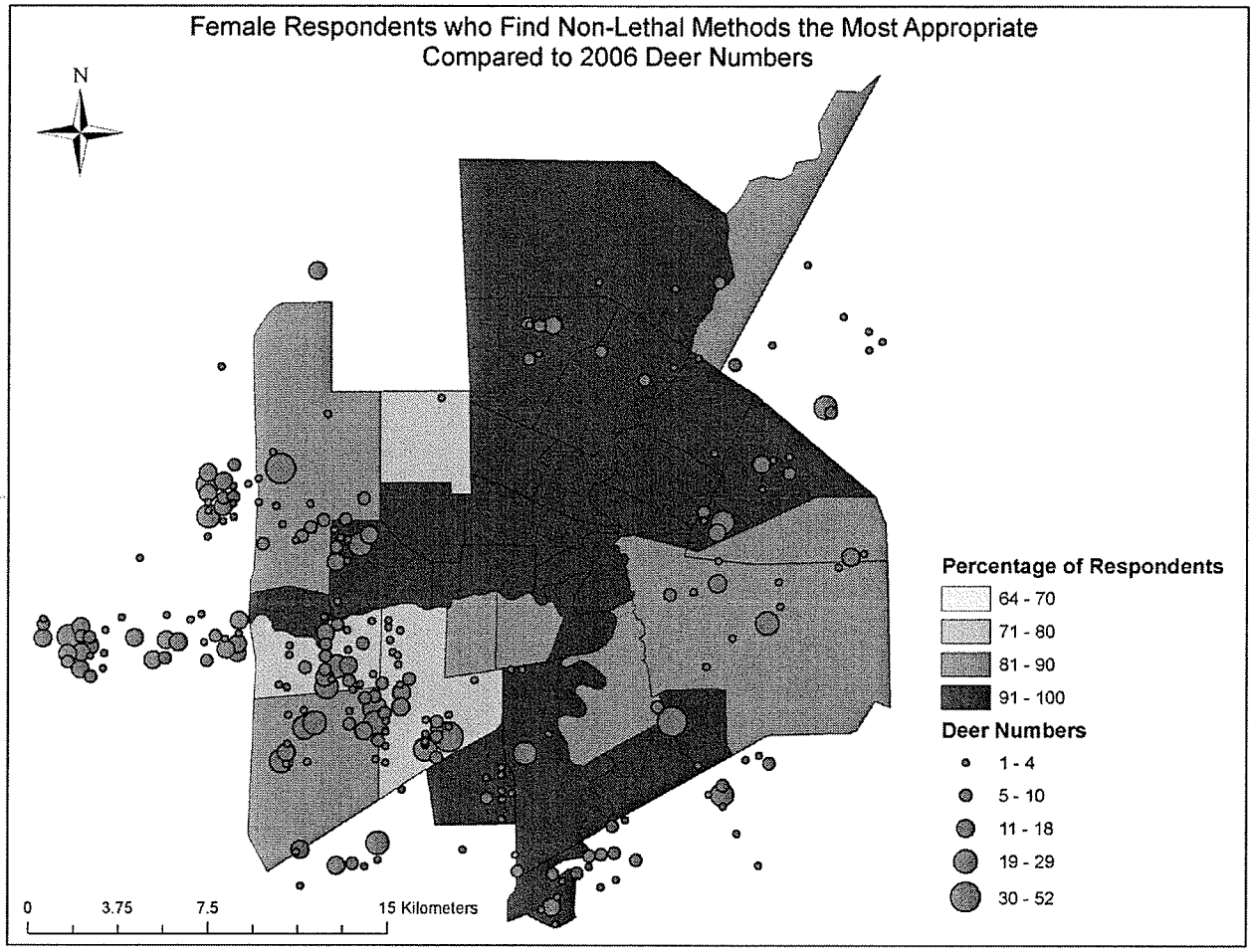
Appendix 15: Percentage of Respondents Finding Lethal Methods of Action the Most Appropriate Compared to 2006 Deer Numbers



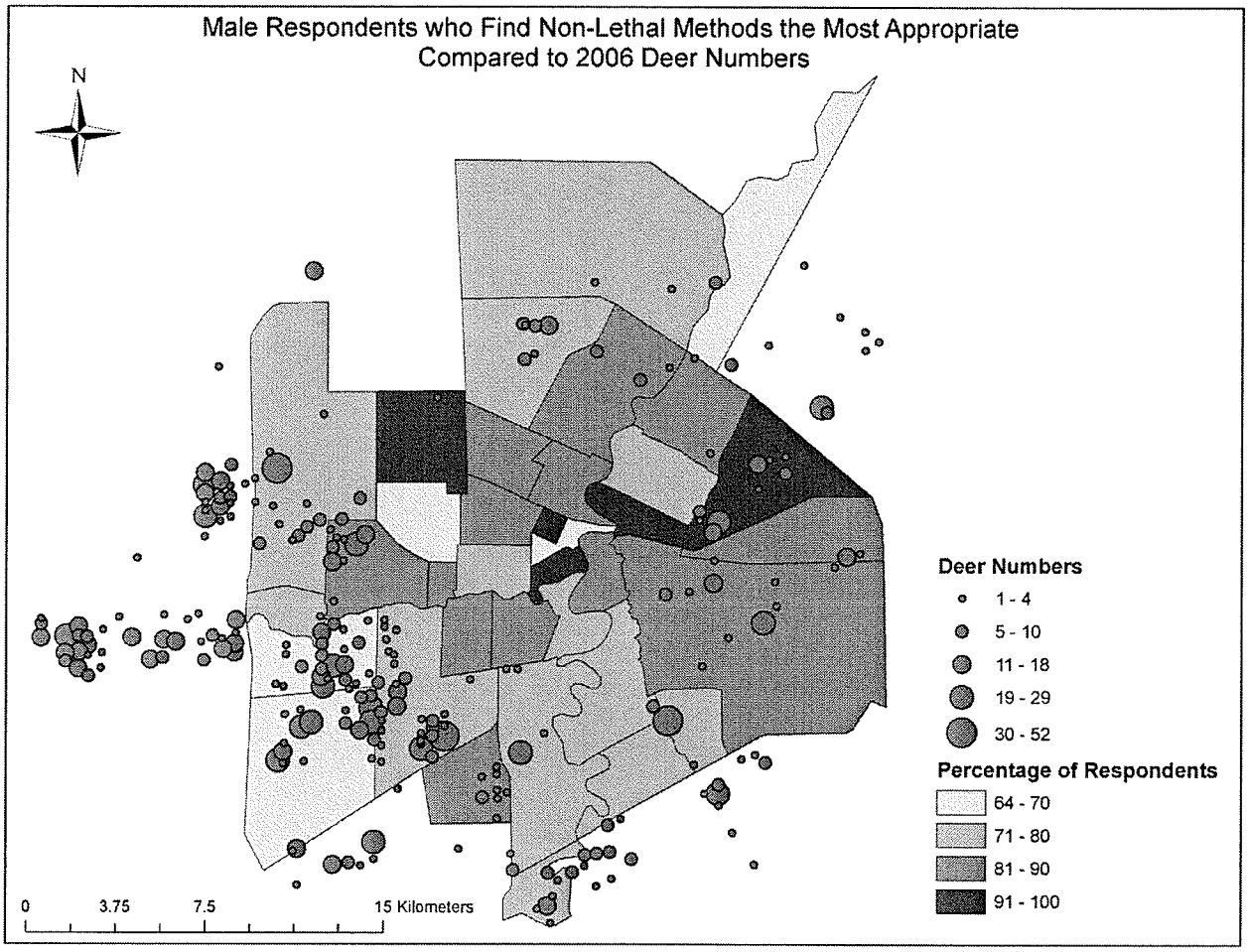
