UNDERSTANDING HUMAN-CARNIVORE CONFLICT
A JOURNEY TOWARDS COEXISTENCE WITH WOLVES

BY

LYNN A. REMMELGAS

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ABSTRACT

This thesis is intended to help develop a better understanding towards wolves and their management and aid in finding a balance between the needs and activities of humans and the needs of wolves in order to promote coexistence. Two studies were conducted; (i) a measurement of attitudes towards wolves and wolf management and (ii) a livestock depredation case studies near a wolf protected zone. The attitudes studies included hunter status (X^2=42.255, $p<0.001$), perception of moose (X^2=8.768, $p=0.033$) and deer populations (X^2=25.462, $p<0.001$), and distance from wolf territory (X^2=6.089, $p= 0.014$) as predictors of agreement levels. Those living further from a wolf territory had more positive attitudes towards awolf harvest ban (r_s= -0.625, $p<0.001$). The livestock depredation study indicated that livestock farms located further from wolf protected zone had lower frequencies of attacks (r_s= -0.596, $p=0.001$). It also revealed that farms with larger herd sizes (r_s=0.50, $p=0.007$) and farms located further away from major highways (r_s= 0.440, $p = 0.019$) had more livestock attacks. Farms with higher overall farm management risk scores (r_s=0.438, $p=0.023$) also had higher frequencies of attacks. Efforts to improve public support should focus on groups having shared values, such as hunters, people affected by human-wolf conflict and such as those living nearest wolf territories, because they tend to have the most negative attitudes towards wolves. Raising tolerance to predators through education, co-management and targeted compensation programs may help lessen the burden on those most affected.

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DEDICATION

To Samantha, Andrea and Jeff, you are my inspirations and to Shawn, who will always be in my heart and live on in my memories.

"In those days, we had never heard of passing up a chance to kill a wolf.....I thought......that no wolves would mean hunters' paradise.....Since then I have lived to see state after state extirpate its wolves....I have seen every edible bush and seedling browsed, first to anemia desuetude, and then to death....I now suspect that just as a deer herd lives in mortal fear of its wolves, so does a mountain live in mortal fear of its deer....Perhaps this is the hidden meaning in the howl of the wolf, long known among mountains, but seldom perceived among men." (Leopold, 1949).

"Our treatment of the wolf measures the scope of our own place in the world, with respect to the landscape and with respect to the human and nonhuman inhabitants with whom we share that world." (Weiss, Haney, Kroeger, & Fascione, 2007)

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CHAPTER 1

INTRODUCTION

1.1. GENERAL INTRODUCTION

Since European immigrants settled in North America, many large carnivores such as wolves, coyotes, bears and cougars were considered undesirable because they interfered with human activities and threatened human safety. The distribution and numbers of large carnivores was significantly reduced by the twentieth century, a result of direct killing and habitat destruction. Declines were less severe in northern Canada and Alaska than in the contiguous United States (Miller, McLellan & Derocher, 2013). In order to protect and preserve remaining large carnivore populations, conservation programs and protective legislation have been instigated in many areas however significant conflict has resulted among humans having differing values and beliefs about the way in which large carnivores are managed.

After centuries of persecution, wolf populations declined at alarming rates across North America; only escaping extinction as a result of legal action. In the last century, many populations of wolves have since recovered, contributing to additional conflict situations (Mech & Boitani, 2003; Treves et.al. 2004), and threatening to hamper conservation efforts. The main focus of this thesis is on wolves and their conservation in Ontario. Coyotes are also briefly discussed because of their entwined relationships with wolves and the difficulties in differentiating the two species in some Ontario regions without DNA testing. It is for this reason that both wolves and coyotes are grouped together under law in certain parts of Ontario. This thesis examines the role of wolves in ecosystem function, human attitudes towards wolves and wolf management and livestock depredation from both wolves and coyotes near Algonquin Provincial Park, Canada.

1.2. THE WAR AGAINST WOLVES IN NORTH AMERICA

"History has demonstrated that societal values ultimately determine the survival of species such as the wolf"(Musiani & Paquet, 2004)

Large carnivores are endangered worldwide; however there has been none so problematic as the wolf (Wayne & Hedrick, 2011). Wolf conservation and control in North America has varied over the last 400 years, from total persecution, including open hunting, government culls and bounties to the other end of the spectrum, absolute protection where numbers are critically low (Wayne & Hendrick, 2011).

The war against wolves in North America officially began in 1609 in Virginia, USA, coinciding with the arrival of the first European livestock. Wolf bounties were enacted in multiple areas and by 1700 the gray wolf (*Canis lupus*) had disappeared from New England (Mech & Boitani, 2003). As human populations expanded westward, so did the livestock industry. At the same time, humans hunted bison in mass numbers and the last wild bison was thought to be killed in 1884, causing wolves to increase their livestock kills as wild prey was scarce (Mech & Boitani, 2003). The increase in human populations and subsequently agriculture across North America, initiated the severe decline in wolves and other large carnivores across the continent (Paquet & Carbyn, 2003). The war between humans and wolves raged as wolf removal efforts increased during the last quarter of the nineteenth century and through the first half of the twentieth century. In Montana for example, an estimated 100,000 wolves were killed in a 7 year period in the 1870's (Mech & Boitani, 2003). Although wolves once ranged over almost the entire North American continent, their distribution is now mostly confined to the northern half of the continent, mainly in Wyoming, Idaho, Montana and Alaska in the US and in the more northern regions of Canada (Paquet & Carbyn, 2003). The status of wolves currently varies widely by country, state and province, as does their management (Mech & Boitani, 2003).

1.3. THE ROLE OF WOLVES IN ECOSYSTEM FUNCTION

"Our treatment of the wolf measures the scope of our own place in the world, with respect to the landscape and with respect to the human and nonhuman inhabitants with whom we share that world." (Weiss, Haney, Kroeger, & Fascione, 2007)

Large carnivores such as wolves, cougars and bears play key ecological roles in the maintenance of biodiversity and ecosystem function. They function as top-level consumers of large and medium sized prey and often require expansive habitats in order to keep up with their high metabolic demands. Their needs unfortunately will often conflict with human activities. Competition with people for resources, loss of vital habitat and depletion of prey species have all been the cause of massive declines seen in large carnivore populations; however human persecution has been the most important factor in their demise (Ripple, et al., 2014). This loss of many large carnivores has broader implications than just declines in species numbers as carnivores also play a large role through top-down effects to lower trophic level species (Ripple, et al., 2014). Losses from top trophic level species can result in inverse patterns of abundance or biomass. Herbivore animal populations explode and they became relaxed to predation pressure, resulting in loss of biodiversity in plant communities (Berger, Gese, & Berger, 2008; Miller et al., 2001). Despite the importance of large carnivores to ecosystem health, their conservation remains controversial (Ordiz, Bischof, & Swenson 2013) and many carnivores are still actively persecuted by humans. In North America, the most extreme large carnivore losses occurred in the contiguous United States and Mexico, where wolves and grizzly bears lost 95-99% of the regions they originally occupied in the last century (Berger, 1999). The extent of the changes to the ecological communities occurring with top predator losses, however, is not known (Berger, 1999; Ripple et al., 2014).

The costs to ecosystem health from removal of large carnivores is only beginning to be realized; however the subsequent return of certain carnivore species by conservationists have provided excellent opportunities for scientists to study large carnivore effects on ecosystems. Situations such as the reintroduction of lions and cheetahs to parts of Africa (Berger, 1999; Hunter & Skinner, 1998) and the wolves to Yellowstone National Park, can give ecologists a better understanding of the specific ecosystem effects of removal and return (Ripple & Beschta, 2012; Weiss, Haney, Kroeger & Fascione, 2007).

Predators such as wolves can have both desirable and undesirable impacts. Negative impacts can include predation on ungulates, livestock animals, and occasionally pets, and their presence often scares humans causing lower human tolerance levels. Multiple studies have consistently shown positive impacts of wolf, and the added ecological benefits since the return of the wolves to Yellowstone translate into greater public support and tolerance for wolves (Ripple et al., 2014; Ripple & Beschta, 2012; Ritchie et al., 2012; Sergio et al., 2008). Changing attitudes about the usefulness of large carnivores in biodiversity and ecosystem health has helped conservation efforts and these animals are now frequently used as indicator, umbrella, keystone, flagship and sentinel species, subsequently benefiting entire communities through establishment of large protected areas (Ordiz et al., 2013). A change in human attitudes will translate into a greater tolerance and help change attitudes about carnivore conservation management in general.

"In those days, we had never heard of passing up a chance to kill a wolf.....I thought......that no wolves would mean hunters' paradise.....Since then I have lived to see state after state extirpate its wolves....I have seen every edible bush and seedling browsed, first to anemia desuetude, and then to death....I now suspect that just as a deer herd lives in mortal fear of its wolves, so does a mountain live in mortal fear of its deer....Perhaps this is the hidden meaning in the howl of the wolf, long known among mountains, but seldom perceived among men." (Leopold, 1949).

The wolf is considered by some to be the single most important predator in regards to ecosystem effects (Mech & Boitani, 2003). Wolves affect ecosystems through both direct [density-mediated] and indirect [trait mediated] predator-prey interactions involving multiple ecological processes (Ordiz et al., 2013). Wolves are a highly interactive species, and their absence can lead to degraded or simplified ecosystems (Ripple & Beschta, 2004; Soulé et al., 2003).When apex predators such as the wolf disappear, meso-predators can take over, creating an unbalanced design. Meso-predators are generally mammalian carnivores of intermediate body size however the term is relative to other species in their immediate habitat. Meso-predators are more prevalent when there are no larger predators to control their numbers as they occupy the trophic levels below apex predators (Soulé et al., 1988). This phenomenon is widespread, occurring in many geographical locations with many different taxonomy (Ritchie & Johnson, 2009; Soulé et al., 1988, 2003). Several studies demonstrate how meso-predator populations are controlled by apex predators. For example, coyotes were shown to be a major source of cat mortality in Southern California (Crooks & Soulé, 1999), red fox (*Vulpes vulpes*) populations were limited by lynx (*Lynx lynx*) predation in Sweden and coyotes (*Canis latrans*) were limited by Gray Wolf (*Canis lupus*) predation in Yellowstone National Park. Meso-predator release occurs through a series of chain reactions which starts with the removal of a single apex predator species causing "population explosions" of meso-predators [herbivores, smaller omnivores or smaller predators] up to four to ten times normal levels (Prugh et al., 2009; Soulé et al., 1988).

The wolf is an excellent example of how apex predators control meso-predators such as coyotes (Prugh et al., 2009; Ritchie & Johnson, 2009). The loss of wolves created mes0-opredator release across much of North America and the rest of the world, with negative impacts in multiple ecosystem types (Prugh et al., 2009). Terrestrial landscape structure was changed as populations of large game populations such as elk (*Cervus canadensis*) flourished and smaller game populations such as pronghorn antelope (*Antilocarpra americana*) quickly declined (Prugh et al., 2009). Reviving wolf populations, even in small pockets, can influence meso-predators and aid in ecosystem balance. The benefits of restored wolf populations are numerous. Wolves create two main types of cascade effects; one is through interference competition with coyotes and the second is through predation on ungulate herds (Mech & Boitani, 2003). Wolves reduce coyote numbers, in turn increasing number of foxes and other smaller mammals, hence helping to restore the natural balance (Prugh et al., 2009; Ripple & Beschta, 2012; Ritchie & Johnson, 2009) Wolves can not only reduce overabundance of coyotes, they can control overabundant populations of ungulates. Wolves influence vegetation through their effects on herd movement, reducing herbivore foraging in one place and they also cause structural changes in the herd to occur. Ungulate herd changes include having more prime age members, removal of diseased members, better overall condition and health, hence higher rate of productivity, and keener anti-predator defenses which have been waning since wolf removal (Ripple & Beschta, 2012).

Wolves increase the year round supply of carrion, and provide food for scavengers such as ravens, crows, eagles, bears, coyotes and magpies, all of which have been observed dining on wolf-kill leftovers. Wolves aid in the financial burden to farmers created by overabundance of ungulates, they provide tourism opportunities for nature-seekers and are even credited for buffering the effects of climate change (Prugh et al., 2009; Ripple & Beschta, 2004, 2012; Weiss et al., 2007). One of the most well known examples illustrating the benefits of restored wolf populations is Yellowstone National Park [YNP], where wolves were once extirpated for a period of seven decades, before their purposeful re-introduction. During their time of absence, there was a collapse of the original three level trophic cascades. With the top predators removed, the elk and other herbivore populations exploded, causing significant damage to the plant communities through intense grazing pressure(Ripple & Beschta, 2004, 2012; Weiss et al., 2007). Not only can herbivores affect plant diversity, structure, productivity and composition, overabundance of herbivores also degrades their habitat quality, making it difficult for fauna to survive (Miller et al., 2001; Ripple & Beschta, 2004, 2012). During the wolves absence in YNP, aspen (*Populus tremuloides*) and willow (*Salix spp.*) were unable to recruit young stems into the overstorey, resulting in long-term decline (Ripple & Beschta, 2012). Over a period of fifteen years, from wolf reintroduction in 1995 to 2000, the wolves were able to restore the food web to a tri-trophic system, involving predators, prey and plants, and in doing so, allowing the woody browse species such as the aspen and willow to regenerate sufficiently (Ripple & Beschta, 2012). This is but one situation in which the return of wolves to their natural habitat restored ecosystem health in ways we never could have imagined. The importance of restoring populations of large carnivores such as wolves, bears, or lions to their natural habitats, cannot be overstated however it would require substantial habitat restoration, strategic application of trophic theory and thoughtful preparation of large carnivore management plans. Restoration could potentially instigate extraordinary ecological changes to all trophic levels and help restore parts of our altered landscape. These rewards could certainly ripple across entire continents with purposeful, strategically planned human interventions.

1.4. WOLF CONSERVATION & COEXISTING WITH WOLVES

"The fate of the species is clearly in human hands; we could eradicate if we decided to"

(Fritts & Carbyn, 1995)

1.4.1. North American Model of Conservation

The wolf, like no other, has swayed people away from the core of the North American Model of Conservation and the foundation it rests upon (Organ et al., 2012). Legal arguments using wildlife as a public trust resource to leverage legal decisions are becoming frequent occurrences in courts across the continent in a desperate effort to save wolves from human persecution (Bergstrom, 2010; Bruskotter, Enzler, & Treves, 2011). The wildlife trust can help protect the wolf "by imposing a fiduciary duty on states to maintain the species for future generations" (Bruskotter et al., 2011).

As European settlers continued to arrive and people expanded across North America, and as the Industrial Revolution occurred, the urban population exploded. Market hunters attempted to satisfy the urban masses by bringing them a continual supply of wildlife goods, quickly resulting in the alteration of landscape and its wildlife. (Geist, 1988) As markets for wildlife rose to meet the needs of urban masses, hunters depleted resources in both the coastal waters and the interior forests. After the expansion of the railroad, bison, elk and other big game species were exploited. The market hunters soon left multiple species such as elk and bison at near extinction levels (Geist, 1988; Organ et al., 2012; Organ, Mahoney, & Geist, 2010). In order to stop the rampant poaching and protect what little remained of the big game species from extinction, the US Army took over the administration of Yellowstone National Park in 1886 and the conservation ethic was born (Organ et al., 2010). To follow this was a serious of events leading to a partnership between Canada and the United States with a united goal of wildlife protection (Organ et al., 2010).

In 1900, The Lacy Act was drafted, making it illegal to transport certain wildlife across state borders. In 1909, the Commission on Conservation was founded to combat resource exploitation in Canada. In 1916, The Migratory Bird Treaty was written which protected migratory birds from egg and nest collectors and also regulated bird hunting. In 1930, ecologist Aldo Leopold published the American Game Policy proposing a program to restore and aid the existing conservation laws (Leopold, 1930). Wildlife Management was promoted as a profession for biologists and by 1933 the first Wildlife curriculum was launched in the United States. In 1937, the Wildlife Society was founded and with the help of the Duck Stamp Act (1934) and the Federal Aid in Wildlife Restoration Act of 1937, sufficient funding was made available for conservation in the United States. Canada mirrored these initiatives and subsequently, the US

Endangered Species Act (1973) and the Canadian Species at Risk Act (2002) were brought into legislation (Organ et al., 2010). Both Acts are built upon three primary policies: (i) the elimination of markets for wildlife, so that there is no longer any legal trafficking in meat, parts and products of game animals (ii) The allocation of wildlife by law, where the access and use of wildlife is regulated by public laws and regulations instead of by markets, (iii) The prohibition on killing wildlife for frivolous reasons, which is deemed unacceptable. The killing of wildlife must have a practical purpose, such as for food, fur, self-defense or property protection (Geist, 1988). In 1995, Geist coined the term "North American Model of Wildlife Conservation" to describe the concept of wildlife conservation in Canada and the United States claiming it could be described as a model based on seven key principles. The formation of a continental set of conservation policies in North America was extremely successful in the recovery of wildlife and also economically productive, and is the most imitated system of wildlife conservation (Geist, 1988). A key component of the model is the concept that wildlife resources are a public trust meaning that it is owned by the public and held in trust for the benefit of the public and future generations (Geist, 1988; Geist, Mahoney & Organ, 2001; Organ et al., 2010, 2012).

Despite dramatic changes in society, the Model, which was initially focused on game species, is relevant in biodiversity conservation and it has become a system of sustainable development (Organ et al., 2012). It is important that citizens in North America have a clear understanding of the Model elements, are engaged in wildlife conservation efforts, and are included in policy development to meet the requirements for truly inclusive public trust resource management. The North American Model of Wildlife Conservation ensures that all citizens have a voice in regards to wildlife conservation and therefore it is critical they are included in the making of carnivore conservation plans.

"The flux in wolf policy and current legislation reflects an important and contentious debate about the balance between meeting human needs and conserving nature and biodiversity."

(Treves & Bruskotter, 2011)

Wolf management depends as much on sociopolitical landscapes as biological landscapes. Finding a balance that satisfies different stakeholder positions is a difficult task yet finding that balance is what conservation is all about. Attitudes towards wolf management and coexistence run along a spectrum from those that are extreme pro-wolf advocates, who fight for continued federal protection and object to any form of lethal control, to those that despise the wolf and fight for wolf removal through state wide hunting, trapping or other liberal forms of lethal removal. There are also the majority of citizens who are in the middle; those who also seek balance (Treves & Bruskotter, 2011). For those seeking balance, the notion of wildlife as a public trust is appealing. From the laws of public trust, came the wildlife trust doctrine, which is the idea that wildlife has no owners at all and therefore belongs to all citizens equally and hence, governing bodies have an obligation to ensure that wildlife resources are protected and managed responsibly; not just for the benefit of current citizens, but for future citizens as well (Bruskotter et al., 2011; Caspersen, 1996; Treves & Bruskotter, 2011). In North America, endangered species are protected under the Endangered Species Act [ESA] in the United States, and the Species at Risk Act [SARA] in Canada, with strict legislation ensuring compliance for ultimate protection of all species listed under their direction. Once a species is delisted however, the care and management moves to individual states, provinces or territories. A valid concern is that not all governing bodies will continue to adequately protect recovering species such as the wolf

(Bruskotter et al., 2011). The voices of the more extreme stakeholder groups [hunters, wildlife activists] are often more involved than other groups and may have more influence in affecting policy than less extreme stakeholder groups. The goal of conservation is to attain balance, to enhance biodiversity and to create healthy, sustainable ecosystems. It is therefore the duty of state-trustees to not privilege private interest over the general public. Trustees are required to give equal voice to all citizens when making decisions regarding wildlife as it is a required component of the public trust doctrine and a key element in the North American Conservation Model (Bruskotter et al., 2011; Organ et al., 2012; Treves & Bruskotter, 2011).

Many prior wildlife management programs have failed to adequately address the complex issues of protecting a predator species such as the wolf, resulting in substantial impairment of the species. A renewed diligence is required for new policy development which can satisfy the needs of the general public while simultaneously ensuring long term survival of the wolf. The idea of human-wolf harmonic coexistence is slowly replacing old ideals. Whether or not this is a realistic and achievable goal remains to be seen but it appears to be the best option so far. Future wolf management must be based on a better understanding of wolf ecology and on human attitudes (Treves & Karanth, 2003).

Closer examination of successful wolf management plans may reveal some novel approaches to the long standing issues that come hand in hand with the management of a predator species such as the wolf, where there is a high occurrence of conflict. Plans must be customized to suit specific areas and cultural environments. Wolf management strategies have been inconsistent across time, varying widely in their approach; ranging from full protection of species to legal hunting and other lethal control methods. The perceived threats and conflict between humans and wolves are what determine the majority of the inconsistencies; the most prevalent threat being depredation on livestock. Conservationists should therefore focus their attention on rural areas where most of the conflict occurs and where the most negative attitudes towards wolves are held for efficient management.

1.4.2. Human attitudes towards wolves and wolf management

"Human attitudes and values will continue to be the ultimate factor limiting the number and distribution of wolves in North America" (Fritts & Carbyn, 1995)

People possess a set of inherent cultural values towards animals and nature which affects their attitudes towards individual species (Kellert, Black, Rush, & Bath, 1996). A wide diversity of values associated with wolves exists. Historically, wolf persecution was not carried out through rational thinking, but instead may have reflected an urge to rid the world of the species in its entirety and these negative attitudes prevail in some communities (Kellert et al., 1996). Relatively few people have had direct positive or negative interaction with wolves yet most have strong opinions about wolves, therefore making wolf management a highly contentious issue. Wolves conflict with humans in several ways but mainly through direct competition for resources, such as livestock or wild prey (Musiani & Paquet, 2004). When human-wolf conflicts arise, very few can agree on how the conflicts should be addressed. Achieving consensus on strategies to prevent and manage human-wildlife conflicts is challenging in light of the diversity of interests. Finding specific approaches to mitigate human-wolf conflicts require consideration of the wide range of values associated with those involved in different communities.

"The motive for wiping out wolves proceeded from misunderstanding, from illusions of what constituted sport, from strident attachment to private property, from ignorance and irrational hatred" (Lopez, 1978).

There is a need for a better understanding and awareness of the nature and complexity of factors contributing to human-wolf conflicts in North America, including land use, agricultural practices and wolf management initiatives. People's attitudes are strongly influenced by the characteristics of a species (Kellert et al., 1996). The wolf is a formidable predator, sometimes revered, often feared, occasionally hated, and massively persecuted throughout all parts of the world. The very predatory behaviours which cause such human strife, is also what helps support sustainable, healthy ecosystems. This notion is just beginning to be realized and conservationists must now find ways to raise the tolerance levels for wolves in order to change perceptions about this great predator.

Attitudes are strong predictors of behaviour (Houston, Bruskotter, Fan, 2010) and people hold strong cultural bias against wolves which is apparent from their history of high levels of persecution compared with other large carnivores (Suryawanshi, Bhatnagar, Redpath, & Mishra, 2013). Perceptions are strongly influenced by personal interactions with wolves, including the way they are managed by government agencies (Kellert et al., 1996). Often, people living in wolf territories have more negative attitudes, because they are more affected than those living further away from wolf regions (Karlsson & Sjöström, 2007). Prevailing negative attitudes also strongly influence compliance levels and illegal killing does occur, which directly affects wolf recovery and long term survival of the species (Karlsson & Sjöström, 2007; Musiani & Paquet, 2004; Suryawanshi et al., 2013).

"unpredictability inflates perceived threats; any improvement in predictive ability makes conflict appear more tractable" (Wydeven et al., 2004).

Kellert (1985) conducted a study to examine the attitudes and knowledge of people regarding predators. Comparisons were made among different demographic groups, distinguished by age, sex, place of residence, education and occupation and also included a group of livestock producers. Results showed that out of 33 different animals, the wolf was among the least liked, regardless of the positive media attention the wolf had received prior to the study. Out of 16 different animals, only skunks were liked less. Negative attitudes were related to fears regarding dangerousness, being the cause of property damage and their predatory nature. Livestock producers hold very negative attitudes; older residents expressed far more dislike than participants under age 25; and less educated participants also liked wolves less than those with post-secondary education. Respondents having a greater knowledge of animals had positive feelings towards wolves as did members of wildlife organizations, environmental groups, scientists, naturalists, birdwatchers and hikers, all of whom reported the most affection for predatory animals. While some groups of people such as hunters or livestock producers generally support the use of lethal controls including trapping, shooting and poisoning to eliminate predators, the general public does not. For example, when livestock is killed by wolves, most people will not support untargeted killing, but instead, favour specifically targeted focus on the animal responsible or relocation of the culprits away from agricultural areas (Kellert, 1985).

Attitudes towards wolves have changed significantly since the Kellert (1985) study. More recently, researchers have replicated the survey (George, Slagle, Wilson, Moeller & Bruskotter, 2016). Results show an attitudinal shift towards more positive feelings about wildlife in general. Wolves are now viewed in a more positive light and attitudes are now positively associated with measures of mutualism and belief in wildlife's intrinsic value (Bruskotter & George, 2014). These changes in perceptions towards wolves are significant and will hopefully influence levels of cooperation regarding wolf conservation.

Often groups pushing for stronger wolf protection are not directly affected by wolves and differences in cultural environments have not always been considered in wolf policy (Manfredo & Dayer, 2004). This variability in cultural groups means that differences among the people involved must be accounted for prior to changing policy. Although wolf protected areas are important to sustaining viable wolf populations, there are economic and political implications because these regions generally have higher incidence of human-wolf conflict and need special attention (Karlsson & Sjöström, 2007). People living in these areas are unable to respond with traditional methods of protection because of legal or social implications. This can leave them vulnerable and in turn, attitudes are negatively affected resulting in non-compliance and illegal killing (Treves, Wallace, Naughton-Treves, & Morales, 2006). Newly acquired attitudinal knowledge regarding wolves, wolf management and the cultural environments near wolf protected zones or other areas of high human-wolf conflict all need careful consideration in regards to wolf management. Taking steps towards understanding the cultural environment of those directly impacted is essential. Affected individuals need to be included in decision making processes and discussions among stakeholder groups need to occur, in order to shorten the gap from the immense differences in cultural values.

1.4.3. Conflict and mitigation

Many vulnerable carnivore species, especially large-bodied species that require large ranges, cannot persist under human pressures such as destruction of vital habitat or loss of prey species. Increasing human populations and demand for natural resources is rapidly eroding the remaining limited carnivore habitats; however cultural attitudes and tolerance has made a global shift towards more positive support for protection of large carnivores. Developing fair carnivore protection plans and securing the adequate habitat needed for large carnivores to recover and survive has become the goal of many governments and animal rights groups, world-wide. The establishment and maintenance of large protected areas such as nature reserves and national parks are a key component of successful carnivore recovery strategies however, these areas are not without their problems. Where carnivore species are recovering through reestablishment and recovery programs, there tends to be higher incidents of human-carnivore conflicts. For example, in areas where livestock farms exist, losses due to depredation are greater if they are situated close to protected areas. Mitigation of these conflicts can take many forms, from the erection of barriers to keep carnivores away from livestock, vigilance, or compensation for losses due to depredation from carnivores (Karanth & Chellam, 2009). There is often a great deal of opposition regarding protection of large carnivores because of their effect on human activities, therefore the needs of all stakeholders must be addressed wherever protected areas are located.

Traditionally, the goal of most government agencies was to kill wildlife animals that threatened agriculture development or human safety. Wildlife needs were not a concern (Naughton-Treves & Treves, 2005). Many species have declined to critically low numbers because of this approach. For example, in Africa, large carnivores such as lions or leopards were eliminated from many areas across the continent (Naughton-Treves & Treves, 2005). For the remaining large carnivores not killed directly by humans, habitat destruction has caused much of their demise (Ripple, Beschta, 2004). Today human attitudes have changed drastically regarding large carnivores, especially wolves (Kellert, 1985; Kellert et al., 1996; Musiani & Paquet, 2004); however, traditional responses often prevail in affected human communities, undermining wildlife protections and even reversing conservation gains (Musiani & Paquet, 2004). In the areas surrounding wolf protected zones, this is particularly apparent. Conservation of wolves can be challenging for wildlife managers and policy makers when the animals they are protecting attack livestock, threaten humans, or interfere with human activities such as hunting by taking game species. Those affected will sometimes retaliate with use of lethal force, which can have cascading ecological effects (Mech & Boitani, 2003; Weiss et al.,2007) and hamper conservation goals (Karanth & Chellam, 2009;Treves, Wallace, & White, 2009) . Top predators, such as wolves, typically have strong influences on prey behaviours. Stress induced by the predators can affect prey population cycles and change in foraging habits. Wolves are highly social and their pack structure has strong influence over their behaviours (Mech & Boitani, 2003). Lethal control can alter pack structure. Loss of an individual member alters the group structure for surviving members which in turn creates strong effects on other species (Ritchie et al., 2012). When lethal force is used to protect their property, wolf protectionist groups and resource managers get involved and this is the cause of many political conflicts between urban and rural citizens and government agencies (Treves, 2008).

In human-wildlife conflict, there are two prevailing groups of people. The first group feels that all wildlife must be protected from people. This group consists mostly of citizens residing in urban areas. The second group believes it is the people that must be protected against wildlife. This group consists of mostly rural citizens; ranchers, farmers and hunters (Kellert, 1985; Kellert et al., 1996; Naughton-Treves & Treves, 2005). We are now at a crossroads between the urban and rural citizens in North America regarding wolf management and it is important to address these concerns. Stakeholder input during the development of new management plans and policies is crucial for compliance once the policies are in place. To do this, the public must be kept abreast of relevant issues. For example, having easy access to current, reliable information regarding successful mitigation methods is important and would allow livestock farmers to make better informed decisions regarding the use of non-lethal wolf control. Wolves are still killed to reduce livestock depredation partly because other methods are not known, don't work or are not affordable and ultimately, the farmer must protect his/her family, property and livelihood, yet their actions are subject to increased public scrutiny in Canada and the US. For many citizens, non-lethal protection methods are preferred; even those affected by depredation (Karanth & Chellam, 2009;Kellert, 1985; Musiani & Paquet, 2004; Mech & Boitani, 2003). Better conflict/mitigation methods need to be determined. Critical assessment of non-lethal protection methods to deal with human-wolf conflict is important to determine best practices.

Increases in livestock predation by wolves make management difficult as it erodes public tolerance levels for wolves even more and leads to more negative attitudes in rural communities (Gehring et. al., 2006). Still, livestock farmers typically take a more passive role with depredation management plans and they tend to be more reactive than proactive using lethal control whenever threatened or when losses have already occurred (Gehring et. al., 2006). In areas of high wolf predation, a more thoughtful approach is necessary to combat the problem effectively. Active participation using proactive methods is also necessary in areas where the wolf populations are at risk as reactive lethal control can threaten recovery of such populations.

Development of depredation management plans incorporating viable non-lethal techniques with limited lethal control use is therefore recommended (Gehring et. al., 2006; Naughton-Treves & Treves, 2005; Shivik, 2004).

1.5. OVERALL RESEARCH OBJECTIVES

My overall research objectives were: (i) to review the history and ecological importance of large carnivores, particularly wolves, and discuss their history of interaction with humans, (ii) develop a better understanding of the attitudes that people have towards wolves and, (iii) develop a better understanding of livestock depredation by wolves and coyotes near a wolf protection zone and wolf territory.

1.6. THESIS ORGANIZATION

This thesis is made up of four chapters. The introductory chapter [Chapter One] gives a brief historical account of the relationship between large carnivores, particularly wolves and humans in North America, discusses the ecological importance of wolves and outlines the overall research objectives. The first research chapter [Chapter Two] examines attitudes towards wolves and wolf management near Algonquin Provincial Park in Ontario, Canada. The second research chapter, [Chapter Three] examines individual livestock farms as case studies, in the areas adjacent to the western borders of Algonquin Provincial Park in an effort to develop better understanding of the factors influencing livestock depredation near a wolf protected zone.

Chapter Four is a concluding chapter which summarizes the thesis, gives some conservation recommendations and offers suggestions for future research.

CHAPTER 2

ATTITUDES TOWARDS WOLVES AND WOLF MANAGEMENT NEAR ALGONQUIN PROVINCIAL PARK

2.1. INTRODUCTION

Many populations of wolves are recovering across North America (Musiani &Pacquet, 2004), resulting in a rise in human-wolf conflict (Mech & Boitani, 2003; Musiani & Pacquet, 2004; Treves et al., 2004) that threatens wolf conservation efforts. For example, rising human-wolf conflict often comes with negative human attitudes and hostility which can result in persecution of the species through eradication campaigns (Dickman, 2010).

When developing conservation policies, conservation managers must not only understand the effects of increasing wolf populations on natural and managed ecosystems, but must also consider public attitudes towards wolves and wolf conservation (Stronen, Brook, Paquet & McLachlan, 2007; Suryawanshi, Bhatnagar, Redpath & Mishra, 2013). Gathering information on public attitudes is an effective tool for ensuring that policies reflecting the preferences of the general public are developed. Ultimately, the success of wolf conservation management programs hinges on understanding the attitudes of impacted stakeholders and gauging their support for wolf conservation programs (Wydeven, Treves, Brost &Wiedenhoeft, 2010).

Attitudes are reliable predictors of behaviour (Fishbein & Manfredo, 1992; Fulton, Manfredo & Lipscomb, 1996; 1992; Heberlein, 2012; Hrubes, Ajzen & Daigle, 2001) and conservationists have become increasingly aware that wolf conservation success is strongly impacted by the often polarized views the public holds towards them (Lute, Bump & Gore, 2014). These polarized views can have social and political repercussions, including non-compliance with harvest legislation, power struggles for natural resources, and biases against competing stakeholders (Lute et al., 2014; Treves, Naughton-Treves & Shelley, 2012). Moreover, strong negative attitudes are often passed on to next generations and can thus persist for long periods of time, making resolution attempts difficult for resource managers (Karlsson & Sjostrom, 2007; Suryawanshiet al., 2013).

My study focuses on Eastern wolves (*Canis sp. cf. lycaon*) living beyond the borders of Algonquin Provincial Park (APP) in Ontario, Canada. Eastern wolves are listed as a threatened species in Ontario (COSEWIC, 2015). They occur throughout most of central Ontario, east to southern Quebec, north and west to Lake Nipigon, and south to the southern edge of the Canadian Shield in central Ontario with their highest concentration residing within APP boundaries (Benson, Patterson & Wheeldon, 2012; Rutledge, Patterson, Mills & Loveless, 2010). Eastern wolves may occupy territories of up to 395 km^2, with averages ranging from 110 to 185 km^2 (Theberge & Theberge, 2004) and densities inside APP at 3.0 to 3.4 wolves per 100 km^2 (Rutledge et al., 2010). Eastern wolves, coyotes and wolf-coyote hybrids have all been given protected status since 2001 (OMNR, 2005) owing to the difficulty to distinguish them without DNA testing (Wilson et al., 2000; Wilson, Grewal, Mallory & White, 2009). Historically, wolf protection through harvest ban in Ontario has been met with strong local public opposition, with some people expressing outrage at the expansion of the harvest ban to areas beyond APP borders and with the inclusion of coyotes and hybrids in the Eastern wolf harvest ban (OMNR, 2005; Straughan, 2004). This new expanded wolf protection legislation, coupled with existing negative attitudes, will affect the dynamics of both human-wolf relationships and the already strained stakeholder relationships stemming from polarized views. Therefore, examination of the factors affecting public attitudes is prudent in order to mitigate the social conflict and for the long-term survival of the Eastern wolf.