Appendix 16: Percentage of Respondents Finding Non-Lethal Methods of Action the Most Appropriate Compared to 2006 Deer Numbers



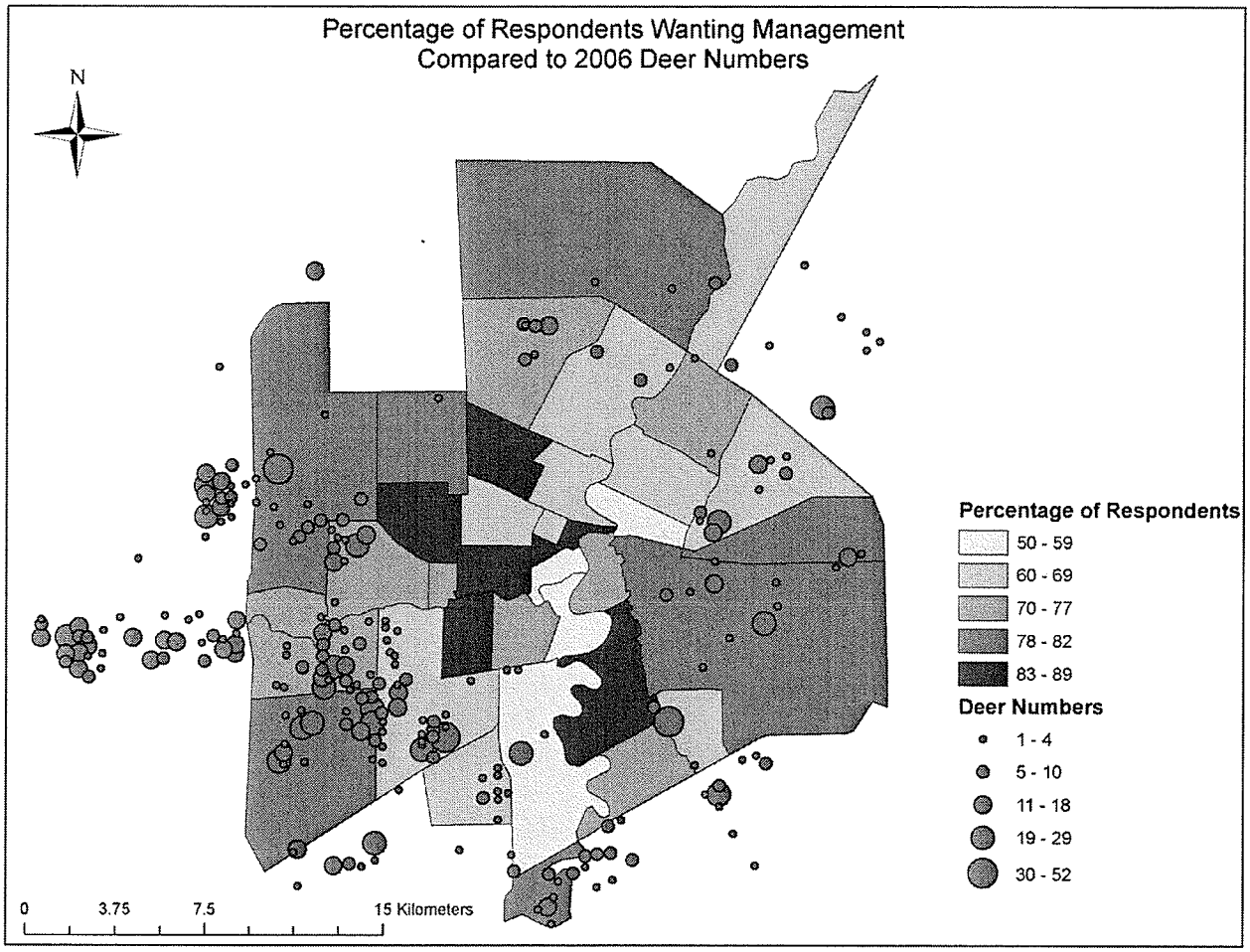
Appendix 17: Female Respondents Finding Non-Lethal Methods of Action the Most Appropriate