2.1.1 Theoretical framework

My study uses attitudinal theory as a framework for the assessment and prediction of relevant factors affecting the level of support for the protection of wolves in Canada. This is based on Fishbein's (1961) attitude theory, coupled with Ajzen's (1991) theory of planned behaviour (TPB). According to Fishbein's (1961) theory, an individual's attitude toward any object is a function of his beliefs about that object. An attitude can be defined as "the evaluative dimension of a concept" (Fishbein & Raven, 1962). According to Ajzen's (1991) TPB, broad values are background variables that influence behaviour indirectly through their influence on beliefs and attitudes.TPB posits that there are three kinds of considerations that control human action: behaviour beliefs, normative beliefs and control beliefs. The attitude an individual holds towards an object or behaviour, in combination with subjective norms and perception of behavioural control, lead to the formation of a behavioural intention (Ajzen, 1991). Together these theories may offer insight into human-wolf conflict situations and the social conflict that is often related to wolves and wolf management.

Based on TPB and Fishbein's attitude theory, we examined the combined effects of public attitudes towards wolves (object) on the level of agreement for the APP wolf harvest ban (behavioral intention). I predicted that level of agreement towards the harvest ban depends on (1) beliefs about wolves and how they are related to other objects (ie. moose and deer populations) and (2) the evaluation of those beliefs (Ajzen, 1991; Fishbein, 1961; Fishbein, 1963).

2.1.2. Study factors

Distance from a known wolf territory

Wolves generally live in rural areas (Mech & Boitani, 2003). Humans living in rural areas, where chance of a wolf encounter is more likely, historically have the most negative attitudes towards wolves, and thus, many rural local residents do not easily accept wolf protection laws (Eriksson & Herverlein, 2003; Kellert, Black, Rush & Bath, 1996). Past studies show that location is an important factor affecting human attitudes towards wolves. For example, Karlsson & Sjostrom (2007) found that people living closer to a wolf territory had more negative attitudes than those living further away.

Group membership (hunters versus non-hunters)

Examining hunters (*versus* non-hunters) as a group having shared values has been found useful for predicting attitudes and behaviours (Luchtrath & Schraml, 2015). Individuals within groups may influence each other's perceptions and behavioural intentions (Luchtrath & Schraml, 2015).

Perception of impact beliefs

Beliefs about impacts that predators such as wolves have on their prey (ie. moose and deer) has been found to influence attitudes (Glikman, Vaskes, Bath, Ciucci, Boitani, 2011).When deer, moose, or other game species numbers drop wolves are often blamed. Historic attempts to manage human-wolf conflict issues include offer of bounties or large culls from the area. These attempts can lead to a range of negative impacts on wolf conservation goals (Graham et al., 2004; Musiani & Paquet, 2004). While it is true that wolves are responsible for up to 9% death of game species (Graham et al., 2004), there are usually other factors, such as disease, weather, and habitat loss due to human expansion that actively influence game species populations (Mech & Boitani, 2003; Shivik, 2014).

The hypotheses tested were: **(H1)** respondents with positive attitudes towards wolves will be more likely to have higher agreement levels for the wolf harvest ban than respondents with negative attitudes towards wolves; **(H2)** respondent attitudes towards wolves and the harvest ban will be more positive with increasing distance from the APP border; **(H3)** respondents who believe there are a higher numbers of wolves since the onset of the harvest ban will have lower agreement levels for the harvest ban than those who believe there are fewer wolves now; **(H4)** respondents who believe that moose and deer numbers have decreased since the onset of the harvest ban will have lower levels of agreement for the ban than respondents who believe moose or deer number have increased; **(H5)** respondents holding current registered hunter status licenses will have lower levels of agreement for the harvest ban than those identifying as non-hunters.

2.2. METHODOLOGY

2.2.1 Study area

The study area is focused on the areas surrounding APP in north central Ontario, Canada, within the districts of Nipissing, Parry Sound and Muskoka, and the counties of Haliburton, Hastings and Renfrew. Respondents located within 60 kilometres from APP borders were considered to live within the focus study area and respondents located further than 60 kilometres from APP borders were considered to live outside the focus study area (Fig. 1).There are no large urban centres within the focus study area and the entire zone is considered rural.

Fig. 1. Algonquin Provincial Park and surrounding focus area with townships and survey origins marked.

2.2.2 Intake instruments and sampling protocol

We used a survey to assess the factors influencing attitudes towards wolves and agreement levels for the APP wolf harvest ban in Ontario, Canada. This study was intended as preliminary research to measure attitudes of the residents residing within or near a known wolf territory. We used a combination of voluntary and snowballing sampling techniques for both online and paper questionnaires (Dillman, Smyth & Christian, 2009). Surveys were made available for anyone over 18 years old. It should be noted that most individuals tend not to comment and those with the strongest opinions are often the most vocal, hence the middle majority tend to be underrepresented. This approach was cost-effective, quick and allowed relevant stakeholders who are interested in wolf management to be reached and to participate.

The survey was designed to examine the strength of the associations among attitudes, subjective norms and impact beliefs related to wolves and the extent to which attitude theory and TPB affords prediction of the agreement level towards the APP wolf harvest ban. Survey questions used five-point scales to measure attitudes: (1) attitudes towards wolves (strongly like, like, neutral, dislike, strongly dislike) and (2) attitudes towards the wolf harvest ban near APP (strongly agree, agree, neutral, disagree, strongly disagree). Survey questions also included multiple choice options to measure beliefs related to wolves: (1) perception of population changes for (a) wolves, (b) deer, and (c) moose since the onset of the permanent wolf harvest ban (no change, more now, less now, don't know), and (2) easy access to trusted information about the wolves near APP (yes, no, no opinion). Participants were asked about group membership: hunter status (registered hunter, non-hunter). We also requested general location data (township of residence) in order to investigate how distance to the nearest APP border (known wolf territory) affects attitudes (Table 1). Surveys were administered from October, 2014 to January, 2015. The design and implementation of the questionnaire was approved by the Lakehead University Research Ethics Board.

Table 1 Definitions of variables used for survey analysis

Variable	Definition
Agreement level towards the wolf harvest ban in areas outside of APP	1 = strongly agree with wolf harvest ban, 2 = agree, 3 = neutral, 4 = disagree, 5 = strongly disagree
Attitudes towards wolves	1 = strongly like wolves, 2 = like, 3 = neutral, 4 = dislike, 5 = strongly dislike
Distance to APP [km]	Distance respondent lives to nearest APP border [km] Measured from respondent residence township centre to nearest APP border via ArcMap 10.3.1 and Google Earth Pro (Version 7.1.8.3036) measurement tools. Most townships ~200 km^{2}area.
Hunter Status	Current Hunter: 1 = Yes [registered hunter] 2 = No [non-hunter]
Belief of moose population changes since 2001 in respondent local area	Does the respondent think there have been changes in overall moose numbers since onset of wolf harvest ban in respondent home area? Responses: 1 = no change, 2 = more now, 3 = less now, 4 = don't know
Belief of deer population changes since 2001 in respondent local area	Does the respondent think there have been changes in overall deer numbers since onset of wolf harvest ban in respondent home area? Responses: 1 = no change, 2 = more now, 3 = less now, 4 = don't know
Belief of wolf population changes since 2001 in respondent local area	Does the respondent think there have been changes in overall wolf numbers since onset of wolf harvest ban in respondent home area? Responses: 1 = no change, 2 = more now, 3 = less now, 4 = don't know
Availability of trusted information	Does the respondent feel they have adequate access to information about wolves and the wolf harvest ban? Responses: 1 = Yes, 2 = No, 3 = No opinion
Township	Township the respondent resides in.

2.2.3. Statistical analyses

Survey responses from both paper and online sources were pooled into a single dataset. Geo-referenced locations of survey responses via respondent supplied township data were determined using Google Earth Pro (Version 7.1.8.3036). Distance (km) was measured to the nearest APP border (known wolf territory) from the township centre point using ArcGIS 10.3.1 and Google Earth Pro (Version 7.1.8.3036).All models were checked for normality and homogeneity of variance while model fits were visually inspected using residual *versus* fitted plots and quantile-quantile plots. Since the majority of the data were not normally distributed, frequency, cross tabulation, and non-parametric analytic procedures were used. For measures of association, Spearman's rho was used. The Kruskal-Wallis H (K-W) Test was used to examine group differences (Boone & Boone, 2012; Classon & Dormody, 1994). All analysis was performed using SPSS 20.0.

Predictive model: multinomial cumulative odds ordered logit model selection

I used a multinomial cumulative odds ordered logit model (Carruthers, Lewis, McCue, Westely, 2008; Karlsson & Sjostrom, 2007; Quinn & Keough, 2002) to explore the combined effects of hunter status, access to trusted information, perception of wildlife populations, and attitudes towards wolves in relation to the level of support for the wolf harvest ban near APP.

Not every question on the survey was answered by all respondents. Out of 248 total survey responses, 149 respondents answered all necessary questions needed and were retained for this analysis. Models examined multiple combinations of the following variables: within/outside study focus area; region; perception of wolf, moose, and deer populations; attitudes towards wolves; hunter/non-hunter status; perception of access to trusted information; and distance to APP. Model outputs were ranked according to fit using Akaike's second-order information criterion (AICc) (Burnham & Anderson, 2004; Burnham, Anderson & Huyvaert, 2011; Symonds & Mousalli, 2011). Assessment results indicate that Model e was the most likely among the 5 candidate models, with an Akaike weight of 0.8356 (Table 2), and was thus selected for further analysis and interpretation. Model e results were analyzed further using Wald Chi-Square in SPSS 20.0.

Table 2
Model selection using Akaike's second-order information criterion [AICc] ranked according to fit.

Model ID	No. of Variables	Log likelihood	AICc	Delta AICc [Δ i]	Akaike weight [wi]	Model Rank	Likelihood Ratio X^2	Likelihood Ratio P-value
A	7	-131.987	316.005	19.852	1.19675	5	133.364	<0.001
B	5	-136.283	303.7	7.547	0.0192	3	124.771	<0.001
C	6	-133.793	303.708	7.555	0.0191	4	129.75	<0.001
D	5	-134.401	299.936	3.783	0.126	2	128.535	<0.001
E	4	-136.113	296.153	0	0.8356	1	125.111	<0.001

Model Variables
a - study area group, region, perception of wolf pop., hunter status, access to trusted info, perception of moose pop., perception of deer pop.
b - study area group, perception of wolf pop., hunter status, perception of moose pop., perception of deer pop.
c - distance to APP, perception of wolf pop., hunter status, access to trusted info, perception of moose pop., perception of deer pop.
d -distance to APP, perception of wolf pop., hunter status, perception of moose pop., perception of deer pop.
***e - distance to APP, hunter status, perception of moose pop., perception of deer pop.[Model e chosen for analysis based on Akaike's selection criterion]**

2.3. RESULTS

2.3.1. Overall results

Overall, there were 248 respondents with 81% (201) from those residing within the main focus area (<60km from APP border); and 19% (47) from outside of the main focus area (>60km from APP border) (Table 3). Half of the respondents were self-identified hunters (n = 118 out of 235) and this percentage was higher than Ontario Ministry of Natural Resources and Forestry

Province-wide survey results (~ 4% of Ontario residents). Rural regions typically have a higher proportion of hunters *versus* non-hunters than urban centres; and thus, it is likely that proportions in our rural study area differs significantly from the Province-wide estimates (nb., note that hunter to non-hunter ratios have not been officially documented for our focus area). Almost half (117, 47.6%) of the participants felt positively (like and strongly like) about wolves. Chi-square tests show significant differences in attitudes (strongly like, like, neutral, dislike, strongly dislike) towards wolves (n=246, χ^2=34.854, p<0.001). Almost half (116, 48.5%) of respondents did not agree with APP wolf harvest ban (n=239, χ^2=16.962, p=0.002).When asked about access to information regarding wolves, 31.5% of respondents within study area and 7.7% outside of the study area felt they did not have access to information they trusted. Some respondents voiced their concerns and distrust of wolf information supplied via government sources. Only 46.4% of total respondents felt that they have sufficient access to trusted information about wolves in Ontario.

Table 3
Regional survey response numbers and demographics

District/County	# of Respondents	Land Area [km2]	Population	Pop. Density / km2
Nipissing	16	17,103.52	84,736	5
Parry Sound	35	9322.8	42,162	4.5
Muskoka	51	3937.76	58,047	14.7
Haliburton	44	4,071.86	17,026	4.2
Hastings	16	5,291.05	39,888	7.5
Renfrew	51	7,419	107,169	22.7
Other	35			
Total	248			

Note: Hastings population excluding Belleville, Quinte and Tyendinaga

2.3.2. Hypothesis testing

There was a positive correlation between respondent attitudes towards wolves and agreement for the wolf harvest ban (N = 237, r_s= 0.747, p <0.001) and therefore our hypothesis **(H1)** is accepted. Respondents having positive attitudes towards wolves had higher levels of agreement for the wolf harvest ban than those having negative attitude towards wolves. Relationship analysis showed a negative correlation (N = 241, r_s = -0.298, p <0.001) between respondent attitudes towards wolves and the distance (km) from APP border. There was also a negative correlation (r_s = -0.188, p = 0.004) between agreement level for the harvest ban and distance (km) from APP border. Both attitudes towards wolves and agreement levels for the harvest ban were more positive as distance to APP border increased. Therefore, the hypothesis **(H2)** that respondent attitudes towards wolves and the harvest ban will be more positive with increasing distance from APP border was accepted (Table 4).

Table 4
Spearman's rho correlations

Variables	N	Test Statistic	Std. Error	P-Value
Agreement level for wolf harvest ban * Attitudes towards wolves	237	0.747	0.031	<0.001
Agreement level for wolf harvest ban * Distance to APP	234	-0.188	0.063	0.004
Agreement level for wolf harvest ban * Hunter status	226	-0.625	0.044	<0.001
Attitudes towards wolves * Distance to APP	241	-0.298	0.056	<0.001
Attitudes towards wolves * Hunter status	233	-0.51	0.057	<0.001

Kruskal-Wallis test results showed that respondents who believe there are greater numbers of wolves now than at the onset of the harvest ban had significantly higher levels of disagreement for harvest ban than all other groups tested (X^2 = 68.908, p < 0.001). Therefore, the hypothesis **(H3)** which states respondents who believe there are higher wolf numbers have lower agreement levels for the wolf harvest ban than respondents believing there are fewer wolves was accepted (Fig.2).

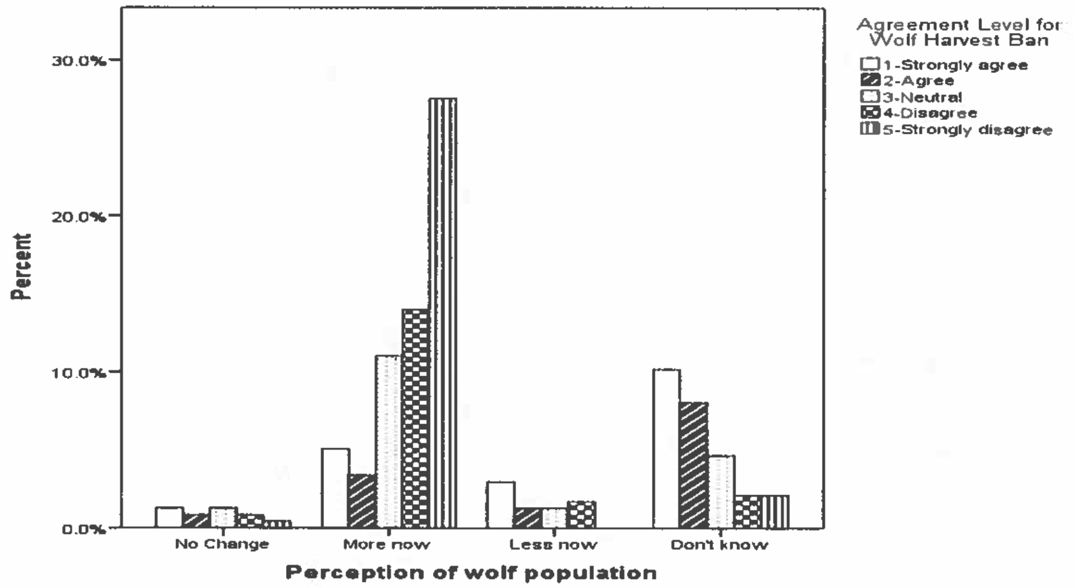

Fig . 2 Agreement levels for wolf harvest ban according to perception of wolf . Kruskal-Wallis tests show significant differences between groups.[N = 236, X2 = 68.908, df = 3, p < .001] Pairwise: More now group different than all others [more now * don't know: X2 = 75.632, SE = 9.999, Adj. sig. < .001; more now * less now: X2 = 74.983, SE = 17.068, Adj. sig. < .001; more now * no change: X2 = -57.692. SE = 20.820, Adj. sig. = .034]

Kruskal-Wallis test results showed that respondents who believe either moose ($X^2 = 31.467$, $p < 0.001$) (Fig. 3a) or deer ($X^2 = 69.403$, $p < 0.001$) (Fig. 3b) numbers had decreased since the onset of the harvest ban had significantly lower levels of agreement to the ban than all other groups tested. Therefore the hypothesis (**H4**) which states respondents who believe moose or deer numbers have decreased since the onset of the wolf harvest ban will have lower levels of agreement is accepted.

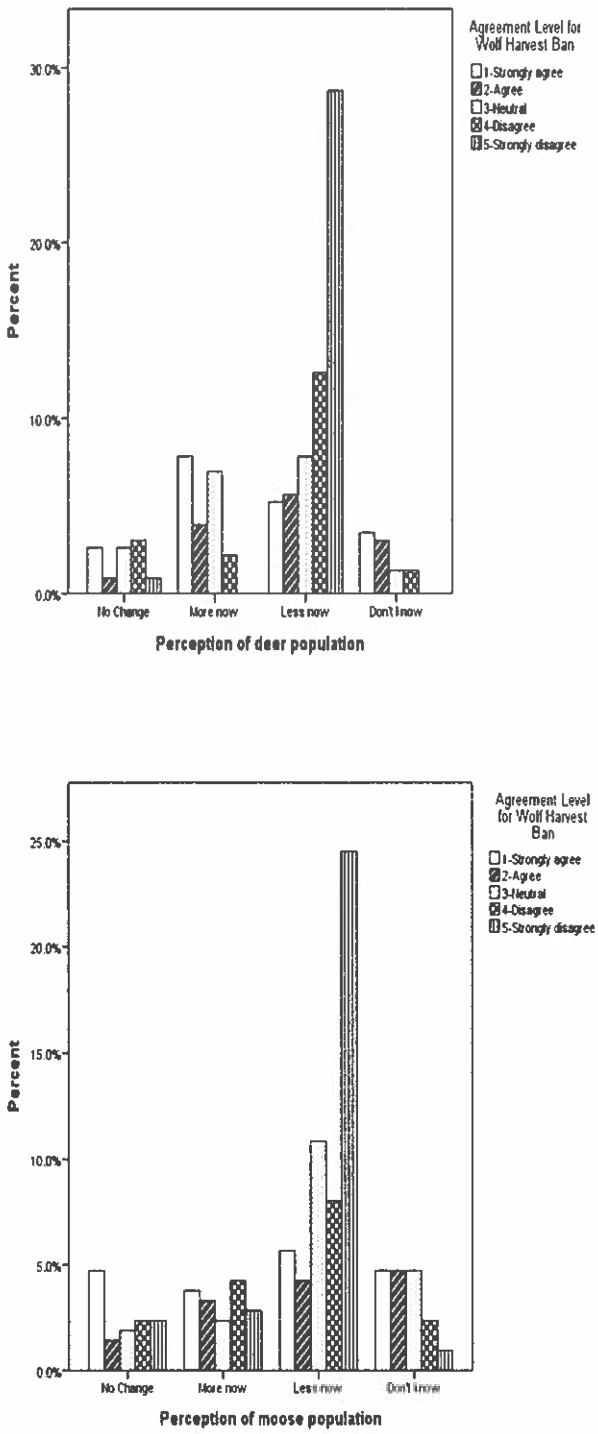

Fig.3 (a & b) Agreement levels for wolf harvest ban according to perceptions of population levels. Kruskal-Wallis tests show significant differences between groups.

Fig. 3a) moose pop.* agreement level [N = 212, X2 = 31.467, df = 3, p < .001] Pairwise: Less now group different than all others [less now * don't know: X2 = 55.197, SE = 11.320, Adj. sig. < .001; less now * no change: X2 = -42.866, SE = 12.803, Adj. sig. = .005; less now * more now: X2 = -34.521. SE = 11.562, Adj. sig. = .017]

Fig. 3b) deer pop.* agreement level [N = 230, X2 = 69.403, df = 3, p < .001] Pairwise: Less now group different than all others [less now * don't know: X2 = 81.264, SE = 15.201, Adj. sig. < .001; less now * more now: X2 = -77.108. SE = 10.874, Adj. sig. < .001; less now * no change: X2 = -47.525, SE = 14.616, Adj. sig. = .007]

With respect to the hunter/non-hunter status of the respondents and their agreement level for the harvest ban (hunters = 117, median = 5; non-hunters = 109, median = 2) (Scale: 1 = strongly agree to 5 = strongly disagree), Mann-Whitney U tests revealed significant differences (U = 1886.500, SE = 478.955, p <0.001). Spearman's rho analysis results showed a negative correlation (N = 226, $r_s = -0.625$, $p < 0.001$) (Table 4) between hunters and agreement levels for the harvest ban. Thus, the hypothesis (**H5**) that respondents identifying as hunters have lower levels of agreement for the harvest ban than non-hunters, was accepted (Fig. 4).

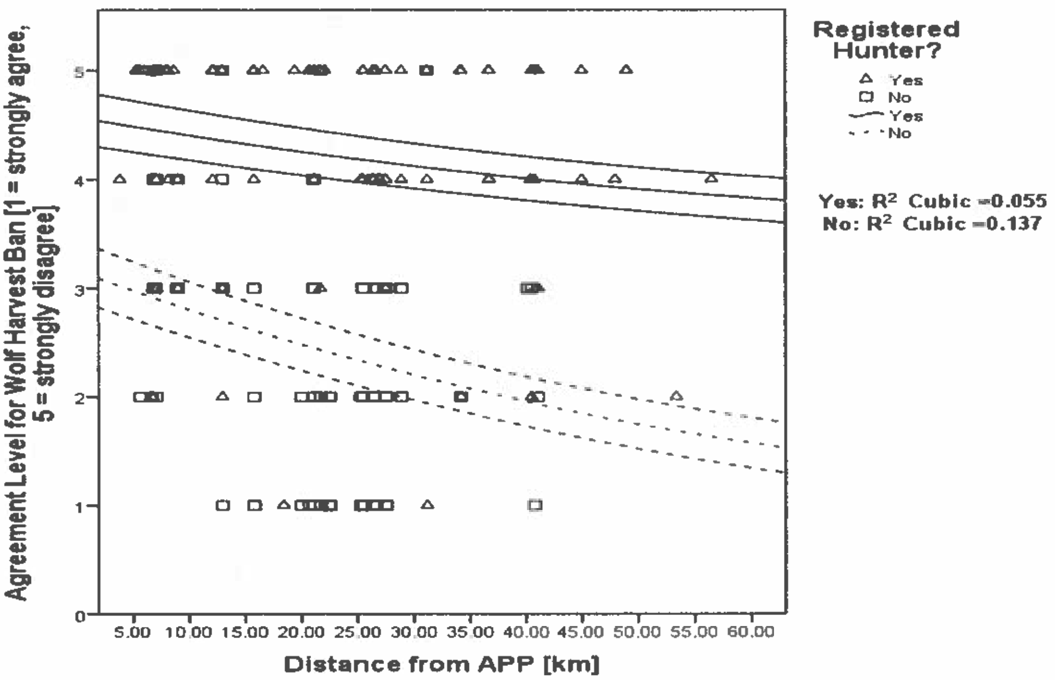

Fig. 4 The relationship between distance to nearest APP border [Within study area group only (0 - 60 km)] and agreement level towards wolf harvest ban for hunters and non-hunters (n = 201).

2.3.3. Model e results

Type III tests of Model e effects show that all 4 variables (hunter status, perception of moose and deer populations, and distance to APP border), were significant predictors in levels of agreement towards the APP wolf harvest ban. The odds of registered hunters having higher levels of disagreement for the wolf harvest ban were 14.016 (95% CI, 6.323 to 31.072) times that of non-hunters, a statistically significant effect, $X^2(1) = 42.255$, $p < 0.001$. The odds of respondents having lower levels of disagreement for the harvest ban were 0.992 (95% CI, 0.986 to 0.998) times for each kilometre further from the nearest APP border, a statistically significant effect, $X^2(1) = 6.089$, $p = 0.014$ (Table 5).

Table 5
Generalized Multinomial Ordinal Logit Model e Prediction Results

Model 1e Variables	Wald χ^2	Df	P-Value
Hunter status	42.255	1	0.0001
Moose population level	8.768	3	0.033
Deer population level	25.462	3	0.0001
Distance from APP [km]	6.089	1	0.014

2.4. DISCUSSION

My study measured attitudes towards wolves and the level of support for a government-mandated wolf harvest ban in Ontario, Canada. Understanding beliefs about wolves and their influence over other species such as moose and deer population levels is of considerable importance because these beliefs are likely to influence attitudes and behavioural intentions regardless of their accuracy. The current results indicate that attitudes towards wolves and wolf conservation are generally favourable. However my analysis also suggests that some factors may hinder support for the wolf harvest ban and expansion of wolf populations in the future in the following ways: (1) if wolf populations rise across central Ontario (with the newly expanded protected regions) attitudes may be negatively affected as greater numbers of wolves means greater potential for human-wolf conflict and this could increase the number of people having negative attitudes towards wolves and the harvest ban. (Real or perceived impact beliefs related to changing wolf, moose and deer populations can affect the level of support for the wolf harvest ban) (2) there are a higher proportion of hunters in rural areas and the analysis indicates that hunter status is correlated with attitudes. Hunters are often vocal proponents opposing predator harvest bans and this may sway other stakeholders not currently holding strong attitudes towards wolves and (3) the desire for access to trusted information coupled with a general lack of trust in government supplied information about wolves, leaves people vulnerable to accepting misinformation about wolves as credible.

The results show that approximately half of the people surveyed feel they do not have access to reliable trusted information about wolves. Although the comments regarding the lack of trust about wolf information supplied via government sources made by some participants were not specifically addressed in this study, it is a cause of concern and may need attention in order to improve stakeholder relationship. Previous studies have found that general trust and confidence have a direct impact on perceptions (Siegrist, Gutcher & Earle, 2005) and attitudes towards wolves and their management may be determined by the level of social trust in a management agency (Sponarski, Vaske, Bath & Musiani, 2014).

Our predictive model indicates that hunter status, impact belief (moose and deer), and residence distance (km) to the APP border have significant influence over agreement levels towards the APP wolf harvest ban. In the surrounding areas of APP, hunters are more than fourteen times as likely to be less supportive of the harvest ban than non-hunters. These findings are similar to results from other studies of hunter attitudes and intentions (Fulton et al., 1996; Hrubes et al., 2001). Hunting is an important part of rural culture (Heberlein & Ericcson, 2005). Consumptive recreation behaviours such as hunting are generally reflective of utilitarian or dominionistic (humans are superior over animals) views towards nature (Dunlap & Heffernan, 1975; Stedman & Heberlein, 2001). This is in contrast to urban views that have a tendency to reflect moralistic values, most likely working against participation in recreational activities such as hunting (Kellert, 1980; Stedman & Heberlein, 2001; Heberlein & Ericcson, 2005). The strong contrast in rural and urban values and views are a major source of social conflict regarding wolves and how they should be managed. When conservationists attempt to impart their strong attitudes on local rural residents, conflict situations arise. Rural people see forced moralistic values as an affront to their own culture and way of life. This leads to increased levels of distrust and unwillingness to sway opinions even when supplied with evidence contrary to their own beliefs. Strong cultural acceptance of hunting practices and views of domination over wildlife in rural areas is equated to attitudes and actions resulting in higher incidents of wildlife killings (Hazzah, Bath, Dolrenry, Dickman &Frank, 2017). Preserving rural culture holds the same level of importance for many hunters as preservation of game species (ie. protection from wolf depredation) (Heberlein, Ericsson & Wollscheid, 2002) and both should be considered when developing and communicating policy.

Wolves are not distributed evenly in Ontario and those people living nearest to wolf territories will undoubtedly be most affected by them. The areas in and around APP have the highest wolf densities in the province and conservationists face considerable challenges in garnering support for the protection of recovering and expanding wolf populations in the area. Although residents living nearest to APP wolf territories may comprise only small numbers compared to the entire Ontario population, their support for wolves and the wolf harvest ban may differ significantly and must be acknowledged, as policy development needs to be reflective of all citizens. A major challenge is to find a wolf management plan that will be widely accepted. Lute et al. (2014) stresses the importance of resolving the "us *versus* them" mentality that often results among stakeholders. I suggest that actively involving all interested stakeholders during the decision-making process can help address stakeholder concerns, reduce social conflict and improve policy effectiveness and efficiency. However, reaching any kind of consensus on the issues pertaining to the protection of wolves in Ontario, alongside protection for any coyotes or wolf-coyote hybrids in the region will require a willingness of involved stakeholders from all sides to compromise on their objectives.

Overall, this study provides insight into attitudes towards wolves and wolf management. It appears that behavioural intentions (ie. level of agreement towards the APP wolf harvest ban) are a function of both individual attitudes (ie. attitudes towards wolves including beliefs about their impact on moose or deer populations and the level of trust in the management agency) and of normative group (i.e. hunters vs. non-hunters) beliefs. This was only a preliminary study and I recommend additional larger scale research measuring attitudes towards wolves and wolf conservation in Ontario. I also suggest that wolf conservation education and outreach programs may be viable options for interested people, as indicated by many respondents' desire for access to trusted information regarding wolves. However, programs directed towards those people having the most negative attitudes towards wolves and harvesting regulations are found to limit impacts (Slagle, Bruskotter & Wilson, 2012) and therefore research is required into some novel approaches. For example future research into the development and delivery of localized community-based education and co-management programs may be more beneficial for people living nearest APP or other wolf territories. Similar theoretical applications based on Fishbein's (1961) attitude theory and the theory of planned behaviour (Ajzen, 1992) is not limited to wolf related studies and could be useful for other at risk large carnivore species.

CHAPTER 3

DEPREDATION OF LIVESTOCK BY WOLVES AND COYOTES NEAR ALGONQUIN PROVINCIAL PARK, CANADA

3.1. INTRODUCTION

Protected areas such as parks and animal reserves can play important roles in the protection of large carnivores. However, the loss of many of these animals when travelling beyond protection zones, where they can encroach human settlements, threatens their conservation (Shivak, 2006). Livestock depredation is a major source of human-predator conflict and these predators are sometimes killed due to threats of livestock depredation (Engle, Vaske, Bath & Marchini, 2017; Loveridge, Wang, Frank & Seidensticker, 2010). For example, human-caused predator mortality because of encounters or retaliatory responses to livestock depredation is a primary threat to jaguars and cougars in Central and South America (Engle et al. 2017; IUCN, 2008).Livestock depredation also results in social conflict when interested stakeholders do not share similar values and attitudes about the acceptability of lethal control (Engle et al. 2017). Natural resource managers must resolve conflicts in order to protect vulnerable populations of carnivores while also preserving peace amongst stakeholders having differing values and opinions about species conservation.

Human-carnivore conflict is often a more significant concern for those living closest to their territories because they are at a higher risk of financial loss due to livestock depredation (Dickman, 2010; Jackson, 2015; Shivak, 2006). Both the frequency and costs of conflict events are on the rise in many areas around the world (Dickman, 2010; Mech and Boitani, 2003;

Shivak, 2006; Treves et al., 2002; Treves &Karanth, 2003).Rural agricultural regions have disproportionate numbers of large carnivores (Lute, Bump & Gore, 2014; Stronen, Brook, Paquet & Mclachlan,2007) and generally, livestock depredation tends to be one of the biggest concerns for carnivore conservation (Karlsson, 2007). The threat of livestock depredation often causes decreased tolerance of large carnivores, resulting in their persecution (Karlsson, 2007; Dickman, 2010). Farmers, for example, must protect their livestock and livelihoods and if human-wolf conflict arises, lethal control may be employed. Although there are some effective non-lethal techniques, these methods are not always feasible, can be difficult to implement, and are not always cost-effective (Miller 2015; Shivak 2006). Culling of predators as a method to counteract depredation has also been employed to combat predation of livestock, however, the effects and effectiveness of culling remain poorly understood and are highly controversial (Bradley et al., 2015). There is now more need for alternative measures in solving livestock depredation issues, as lethal force is becoming less acceptable, with an expanding global movement working towards finding a balance between the needs and activities of humans versus those of wildlife conservation (Shabekova 2013). The ways in which human-wildlife conflict can be mitigated is changing and requires the use of more proactive tools rather than reactive measures wherever possible. Using preventative measures such as electric fencing and livestock guardian animals can lessen the stress on vulnerable species and lower social conflict levels.

Under certain circumstances, the use of lethal control in retaliation of livestock loss or because of fear associated with living within or near carnivore territories is more readily accepted (Bruskotter, Vaske & Schmidt, 2009; Jacobs, Vaske& Dubois, 2014; Manfredo, Zinn, Sikorowski & Jones, 1998). In order to raise tolerance levels of rural farmers, the threat of livestock depredation must be addressed adequately. High conflict locations and the factors influencing the rate of attacks on livestock in those locations need to be identified to aid conservationists and farmers in human-carnivore conflict mitigation. Identification of human-carnivore conflict sites is a major challenge in carnivore conservation (Miller, 2015) and it is important to identify high conflict areas or "hot spots" where rise in conflict situations can potentially put threatened and endangered species in serious peril (Antoneli, Boysen, Piechowski, Smith, Willard, 2016; Miller, 2015). Livestock attack hot spot regions tend to have similar characteristics. For example, carnivore-livestock interactions occur more frequently where higher numbers of livestock are present (Miller, 2015) because predators such as wolves rely on optimal foraging and seek locations with highest prey densities (Miller, 2015). Wolves also tend to kill in flat open areas (Kaartinen et al. 2009) and further away from towns and roads (Miller, 2015) and close proximity to high quality wolf habitat and/or protected areas has been touted as one of the strongest indicators of higher incidence of livestock attacks (Karanth et al. 2012, 2013).

Farmers often take multiple measures to protect their livestock from depredation. Herd size, fence maintenance, human activity level, night containment and guardian animal presence have been shown to influence livestock depredation frequency in past studies (Baruch-Mordo, Breck & Wilson, 2008; Bradley & Pletscher, 2005; Gehring, VerCauteren, Landry, 2010; Iliopoulos, Sgardelis, Koutis, Savaris, 2009; Karanth, Gopalaswamy, DeFries, Ballal, 2012; Ogada, Woodroffe, Oguge & Frank, 2003; VerCauteren, Lavelle, Phillips, 2008). Certain eco-geographical variables such as elevation, slope, distance to major roads, trails and railways, and distance to wolf territories are also determined to be important features influencing livestock depredation (Behdarvand et al., 2014;Bradley & Pletscher, 2005; Kaartinen, Luoto & Kojoa, 2009; Kaboli, Ahmadi, Nourani, Mahini, Aghbolaghi, 2014; Karanth et al., 2012; Miller, 2015).