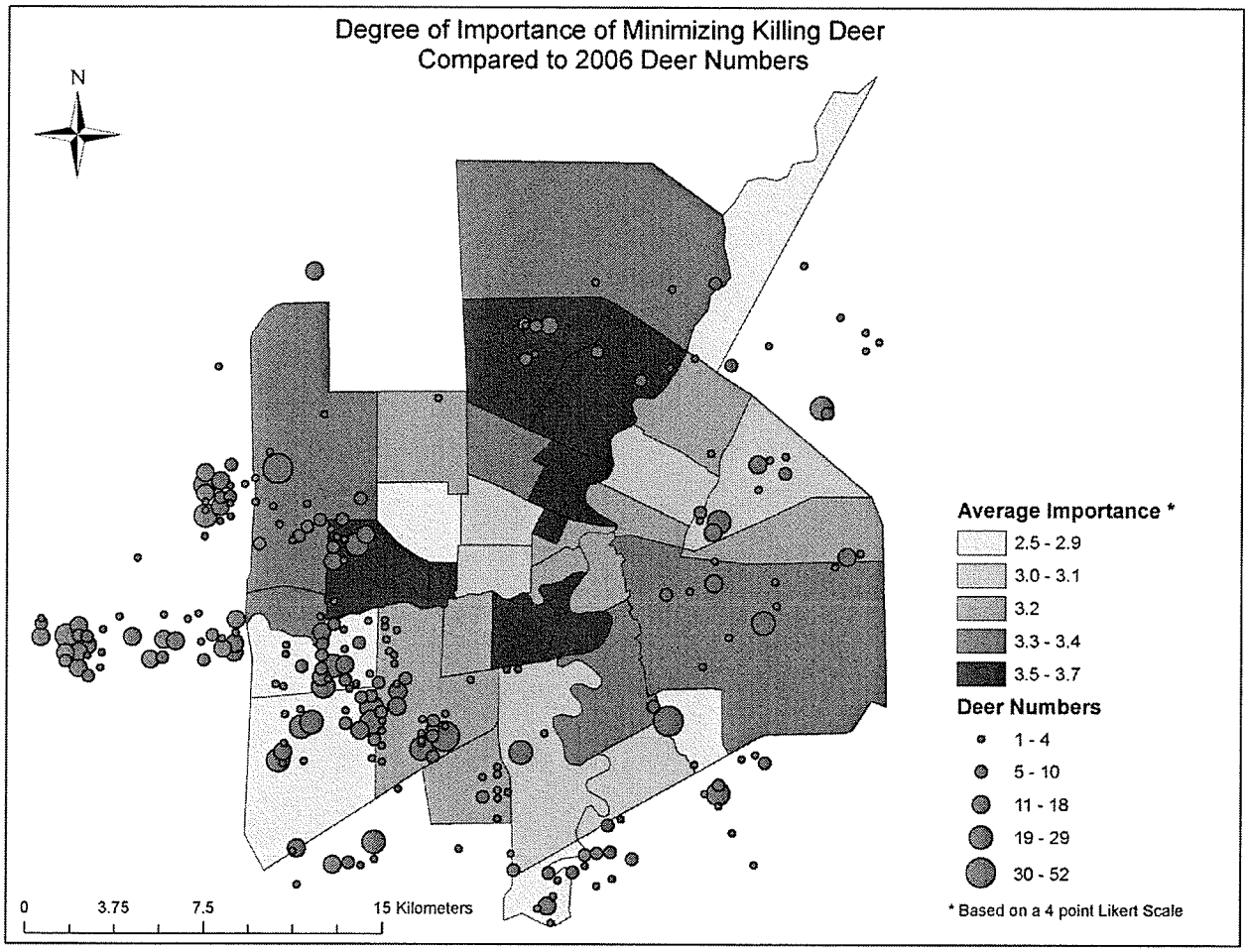
Appendix 18: Male Respondents Finding Non-Lethal Methods of Action the Most Appropriate



Appendix 19: Percentage of Respondents Wanting Urban Deer Management Compared to 2006 Deer Numbers



Appendix 20: Degree of Importance of Minimizing the Killing of Deer Compared to 2006 Deer Numbers



Appendix 21: Degree of Importance of Minimizing the Use of Firearms within City Limits Compared to 2006 Deer Numbers