If conservation managers could improve understanding of the key landscape characteristics and anthropogenic factors that influence susceptibility to livestock predation, more effective animal husbandry practices could be developed. For example, models that predict future sites of human-carnivore conflict associated with livestock depredation based on both anthropogenic and eco-geographical variables could be valuable. This would potentially aid in more targeted implementation of nonlethal carnivore conflict avoidance measures, which has shown some positive results in past instances (Karlsson et al., 2007).

3.1.1 Objectives

The main objective of my study was to determine the key landscape characteristics and anthropogenic factors predisposing livestock farms to wolf or coyote depredation. More specifically, I:

(i) assessed the relative importance of traditional husbandry practices in alleviating the risk of depredation on livestock in high risk areas;

(ii) determined key eco-geographical factors that influence livestock depredation by wolves or coyotes; and

(iii) determined whether seasonality or herd species type influence livestock depredation levels and

(iv) developed a model that predicts risk of future livestock attacks by wolves or coyotes based on (i) and (ii).

3.1.2 Questions and hypothesis

I addressed the following questions:

1) What are the livestock management factors that are most influential in predicting livestock depredation rates by wolves or coyotes in the study area? The prediction is that farms having the best overall management plans will have less attack events on livestock relative to those with poor management plans. Factors such as night containment, well maintained fencing, farm guardian animals, keeping smaller herd sizes and higher human activity will all aid in lessening the level of attacks on livestock

2) What are the environmental factors that are most influential in predicting livestock depredation rates by wolves or coyotes in the study area? The prediction is that farms located closer to the borders of the protected zone of APP will have higher incidences of attacks than those located further away; farms located further away from major highways, farms located at lower elevations, with lower slopes, and located closer to railway lines will have higher incidences of attacks on livestock

3.2. METHODS

3.2.1 Study Area

The study area covers several townships within the districts of Nipissing, Parry Sound and Muskoka in north-central Ontario, Canada. All are adjacent to the western border of Algonquin Provincial Park (APP), where wolf and coyote harvest has been banned since 2001 [Fig. 1].The area consists of a mixture of rural, private and publicly-owned lands, with many agricultural areas dispersed throughout, providing a favorable habitat for both wolves and coyotes (Mech & Boitani, 2003; Benson, Loveless, Rutledge & Patterson, 2016). Area roads are generally secondary or tertiary in nature. Twenty-eight livestock farms ranging in size from small hobby farms to farms with herds of 300-500 head and having many types of farm herd species (ie. cattle, sheep, goats, pigs, poultry, horse) all located within 60 km from APP were assessed. Sheep and cattle were the main herd species of the participating farms.

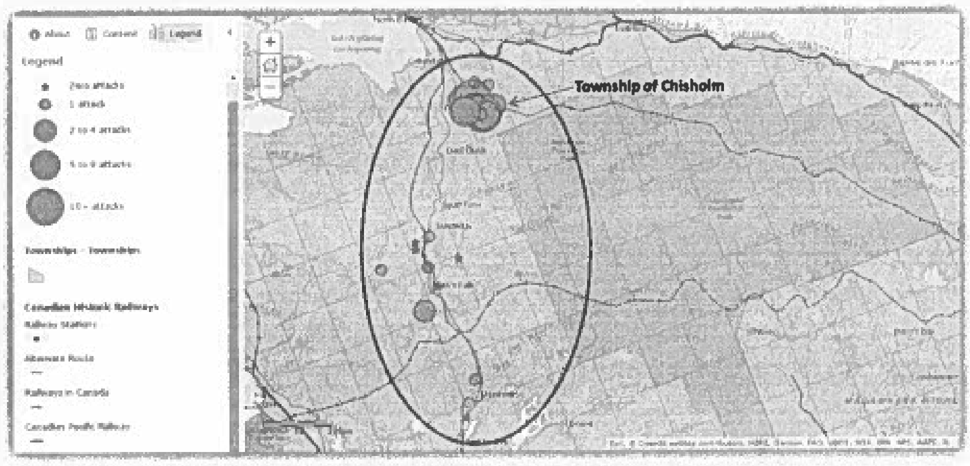

Fig. 1. Location Map: Livestock farm case studies. Active and abandoned railways are marked. There are two railway lines within APP which are no longer used for trains and several abandoned railways outside of APP. Inactive railway lines are marked in black. Animals are known to use the abandoned railways for travel.

3.2.2 Eastern wolf and depredation

The Eastern wolf (*Canis lycaon*) was recently classified as a threatened species having an estimated 500 mature individuals living in Ontario, Canada with their core concentration residing in APP (COSEWIC 2015). Wolf densities inside APP are 3.0 - 3.4 wolves per 100 km^2 (Rutledge, Patterson, Mills, Loveless, 2010). Eastern wolf territories are generally smaller than other Ontario wolf species with the average pack territory ranging from 110 to 185 km^2 (Theberge & Theberge, 2004). Sometimes, the high wolf densities inside of APP result in wolves leaving their packs in search of new territories beyond the Park's borders, resulting in conflict situations with humans.

Livestock farming is a large industry in Ontario. The 2011 Ontario agriculture census reported 51,950 total registered agricultural farms with a net farm income of $730,000,000 of which $5,214,000 was for livestock. Loss due to depredation of agricultural livestock in Ontario is significant. Compensation paid to registered farms for losses due to depredation from wolves or coyotes in the districts of Parry Sound, Muskoka, and Nipissing on all wolves and coyotes in and around APP was $12,043 in 2015 (OMAFRA, 2015). Although this is only a small percentage of livestock income and loss to the industry as a whole, it is a significant cost to the farmers affected. Many times, it is the same farm that experiences repeated losses. More importantly, this region is a central part of the Eastern wolf's natural range, and any retaliation because of livestock losses can severely impact vulnerable populations of this threatened species.

3.2.3 Collection of depredation data

Livestock farm operators within the study area were informed of our case study research and asked to participate via social media, at local feed and co-op stores, farmers markets, the Beef Farmers of Ontario [BFO] website, the Ontario Sheep Marketing Agency [OSMA], and township offices. Twenty-eight farms, 21 where depredation events had occurred and 7 farms where no depredation events had occurred ultimately agreed to participate.

I used a survey to assess the factors influencing livestock attack frequencies at each of the 28 case study locations. Surveys were administered from September 2015 to November 2016. The survey protocol was approved by the Lakehead University Research Ethics Board. Further, compensation claims data from 2009 to 2015 were collected from Township Offices.

3.2.4 Selection of anthropogenic variables

I selected five individual farm management variables [herd size, fence maintenance, human activity level, night containment, guardian animal presence] that were commonly used by the case study participants to mitigate conflict and protect livestock [Table 1].I calculated an overall farm management risk score for each case study location based on the scores from the five individual management variables (Ogada et al. 2003). Herd sizes were grouped as follows: (1) 1-50 (2) 51-100 (3) 101-150 (4) 151-200 (5) >200. I assessed fencing levels as: (1) very well maintained, (2) good, (3) needs some repair, and (4) poorly maintained. We assessed human activity levels as (1) high farm activity (2) moderate farm activity (3) low farm activity. We assessed presence of a farm guardian animal [yes or no] such as a farm dog, donkey or llama. Livestock was considered to be contained at night [yes or no] if they were placed either inside a barn or within a small barnyard close to the house. Assessments were based on livestock valuer reporting criteria and ministry standards (Appendix)

Table 1 Definitions of variables used for analysis

Anthropogenic Variables	Definitions	Eco-Geographical Variables	Definitions
Fence Maintenance	1 = very well maintained, 2 = good, 3 = needs some repair, 4 = poorly maintained	Distance to APP	Measured from nearest APP border to case study farm location in km
Human Presence Level	1 = active human presence most times, 2 = moderate farm activity, 3 = low farm activity, 4 = minimal human activity	Distance to Hwy	Measured from major Hwy to case study farm location [km]
Farm Guardian Animals	1 = yes, 2 = no	Distance to old railway	Measured from nearest old railway locations to case study farm location (km)
Night Containment	1 = yes, 2 = no	Distance to active railway	Measured [km] from nearest active railway locations to case study farm location
Herd Size	1 = 1-50, 2 = 51-100, 3=101-150, 4=151-200, 5=200+	Average Elevation	Mean elevation profile measured at each case study farm location (m)
Farm Maintenance Risk Factor	0 = low risk, 3 = very high risk [sum of 5 anthropogenic variable scores/5]	Average Slope Percentage	Mean slope profile measured at each case study farm location [%]

3.2.5 Eco-geographical variables

Detailed information including eco-geographical data, number and type of herd animals on site, and specific day-to-day farm management practices used were collected for each site [Table 1]. I chose five eco-geographical variables [elevation, slope, distance to highway, distance to APP, distance to railways] based on their ability to influence livestock depredation [Table 1]. Both slope and elevation averages were measured for each farm location using Google Earth

Elevation Profile Tools [Version 7.1.8.3036]. Distance [km] was measured to the nearest border of APP. Distance [km] was measured to nearest major road. Distance [km] was measured from farm location to nearest active and abandoned railways. Distances were measured using ArcGIS 10.3.1 and Google Earth Pro [Version 7.1.8.3036].

3.2.6 Statistical analyses

Statistical analyses were performed using SPSS20.0. All model assumptions were checked using statistical tests for normality and homogeneity of variance and the fit of all models was visually inspected using residual versus fitted plots and quantile-quantile plots. Since the majority of the data were not normally distributed even after transformations were applied, frequency statistics, cross tabulations, parametric and non-parametric analytic procedures were used.

(i) I assessed farm management practices, eco-geographical factors, seasonality and herd species type in several ways. For measures of association, Spearman's rank correlations were used (Quinn & Keough, 2002). Differences between groups were examined using non-parametric tests as data failed assumptions of ANOVA. Both the The Jonckheere Terpstra [J-T] and the Kruskal-Wallis H [K-W] Tests were used to examine group differences (Ali et al., 2015; Terpstra, 1952). The J-T Test is a non-parametric test for ordered medians and was used to analyze ordinal data (Ali et al. 2015) while the K-W Test was used for nominal data.

(ii) Two separate models [Model 1 and Model 2] were developed in order to predict the frequency of attacks from wolves or coyotes at livestock farm locations in the regions surrounding APP. Several versions were created for each model, based on many combinations of variables. Models were assessed by Akaike's second-order information criterion [AICc] and ranked according to fit (Burnham & Anderson, 2002; Burnham, Anderson & Huyvaert, 2011; Carruthers, Lewis, McCue, Westley, 2008; Symonds & Moussalli, 2011).

Model 1 assessed five individual farm management variables [herd size, fence maintenance, presence of guardian animal, night containment, human activity level] along with five eco-geographical variables [distance to APP, distance to highway, distance to railway, slope & elevation]. Four candidate variations [Model 1A – 1D] of the variables were assessed and ranked according to fit [Table 2]. Model 1d was considered the best fit of the four candidate variations with the highest AICc weight of 0.6964 and was therefore chosen for statistical analysis of the case study data.

Table 2. Model 1 Selection

Akaike's second-order information criterion [AICc] of the generalized ordered regression models of the number of farm attacks by five eco-geographical type variables and five farm management variables. A total of 27 livestock farm case studies were retained for analysis.

Model ID	No. of Variables	Log likelihood	AICc	Delta AICc [Δ_i]	Akaike weight [w_i]	Model Rank	Likelihood Ratio X^2	Likelihood Ratio P-value
A	9	-18.854	83.994	27.283	0	4	23.661	0.005
B	4	-21.03	61.955	5.244	0.0506	3	19.309	0.001
C	3	-21.268	58.736	2.025	0.253	2	18.834	<.001
D	2	-21.927	56.711	0	0.6964	1	17.516	<.001

Model Variables
A [Raw Model] - elevation, distance to APP, distance to Hwy, distance to old railway, distance to active railway, Z-score 1-4, herd size
B - herd sie, distance to old railway, distance to APP, average elevation
C - herd size, distance to APP, distance to old railway
D - herd size, distance to APP
z scores: 1 = fence maintenance, 2 = human presence level, 3 = farm guard animals, 4 = night containment

Model 2 assessed overall farm management as a risk score based on an average of five individual farm management variables [herd size, fence maintenance, presence of guardian animal, night containment, human activity level] and five eco-geographical [distance to APP, distance to highway, distance to railway, slope & elevation]. A total of 27 livestock farm case studies were retained for analysis. Results indicated that model c was the best given the set of 3 candidate models with an Akaike weight of 0.8548. Model 2c was clearly the best candidate from our set of models and was therefore chosen to use for case study analysis. Three candidate variations [Model 2a – 2c] of the variables were assessed and ranked according to fit, using AICc criterion [Table 3]. Assessment results indicated that Model 2c was the best fit given the three candidate variations, with the highest Akaike weight of 0.8548. The other variations in the set of candidates were unlikely. Model 2c was used for statistical analysis of case study data.

Table 3. Model 2 Selection

Akaike's second-order information criterion [AICc] of the generalized ordered regression models of the number of farm attacks by five eco-geographical type variables and an overall farm management risk score.

Model ID	No. of Variables	Log likelihood	AICc	Delta AICc [Δ_i]	Akaike weight [w_i]	Model Rank	Likelihood Ratio X^2	Likelihood Ratio P-value
A	6	-20.647	69.883	12.141	0.002	3	20.075	.003
B	4	-20.710	61.315	3.573	0.1432	2	19.950	<.001
C	3	-20.771	57.742	0	0.8548	1	19.828	<.001

Model Variables

a - elevation, distance to APP, distance to Hwy, distance to old railway, distance to active railway, farm risk score

b - farm risk score, distance to APP, distance to old railway, distance to active railway

c - farm risk score, distance to APP, distance to active railway

farm risk scores: 0 = low risk, 1 = moderate risk, 2 = high risk, 3 = very high risk

Model 1d and Model 2c were analyzed further using Wald Chi-Square in SPSS 20.0.

3.3. RESULTS

3.3.1. Overall Results

Of the 28 livestock farms examined, 21 (75%) experienced loss due to depredation from wolves or coyotes since 2009. Generally, farmers took multiple measures to protect their animals with 60.7% contained their livestock overnight, the majority [55.6%] had very well-maintained fencing, 37% had adequate fencing and 7.4% of farmers had fencing that was inadequate and required maintenance. A total of 71.4% of livestock farms had a farm guardian animal such as a dog, llama or donkey present and 74.1% of farms were considered to have active human activity levels, 11.1% medium levels and 14.8% of farms had low human activity levels. Herd size varied from hobby farm size with less than 50 animals [64.3%] to herd sizes of over 300 animals and this was the number one anthropogenic factor [$N = 28$, $r_s = 0.5$, $p = 0.008$] influencing the depredation rates, as 14.2% of farms had > 200 animals in their herds [Table 4]. The distance from APP showed a strong negative correlation with attack frequency [$N = 28$, $r_s = -0.596$, $p = 0.001$] and this was the number one eco-geographical factor influencing depredation rates. A significant number of case study farms were located in Nipissing [60.7%] within the township of Chisholm, located adjacent to the northwest corner of APP [Fig.2].

Table 4. FARMS BY REGION

REGION	COUNT	PERCENT
NIPISSING	17	60.7%
MUSKOKA	2	7.1%
PARRY SOUND	9	32.1%
TOTAL	28	100.0%

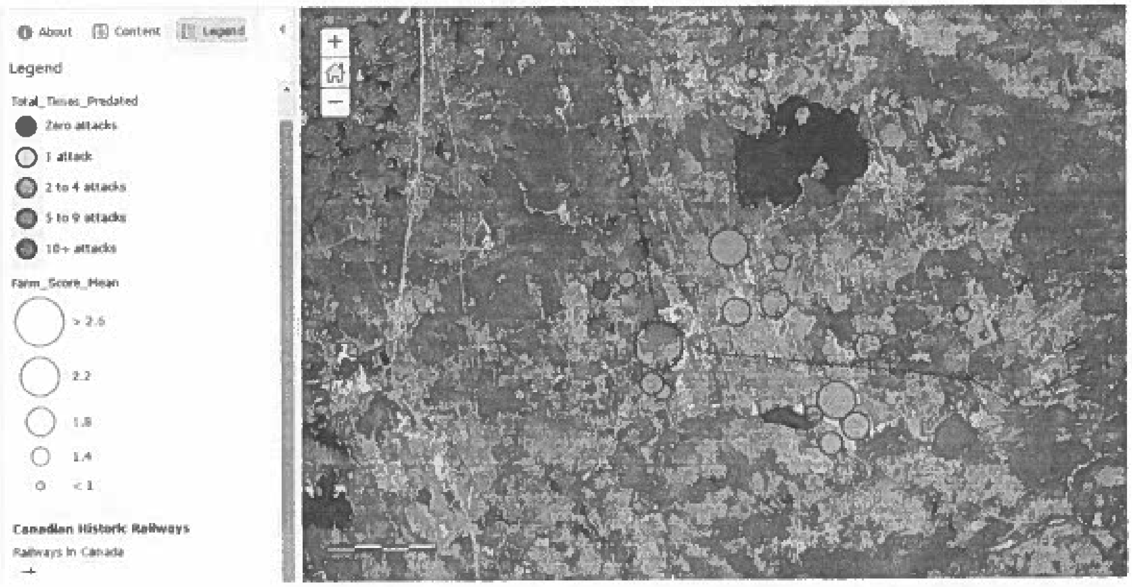

Fig. 2. Chisholm Township Case Studies. All of Chisholm Twp. is located within the APP wolf moratorium buffer zone where there is no legal hunting or trapping of any wolves or coyotes. Much of Chisholm land is pasture for livestock. An abandoned railway trail runs from APP directly through Chisholm Twp and is a known travel corridor for wildlife. Directly east of Chishom is Boulter Twp, a densely forested region with zero population.

3.3.2 Attacks by species/by season

Overall, 39.3% of livestock kills occurred in summer, 21.4% occurred in spring and 14.3% occurred in the fall. There were no recorded livestock depredation events between Jan. 1^{st} and March 30^{th} [winter]. 80% of cattle are killed between April 1^{st} and June 30^{th} [spring] 63.6% of sheep and goats are killed between July 1^{st} and Sept. 30^{th} [summer] and 57.1% of poultry is killed between July 1^{st} and Sept. 30^{th} [summer]. Crosstabulations show significant differences between the seasons [Fig. 3][$N = 28$, Phi = 1.112, $p < 0.001$, Spearman's rho = -0.491, $p = .008$, Monte Carlo Sig. = 0.007; K-W Tests: $N = 28$, Test Stat. = 18.031, $df = 3$, $p < 0.001$, Monte Carlo sig. < 0.001].

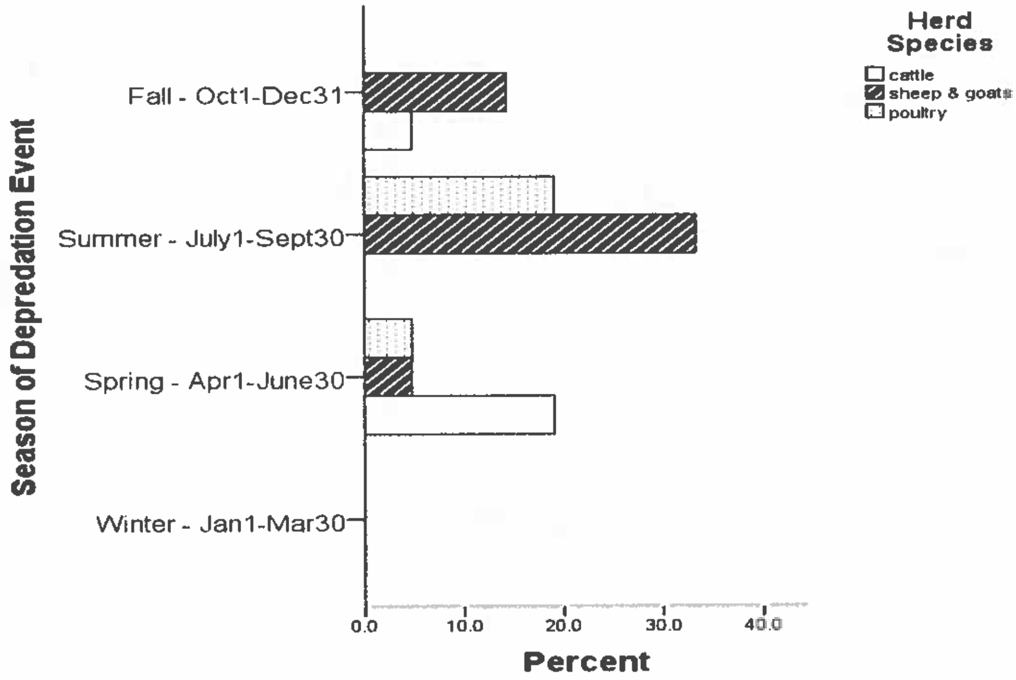

Fig. 3. Percent of livestock depredation events by season for case study participants [N = 28]

3.3.3 Frequency of depredation events by species

Sheep and goat farms had the highest number of overall losses [39.3%] and were the only herd type to experience >10 losses at one farm location during the study period. Additionally, 25% of farms reported zero attacks from 2009 - 2016, 53.6% experienced 1 - 4 livestock attacks and 21.4% of farms experienced 5 livestock attacks or more. Cattle farms had 17.9% of losses with the majority [80%] experiencing1-4 losses between 2009 and 2016. There were significant differences between groups [Fig. 4][J-T Test: N = 28, J-T Stat. = 47.000, Std. Dev. = 21.868, p = 0.001, Monte Carlo p <0.001. Cross tabulations: N = 28, Phi = 0.950, p = 0.003, Spearman's rho = -0.661, p < .001, Monte Carlo sig. <0.001].

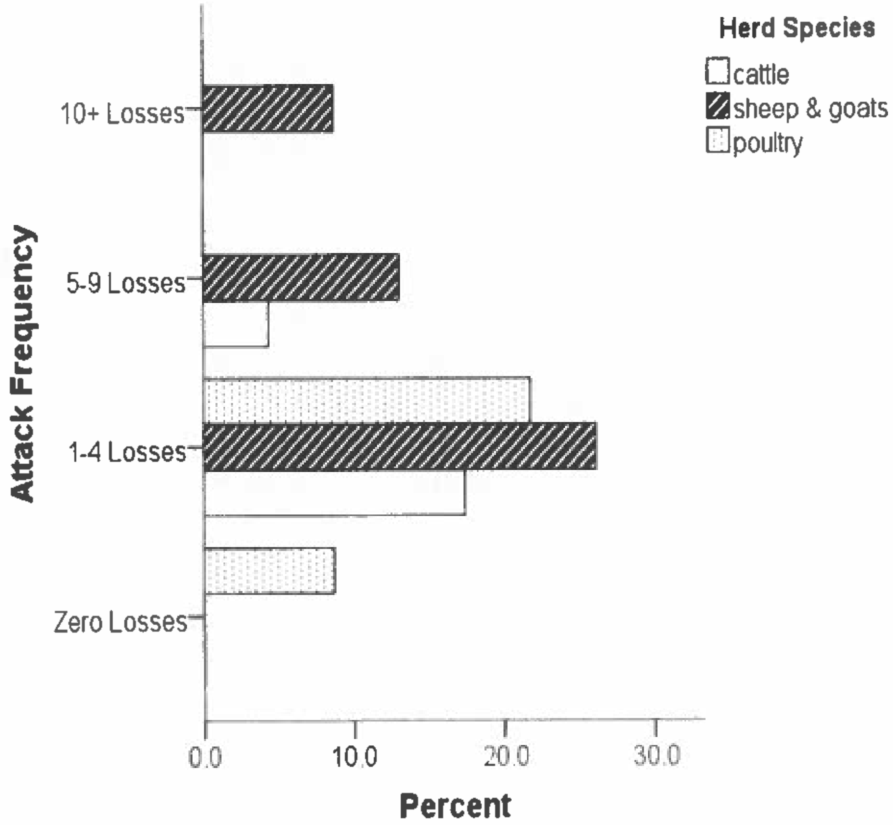

Fig. 4 Graph depicts percent of case study farms by frequency groupings [N = 28]

3.3.4 H1 hypothesis testing - anthropogenic factors

The factors tested under this category were herd size, fence maintenance, presence of guardian animals, night containment, human activity level, and overall risk score [Table 5].

Herd size by frequency of farm attacks

Farms having larger herd sizes had higher frequencies of attacks by wolves and coyotes than farms with smaller herds. Group differences were also significant. [Fig. 5][N=28; Spearman's rho = 0.50, p= 0.007, SE = 0.133, Monte Carlo sig. = 0.008; J-T Tests: N = 28, Test Stat. = 201.500, SE = 22.070, p < 0.001, Pairwise: zero losses and all other groups was significant. 0 and 1 -4 JT = 86.500, Adj. sig. = 0.033, 0 and 5 - 9 JT = 27.000, Adj. sig. = 0.020, 0 and 10+ JT = 14.000. Adj. sig. = 0.043].

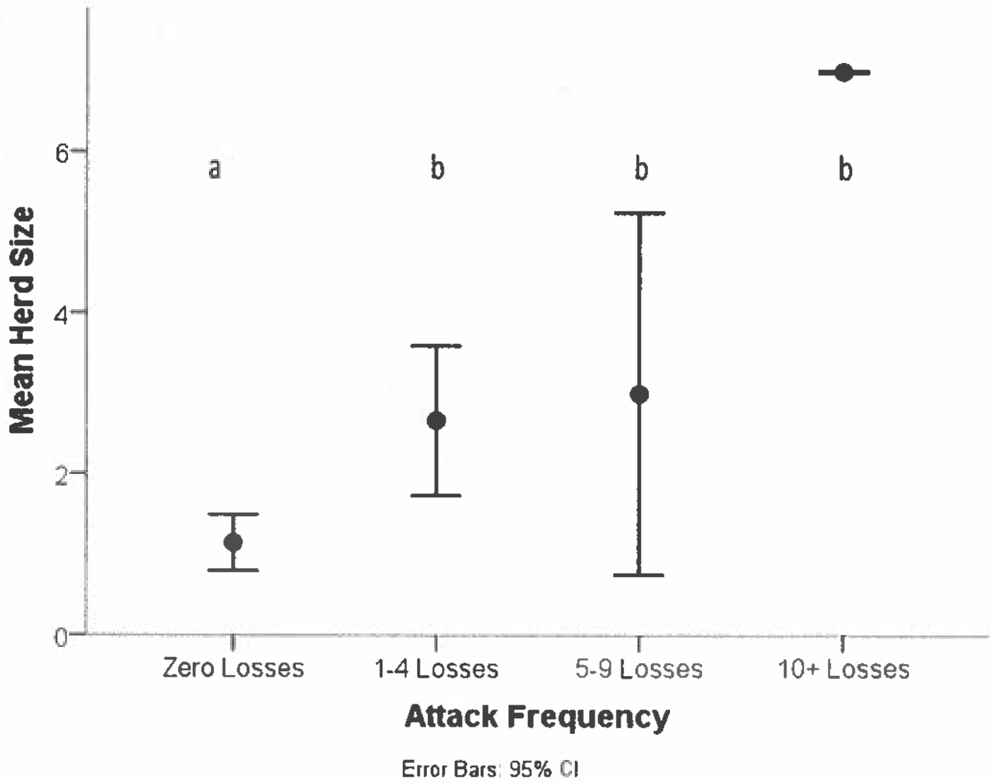

Fig. 5. Frequency of attack events at case study locations by mean size of main herd [N = 28]

Herd size by frequency of farm attacks and by species

The frequency of attacks by species was examined. Sheep & goat herds group showed a strong positive correlation between the number of attacks on livestock and the size of the herd. There are also significant group differences for sheep and goats but not for other herd types [Fig. 6][Sheep & goats, N=11, Kendall's Tau b = 0.541, SE = 0.235, p = 0.039, Monte Carlo sig. = 0.059; other herd species no significant differences. J-T Tests: N=11, Test Stat. = 30.000, SE = 5.673, p= 0.034; No significant Pairwise comparisons].

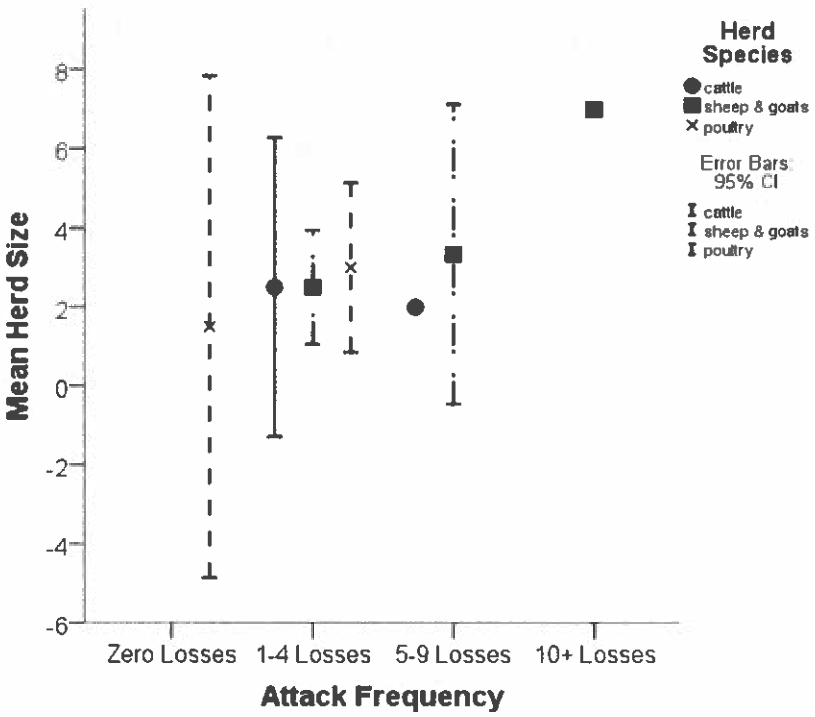

Fig. 6 Frequency of case study depredation events by herd size and by herd species [N = 28]

Overall farm management risk score

There was a moderate positive correlation between the number of times a farm experiences livestock depredation events and the farm risk score [Fig.7][N = 27, Spearman's rho = 0.437, SE = 0.148, p = 0.023, Monte Carlo sig. = 0.018; J-T Tests: N = 27 Test Stat. = 146.500, SE = 15.480, p = 0.026, Pairwise: 0 and 10+ J-T = 12.000, SE = 2.268, Adj. sig. = 0.024].

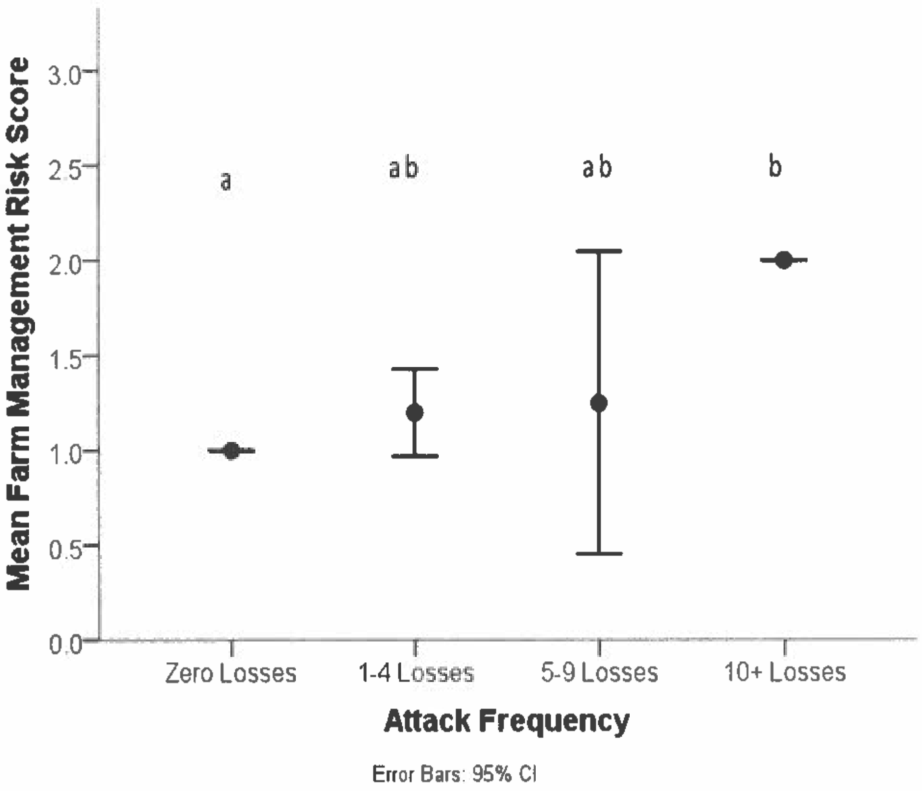

Fig. 7. **Attack Frequency by Overall Farm Management Risk Score [based on 5 factors: herd size, fence maintenance, human activity, night containment, guardian animals] [N = 28]**

Table 5
Results from crosstabulations [Spearman's rho] correlation analysis. Significant results only shown [SPSS]

Variables	N	Test Statistic	Standard Error	P-Value	Monte Carlo Sig.
Anthropogenic variables					
Attack Frequency * Herd Size	28	0.5	0.133	0.007	0.008
Attack Frequency * Risk Score	27	0.437	0.148	0.023	0.018
Eco-geographical variables					
Attack Frequency * Distance to Hwy	28	0.44	0.116	0.019	0.016
Attack Frequency * Distance to APP	28	-0.596	0.096	0.001	0.001
Attack Frequency * Active Railway	28	0.48	0.132	0.01	0.01
Attack Frequency * Elevation	28	-0.382	0.124	0.045	0.041

3.3.5 H2 hypothesis testing - eco-geographical factors

The factors tested under this category were distance to APP, distance to nearest highway, distance to nearest railway, slope, and elevation [Table 5].

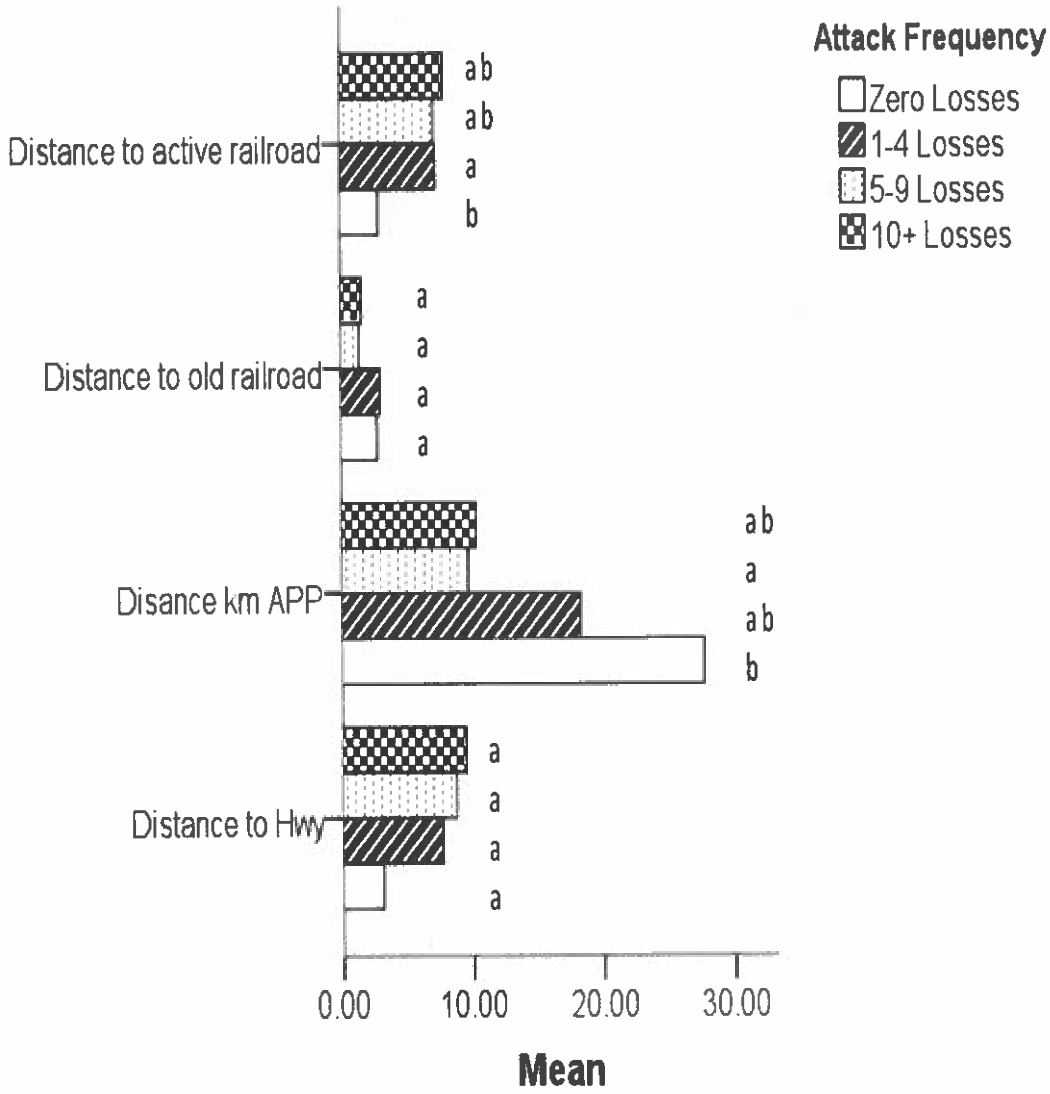

Fig. 8. Mean distance of case study farm from main highway, nearest Algonquin Provincial Park border, active and abandoned railway exiting APP [N = 28]

Distance to APP [km]

Farms located further away from APP border had lower frequency of livestock attacks [Fig. 8][N = 28, Min = 6.3, Max = 43.77, Mean = 18.85, SD = 11.4, Spearman rho = -0.596, SE = 0.096, p = 0.001, Monte Carlo sig. = 0.001; J-T Test stat. = 52.000, SE = 22.911, p = 0.002; Pairwise: zero and 5-9 attacks - J-T Test stat. = 0.000, SE = 5.292, Adj. sig. = 0.024].

Distance to nearest abandoned railway [km]

The distance a farm was located from the abandoned railway was not significantly correlated [Fig. 8][N = 28, Min = .44, Max = 13.4, Mean = 2.64, SD = 2.96, Spearman's rho = -0.098, SE = 0.162, p = 0.619, Monte Carlo sig. = 0.615; J-T = 113.500, SE = 22.904, p = 0.694].

Distance to nearest active railway [km]

Farms located further from the active railway had a higher frequency of attacks [Fig. 8] [N = 28, Min = .8, Max = 15.6, Mean = 6.25, SD = 3.96, Spearman's rho = 0.480, SE = 0.132, p = 0.010, Monte Carlo sig. = 0.010; J-T = 178.500. SE = 22.908, p = 0.015; Pairwise: zero and 1-4 attacks - J-T = 86.500, SE = 14.182, Adj. sig. = 0.050].

Distance to nearest Highway [km]

Farms located further from the highway had higher frequencies of attacks [Fig. 8][N = 28, Min = .05, Max = 14.73, Mean = 6.8, SD = 4.64, Spearman's rho = 0.440, SE = 0.116, p = 0.019, Monte Carlo sig. = 0.019; J-T = 172.500, SE = 22.908, p = 0.029; no pairwise].

Elevation [ft]

Lower elevation sites had higher frequency of attacks [Fig. 9] [N = 28, min = 884, Max = 1291, Mean = 989.04, SD = 102.88, Spearman's rho = -0.382, SE = 0.124, p = 0.045, Monte Carlo sig. = 0.041; J-T = 81.000, SE = 22.908, p = 0.070].

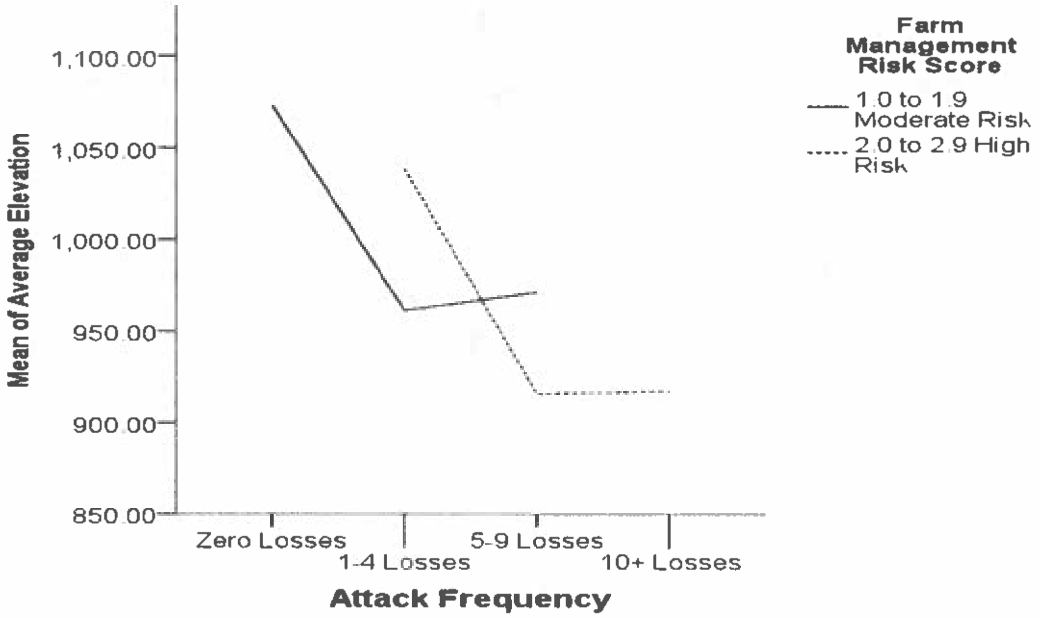

Fig. 9. Mean of average elevations for case study farms by frequency of livestock attack [moderate & high risk farms only as all case study farms scored either moderate or high risk. None were low risk or very high risk. [N = 28]

Slope [%]

The slope leading to the farm was found to be not a significant factor that determine the predation [N = 28, Min = .5, Max = 7.5, Mean = 2.46, SD = 1.55, Spearman's rho = 0.012, SE = 0.183, p = 0.953, Monte Carlo sig. = 0.954; J-T = 123.500, SE = 22.869, p = 0.965].

3.3.6. Model Results

Model 1d predicted that herd size and the distance a farm was located from the APP border have statistically significant effects on the frequency of livestock depredation events. Specifically, an increase in herd size level [using 5 groups in increments of 50 from Group 1:0 - 50 up to Group 5: >200 head in a herd] was associated with an increase in the odds ratio of higher attack frequency by 1.912 [95% CI, 1.083 - 3.375] times. An increase in distance in kilometers from the nearest APP border was associated with a decrease in frequency of attack by 0.905 [95% CI, 0.831 - 0.986] times. For example, for every 10 km distance away from the Park, there was a 9.05% reduced risk of attack on livestock [Table 6].

Table 6Model 1d Results

Results of generalized ordered regression model for predicting attack frequency of livestock farms, presented as standard errors, Wald Chi-Square values, relative odds-ratios [Exp(B) and associated p-values for independent variables for Model #1. N = 27

Model Variables	Std.Error	Wald χ^2	Exp (B)	P-Value
Herd Size	0.2899	5.000	1.912	0.025
Distance to APP	0.0437	5.211	0.905	0.022

Model 2c predicted that overall farm risk score, distance to nearest active railway and distance to APP border, all had statistically significant effects on the frequency of livestock depredation events. All farms achieved farm risk scores of either moderate or high risk. None were classified as low risk or very high risk. An increase in overall farm risk from moderate to high risk was associated with an increase in odds ratio of higher attack frequency by 0.029 [CI

95%, 0.003 -0.323] meaning that farms that were assessed to have a high risk score are 34.5 times more likely to be in a higher frequency of livestock attack compared to farms that were assessed to have moderate risk score. The distance [km] from an active railway line was associated with an increase in attack frequency by 1.314 [95% CI, 1.021 - 1.691] times. As the distance increased from the APP border, a decrease in frequency of attack of 0.905 [95% CI, 0.824 - 0.994] times was observed, which is similar to the Model 1d results. [Table 7]

Table 7 Model 2c Results

Results of generalized ordered regression model for predicting attack frequency of livestock farms, presented as standard errors, Wald Chi-Square values, relative odds-ratios [Exp(B) and associated p-values for independent variables for Model #2. N = 27.

Model Variables	Std.Error	Wald χ^2	Exp (B)	P-Value
Farm Risk Score	1.2362	8.262	0.029	0.004
Distance to Active Railway	0.1287	4.498	1.314	0.034
Distance to APP	0.0478	4.350	0.905	0.037

3.4. DISCUSSION

It is difficult to assess individual factors that may predispose livestock to predation by large carnivores because of the interdependence between farm management practices, eco-geographical variables and the behavioural ecology of predators (Kaartinen et al., 2009; Stahl,Vandel, Ruette, Coat & Balestra, 2002). Spatial analysis revealed that some farmers have chronic predation problems, with some farms experiencing more than ten events during the study period [2009-2016] whereas nearby neighbouring farms experienced none or very few predation events. Although we could not determine the reason some farms had chronic depredation when nearby farms has very few, we were able to determine some contributing factors. Prediction models used in this study suggest that herd size was the most important anthropogenic and factor and distance to APP border was the most important eco-geographical factor influencing attack frequency.

The results of the present study are consistent with other similar large carnivore studies (Bradley & Pletsher, 2005; Iliopoulos et al. 2009). Attacks on sheep & goats peaked in summer and cattle in spring when calves are young. The presence of guardian animals generally lessens the number of livestock attacks. Larger herd sizes generally increased the attack frequency. Night time enclosures were not found to be significantly effective. Iliopoulos et al. (2009) found enclosures were only effective when coupled with guardian animals as the prey could not escape attack inside enclosed areas. Farms having higher levels of human activity were found to have lower frequencies of livestock attacks. Large farms tended to have more day time human activity than the smaller hobby farms and reported attacks occurred mainly at night when surveillance of livestock was limited. Iliopoulos et al. (2009) found human activity and surveillance of livestock to be one of the most effective protection measures. The majority of case study farms had well maintained fencing and fencing was not shown as a significant factor; however, every farmer stressed the need of keeping it maintained on a regular basis and some noted observing coyotes "easily" climbing over fences that were not electrified in order to access livestock. Although this study did not analyze the number and type of guardian dogs used for protecting livestock, several farmers stated the importance of having multiple dogs and the mixing of breeds with different guarding styles. It would probably be beneficial to delve deeper into this in the future since guardian dogs in general have been quite successful in protecting herds for centuries and are still touted as being highly advantageous (Andelt, 1999; Iliopoulos et al. 2009).

In general, farms located closer to wolf territories and further from major highways have higher incidents of livestock depredation. Behdarvand et al. (2014) found that the distance to protected areas and distance to settlements were two of the most important variables influencing wolf attacks. Wolf and coyote populations in central Ontario are not evenly distributed. APP and the surrounding townships harbour the highest wolf densities in the province. My study revealed depredation levels were highest for farms located in these areas. My analysis revealed the frequency of attacks was negatively correlated with distance a farm was located from the border of APP and positively correlated with distance to highway. Wildlife is known to travel via trails and railways (MacKenzie, 2008). Our analysis revealed an increase in the number of livestock attack events as distance increased from active railways. All case study farms were located less than 16 km from either an active or an abandoned railway line. Mean distance was 6.3 km from active lines and 2.6 km from abandoned lines. We hypothesized that farms located closer to railway lines would have higher incidences of attacks on livestock; however, we found this only to be true for abandoned railway lines and not for active ones. This could be in part due to the small scale of our study as all case studies were located fairly close to a railway line and larger scale studies may clarify this better. It is also feasible that the activity on the active lines deterred predators from actively hunting too close to the railways and that the lines were merely used as a mode of travel.

Within APP borders, there are two abandoned railways that exit near the northwest corner of APP and run directly through the township of Chisholm [hot spot location]. Some portions of these lines have been converted to recreation trails and are well traveled by wildlife (MacKenzie, 2008; Theberge & Theberge, 2004). I suggest a possibility that wolves are traveling the abandoned railways and exiting the Park at a higher frequency than the other areas, offering a feasible explanation for the high levels of livestock depredation concentrated in this conflict hot spot area. Locating conflict hot spots such as Chisholm can be helpful when planning mitigation strategies and should be the focus of resources for government mitigation and future research in order to implement effective non-lethal wolf protection strategies. Further examination into the specific "hot spot" region, including investigation into railways and trails exiting the Park and specific husbandry practices such as fencing types and maintenance schedules and guardian dog studies may be helpful to interested stakeholders. This along with a concentrated effort towards raising tolerance levels through education, co-management planning and perhaps even some specific local proactive compensation program implementation to help alleviate the burden of residing in a problematic "hot spot" area, in order to work towards devising a non-lethal human-wolf conflict resolution strategy (Antoneli et al. 2016; Miller, 2015).

The additional human-wolf conflict in this area may result in higher use of lethal force. Mitigating conflict between wolves and humans should be given priority in hot spot areas such as Chisholm in order to raise tolerance levels and help protect this threatened predator. Understanding the anthropogenic and eco-geographical factors influencing predation of livestock by wolves and coyotes in the regions surrounding APP can help reduce the frequency of attacks and in turn, decrease the need or desire to opt the lethal route. Although the farms in our study area are small compared to southern Ontario standards, the issue of livestock depredation should be prioritized because the economic losses per capita are higher and therefore have greater negative influences on overall tolerance levels for wolves and coyotes in the region.

CHAPTER 4

CONCLUSIONS

4.1. THESIS SUMMARY

Wolves were once distributed throughout the entire North American continent but that changed drastically with the arrival of European settlers and their livestock several hundred years ago. The increase in human populations and in the agricultural industry initiated the decline of wolves across the continent. Today, in many regions of North America, enormous efforts are being made to reverse the damage and restore or protect the remaining populations of wolves. This thesis contributes to a better understanding of attitudes towards wolves and wolf management, provides important new insights into livestock depredation by wolves and coyotes, and therefore could aid in development of new strategies towards protection of wolves and other at risk large carnivore populations.

Chapter One gives a brief glimpse of our history with wolves in North America, discusses the important contributions from wolves towards ecosystem health, provides some background about the North American Model of Conservation, examines human attitudes towards wolves and their management and discusses issues of conflict and mitigation regarding wolves.

Chapter Two examines public attitude towards wolves and a wolf harvest ban near Algonquin Provincial Park in Ontario, Canada. This area provides a unique situation where all wild large *Canis* species are protected under a government sanctioned harvest ban because of difficulties in differentiating individual species (wolves, coyotes, wolf x coyote hybrids) without DNA testing. Wolf conservation is already a contentious issue where people are divided about how wolves should be managed. Extreme views from both ends of the spectrum (ie. all wolves should be killed to no wolves should be harmed) stemming from individual values and societal norms, creates conflicting situations between stakeholder groups having different opinions. The addition of coyotes and hybrids under government protection from harvest causes additional conflict as many local citizens do not agree with the decision.

I measured attitudes towards wolves to evaluate relevant factors affecting one's level of support for a wolf harvest ban near Algonquin Provincial Park, ON, Canada. Significant differences in attitudes were observed relative to location, hunter status and impact beliefs. There was a negative correlation between hunters, as a group, and agreement level towards the ban (r_s= -0.625, p<0.001). My generalized ordinal model indicated hunter status (X^2=42.255, p<0.001), perception of moose (X^2=8.768, p=0.033) and deer populations (X^2=25.462, p<0.001), and distance from wolf territory (X^2=6.089, p= 0.014) were predictors of agreement levels. Those living further from the Park (wolf territory) had more positive attitudes towards wolf harvest ban (r_s= -0.625, p<0.001). Efforts to improve public support should focus on groups having shared values, such as hunters, and people affected by human-wolf conflict, such as those living nearest wolf territories, because they tend to have the most negative attitudes towards wolves.

Chapter Three investigates livestock depredation by wolves and coyotes in Ontario, Canada. Many large carnivore species are declining rapidly due in part, to their involvement in depredation of livestock. Eastern wolves are a threatened species with less than 500 adults in

Ontario. Algonquin Provincial Park in Ontario is home to the majority of Eastern wolves. Recently, wolf territories have been expanding outside the park borders, thereby potentially interacting with human settlements, and thus, leading to increased human-carnivore conflicts. I examined the anthropogenic and eco-geographical factors influencing livestock depredation rates by wolves and coyotes at 28 livestock farm locations near Algonquin Provincial Park.

Overall, 75% of the farms examined experienced at least one depredation event from 2009 to 2016, with 21% of these farms experiencing 5 attacks or more. Attack frequency was positively correlated with herd size [r_s= 0.50, p = 0.007], overall management risk score [r_s= 0.438, p = 0.023] distance to highway [r_s= 0.440, p = 0.019] and distance to active railways [r_s= 0.480, p = 0.010] and negatively correlated with distance to Park [r_s= -0.596, p = 0.001]and elevation [r_s= -0.382, p = 0.045]. Sheep/goat farms had the highest number of losses [38.2%] and the attacks peaked during summer months [33.3%]. Results of generalized cumulative models indicated herd size, distance to protected zone, and overall management score to be influential factors determining susceptibility to attack. Concerted efforts towards raising tolerance to these attacks through education, co-management and targeted compensation programs may help lessen the burden on depredation hot spots.

Overall Thesis Objectives

There were three main objectives for this thesis. The first objective was to discuss the history and ecological importance of large carnivores, concentrating mainly on wolves. It is important for people to learn about the history of wolves and other large carnivores, to have knowledge about the effects that large carnivores have on whole ecosystems and to gain a greater understanding of the costs and benefits of large carnivores in order to work towards human-carnivore coexistence. This objective was accomplished in Chapter One. The second thesis objective was to develop a better understanding of the attitudes that people have towards wolves. Views about wolves and wolf conservation are often polarized and this can cause social conflict among different stakeholder groups. In order to move towards coexistence with wolves, it is important to gain a greater understanding of the differing viewpoints and attitudes that people have towards them. This objective was accomplished in Chapter Two. The final thesis objective was to develop a better understanding of livestock depredation from wolves and coyotes near a protection zone and wolf territory. At risk species often have protective legislation put in place in order to safeguard future generations. However, when the protected species is also a predator of livestock, there are additional considerations. Gaining a greater understanding of the factors affecting livestock depredation levels will aid in taking more proactive and non-lethal approaches to protect livestock which in turn will lessen the impact that lethal protection methods have on species at risk. This objective was accomplished in Chapter Three.

4.2. MANAGEMENT IMPLICATIONS

Large carnivore conservation strategies often fail when based purely on biophysical evidence and the integration of human dimensions research is imperative for successful development and delivery of effective large carnivore conservation plans. A true integration of the biological and social sciences must take precedence where large carnivore conservation is concerned. Understanding and addressing wolf management requires the cooperation of many interest groups. Understanding the beliefs and attitudes of these groups will help to ensure more effective decisions and easier implementation of management plans.

The successful conservation of large carnivores requires more intensive management and public education in order to maintain ecosystem health and find a balance between human and wildlife needs. Government support can help ease the burden placed on individuals in areas where human-carnivore conflict is highest (hot spot areas). Education can modify behaviours, lower losses of livestock due to depredation from predators and help lessen the use of lethal control of predators and thus to increase public support for conservation policies.

Support of wolf conservation is imperative for their recovery and long term survival in many regions across North America and the lack of communication between different interest groups is perhaps one of the most important issues affecting this support. Differing cultures, values and lifestyles equate to differing attitudes and opinions as to how wolves should be managed. Management plans should reflect the views of all citizens. Decision makers must gain a better understanding of existing views so that they can translate them into more effective policies. In order to ensure that decisions regarding wolf management do not have a tendency towards one side or the other, there should be more emphasis placed on the human dimensions component of wildlife conservation. Decision making processes should be based on a consensus of values and attitudes towards wolves and their management. Interested stakeholder groups could begin with discussion sessions involving informing and listening to other perspectives. Issues of mistrust and historical social conflict must be dealt with in a calm and safe environment, and would probably require independent mediators. Conflict between the different stakeholder groups can only be addressed when there is a willingness to listen to differing viewpoints while having some common goals kept in clear focus during the entire process. Development of community co-management programs may help raise tolerance levels of large carnivores such as wolves in order to learn to better coexist with these animals. The outcome of this study thus addresses all of the important above said aspects of wolf management by providing better understanding of the ecological, cultural and social aspects of this problem and therefore hopes to help the decision makers to adopt an effective wolf population management strategy in this important area.

4.3. RECOMMENDATIONS FOR FUTURE RESEARCH

Results from the attitudes study show that approximately half of respondents did not feel they had proper access to trusted information regarding wolves near Algonquin Provincial Park. It is important that the public is involved in conservation efforts and policy development so that the public is able to make informed decisions or contribute to adopting strategies. An effort to improve communication and trust between conservation managers and local residents is needed. Targeted analysis of local communities versus urban populations would help generate a map of attitudes and perceptions that would provide a baseline data that can be used to aid wildlife managers in designing more effective carnivore management strategies and enhanced conservation performance.

The assessment of attitudes in this thesis revealed significant difference between hunters versus non-hunters, resident distances from a known wolf territory and personal perceptions of wildlife population levels (wolf, deer, moose). Future research therefore should include further attitudinal studies in the regions surrounding Algonquin Provincial Park. Data should include social, cultural and geographic factors such as location, age, occupation, religion, education, direct and indirect experience with wolves, knowledge about wolves and group membership.

Traditionally, predator management focused on mitigating the conflict from livestock depredation by erecting barriers such as electric fences to keep predators out, using lethal force to eliminate predators or offering financial incentives as compensation to farmers for losses. Gaining a better understanding of the anthropogenic and eco-geographical factors that can influence depredation levels will aid managers in finding alternative solutions for conflict mitigation. Research into more effective non-lethal predator protection in specific hot spot areas would be helpful to adopt better management strategies. A combination of traditional and incentive-based instruments designed to address the economic and social factors is suggested to help raise tolerance levels towards predators such as wolves and coyotes. There is a need for better education to address the myths and misconceptions about wolves and for specifically targeted education programs for specific groups, such as livestock farmers and hunters. Wolf management is a contentious issue. Achieving a balance between the needs of humans and the needs of wolves is as much a socio-political issue as a biological one, and will require a significantly better understanding of the human dimensions involved in order for humans and wolves to coexist. This thesis is but one small step towards this process.

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APPENDICES

CHAPTER 2 STUDY – QUESTIONNAIRE

CHAPTER 3 STUDY – OMAFRA INTAKE FORM FOR LIVESTOCK VALUER

CASE STUDY INTAKE SURVEY

QUESTIONNAIRE 2014/2015

ALGONQUIN PARK & SURROUNDING TOWNSHIPS WOLF MORAORIUM

1. What Township do you live in?____

2. What are your feelings about the Algonquin Park wolves?
Strongly like____ like ___ neutral ___ dislike ___ strongly dislike ___

3. Where do you get your information about wolves?
Local newpapers ___ books ___ tv/internet ___ Algonquin Park ___ other ______________

4. Do you believe the wolf population in the area has changed over the last 10-15 years and in what way?
Nochange ___ there are more wolves now ___ there are less wolves now ___ don't know___

5. Do you believe the deer population in your area has changed over the last 10-15 years?
No change ___ more deer now ___ less deer now ___ don't know ___

6. Do you believe the moose population in our area has changed over the last 10-15 years?
No change ___ more moose now ___ less moose now ___ don't know ___

7. Did you know there was a wolf moratorium in place in Algonquin Park and surrounding areas since 2001?
Yes ___ No ___ Yes but did not know the length of time _______

8. Do you feel you have adequate access to information about the wolves?
Yes ___ No ___ no opinion ___
Please add any comments: _
____

9. Do you agree with the wolf moratorium?
Strongly agree ___ agree ___ neutral ___ disagree ___ strongly disagree ___
Please add any comments:_
____

10. Do you think the wolf moratorium has had an impact on the deer population in the area?
Yes ___ No ___ Don't know ___

11. Do you think the wolf moratorium has had an impact on the moose population in the area?
Yes ___ No ___ Don't know ___

12. Has the wolf moratorium affected you personally?
Yes ___ No ___ Don't know ___
Please add any comments: ____

13. Have you ever attended the Algonquin Park Wolf Howl?
Yes ___ No ___ If yes, what year(s)? __________Would you go again? __________________

14. Have you visited the Haliburton Forest wolves?
Yes ___ No ___ If yes, what year(s)? __________ Would you go again? __________________

15. Do you hunt?
Yes (I hold a current license) ___ Yes, I have in the past but not currently ___ No, never ______

16. Are you a trapper?
Yes (I hold a current license) ___ Yes, I have in the past but not currently ___ No, never ______

Further comments are welcomed: ____
____
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____

Ontario Wildlife Damage Compensation **Program Application**

Note – This form is to be used by all livestock and poultry owners and valuers. Clear Form

Section 1 – Identification

Name of Valuer

Last Name	First Name

Farm Location (where the damage occurred)

Lot No.	Concession No.

County/Region/District

Municipality	Vendor Number (to be completed by OMAFRA)

Section 2 – Owner/Business Information

Owner of Livestock/Poultry – Contact Information

Owner Last Name	Owner First Name

Social Insurance No. (SIN) or Business No. (BN)

Mailing Address

Unit No.	Street No.	Street Name	Rural Route	PO Box
City/Town			Province	Postal Code
Email Address			Telephone No.	Fax No.

Section 3 – Description of Livestock/Poultry Killed or Injured

Description – Include species and breed.

Kill or Injury Date (yyyy/mm/dd)

Description of Injuries Sustained – Attach photographs (3-6) of the injured livestock/poultry to indicate attack site, wounds and other pertinent evidence.

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Section 4 – Description of Predator

Description – Species

Description of the supporting evidence.

Section 5 – Valuation

Species	Number of Head(s)	Live Weight (lb or kg)	Market Price (lb or kg)	Additional Value Over Market*	Veterinary Costs for Injured Animals	Total Value of Animal	Less Amount to be Claimed by Insurance	Compensation Applied For **
							Total Compensation Applied For ($)	

* For bred, purebred or high quality animals, animals must have physical identification that corresponds to written records. Copies of records supporting the additional award must be attached to this report.
** Total Compensation applied for must not exceed the program limit (% coverage and per species maximums).

Section 6 – Reasonable Care

Risk Assessment

Current Regional Predation Risk is
☐ High ☐ Medium ☐ Low

Regional Risk of Predation is
☐ Increasing ☐ Stable ☐ Decreasing

Predation on this farm is
☐ 1st incident ☐ 1 claim/year ☐ 2 claims/year ☐ 3 or greater claims/year

Most Recent Predation Date(s) (yyyy/mm/dd)

Describe actions taken by owner to decrease likelihood of predation since last claim

Farm Management

Health condition of the livestock herd/poultry flock
☐ Healthy ☐ Diseased ☐ Sick

Herd/Flock Size

Location where the kill/injury occurred
☐ Barnyard ☐ Pasture-Near Buildings ☐ Pasture-Distant
☐ Other (specify)

Livestock Inspection Frequency – How often, by whom?

Livestock/Poultry confined at night?
☐ Yes ☐ No

Dead Livestock Disposal Practices
☐ Collected ☐ Buried ☐ Composted
☐ Other (specify)

Fencing Description – Type/Condition

Type of Guard Animals Used (if any)

Other Predator Prevention Practices Used

Owner will implement the following practices to prevent/reduce future predation

Valuer Finding – I have found that the owner:

☐ Had taken reasonable measures to prevent predation ☐ Had not taken reasonable measures to prevent predation

[illegible] Page 2 of 4

Section 7 – Program Compliance Verification

☐ Farm Business Registration (FBR) No. ______________________

OR

☐ Farm Business Registration (FBR) No. Alternate

- An OMAFRA Gross Farm Income Exemption Certificate for New/Retired Farmers that do not currently qualify to obtain an FBR number,
- A confirmation letter provided from the Indian Agricultural Program of Ontario (IAPO) for premises situated on First Nations Land, or
- A Religious Exemption approved by the Agriculture Food and Rural Affairs Appeal Tribunal

Explanation (supporting verification must be supplied)

☐ Premises ID No. ______________________

OR

☐ Premises ID No. Alternate

- A confirmation letter provided from the Indian Agricultural Program of Ontario (IAPO) for premises situated on First Nations Land

Explanation (supporting verification must be supplied)

Section 8 – Valuer Declaration and Signature

☐ I have found sufficient evidence, to the best of my knowledge and belief, that the livestock/poultry in question has been killed or injured by a predator within the requirements of the Ontario Wildlife Damage Compensation Program and the owner is eligible for the amount of compensation indicated above.

OR

☐ There was insufficient evidence to make a finding due to deterioration or lack of carcass remains

☐ Died of natural causes, sickness or disease

☐ Scavenged only – did not die from predation

☐ Damage was caused by a dog owned or habitually kept on premises of owner of livestock and/or poultry

☐ Other reason claim is declined (specify)

☐ I hereby certify that the information I have provided in this Application Form is true and accurate to the best of my knowledge. I also understand that submitting false or misleading information in this Application Form could result in the denial of the claim. I further understand that any payment the municipality that I work for receives from OMAFRA under the Ontario Wildlife Damage Compensation Program as a result of the submission of false or misleading information I have submitted may have to be repaid by the municipality I work for to OMAFRA.

Valuer Mailing Address

Unit No.	Street No	Street Name	Rural Route	PO Box
City/Town			Province	Postal Code
Email Address			Telephone No.	Fax No.

Valuer Signature

Valuer Last Name (Print)	Valuer First Name (Print)	
Position	Signature	Valuation Date (yyyy/mm/dd)

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Section 9 – Notice of Collection of Personal Information

Any personal information collected on this form, such as the Social Insurance Number of an individual acting as a sole proprietor or as an unincorporated partner in a partnership, is necessary for income tax purposes because a payment is being made as well as for the overall administration of the Ontario Wildlife Damage Compensation Program. More specifically, the Social Insurance Number will also be used for auditing and the collection of any debts incurred under the Ontario Wildlife Damage Compensation Program. The Social Insurance Number is being collected pursuant to the *Income Tax Act* (Canada), as amended and the Order-in-Council that established the Ontario Wildlife Damage Compensation Program.

Questions as to the collection of this information may be directed to:

Ontario Ministry of Agriculture, Food and Rural Affairs
1 Stone Road West
Guelph, Ontario N1G 4Y2
Tel: 519 826-4047 or 1 877 424-1300 (toll free)
Email: ag.info.omafra@ontario.ca

Section 10 – Livestock and Poultry Owner Declaration and Signature

☐ I hereby certify that the information I have provided in this Application Form is true and accurate to the best of my knowledge. I also understand that submitting false or misleading information in this Application Form could result in the denial of this claim and any potential future claims that could be made by myself, myself on behalf of another person or any other person affiliated with myself in any type of business relationship in which this claim is being made may have under the Ontario Wildlife Damage Compensation Program and/or a requirement that any compensation received under the Ontario Wildlife Damage Compensation Program as a result of the submission of false or misleading information be repaid.

Owner Signature

Owner Last Name (Print)	Owner First Name (Print)

Signature	Date (yyyy/mm/dd)

Completed applications and all supporting documents should be submitted to your local Municipal Clerk.
If the damage occurred in an unincorporated township (a territory without Municipal organization as defined in Section 2 of the *Northern Services Board Act*), completed applications and all supporting documentation should be submitted to the Ontario Ministry of Agriculture, Food and Rural Affairs.

Print Form

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Livestock Depredation Case Study 2015-2017

Case Study Intake Form

Case Study # ______________________

Intake Date ______________________

Name of Farm Owner ______________________

Farm Location Address ______________________

____

Location Township ______________________

GPS Coordinates ______________________

Lot & Concession # ______________________

Nearest human settlement:________ **kms. Place name:** ______________________ **Pop.**______________

Lot Size (# of acres) ____________ **Total # of acres devoted to livestock** ______________

List of Attachments (photos; maps, field notes etc.)

____

____

Notes: ______________________

Page 1 of 6

Livestock Type	# of Head (Herd Density)	# of Acres (Grazing area)	Type of Fencing (see list)	Distance to Forest (Meters)	Distance to Farmhouse (Meters)	Loss due to predation (yes/no); Date	Animal Details: Sex; Age; Health of animal: (Good/Injured/Sick/Old)	Compensation $ Amount Received
Cattle: Dairy Heifers/Steers								
Dairy calves								
Cattle: Beef Heifers/Steers								
Beef calves								
Sheep								
Lambs								
Goats								
Swine								
Chicken								
Turkey								
Horses								
Other								

Note: Fencing Type Examples: Page wire; Barbed wire; Suspension (high tensile); Smooth wire suspension (12.5 gauge high-tensile); Barbed wire suspension; Electric. See attached OMAFRA fencing information sheet for full descriptions.

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LIVESTOCK GUARDIAN ANIMALS

Guardian Species	Age	Sex	Herd Type	Herd Size	Injury/death from Predator	Date of Incident	Predator Species	# of Predators
Dog (type)								
Llama								
Donkey								
Other								

OTHER PROTECTION MEASURES

Lighting Used for Protection: Yes _______ No ___________

Fladry Used for Protection: Yes _______ No ___________

Other Protection Measures Used:

____

____

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PREDATOR CONTROL

Agent Name & Contact Info or Independent	Date	Predator Species	# of Predators if known	Method Used (Lethal/ Non-lethal)	Outcome of Depredation Issue (Removal: Success/Fail)

Page 4 of 6

Wolf or coyote sightings in your area within last 5 years? Yes _____ No _____

Date __________ **Type** _______________ **# Observed** _________

Date __________ **Type** _______________ **# Observed** _________

Date __________ **Type** _______________ **# Observed** _________

PRACTICES & HABITS ON THE FARM

# of years farming livestock (owner) ________________

Do you work at the farm full time? Yes _____ No _____

Outside Employment: Yes __ No __ Full Time __ Part Time __ Seasonal _________

# of Family Workers on Farm _________

# of Farm Employees _____ # of hours/week/employee ____

Animal husbandry practices Yes _____ No _____ Species: ____

Details (Time of year for births, how often, how many, etc..)

____

____

____

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Dead-stock disposal practices: Please Describe.

____

____

If you have experienced losses due to depredation, did you change your protection practices? Yes____ No ____

____

____

Are there any suggestions you would like to add regarding livestock protection and depredation?

____

____

____

Additional comments?

____

____

____

____

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