Risk Perceptions and Public Willingness to Support CWD Management in Canada

by

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Abstract

In this study, we explore how the Canadian public's risk perceptions regarding Chronic Wasting Disease (CWD) are related to their willingness to support increased surveillance for CWD -a neurological disease that affects certain species of deer, elk and moose. In our case, the relationship is not the level of risk perceptions held but how exposure to different sets of risk perception questions may prime survey respondent's willingness to support additional taxes for CWD surveillance. Due to the nature of CWD, the risk perceptions defined and researched in this study are food safety risk perceptions, animal health risk perceptions and economic risk perceptions, a mixture of personal (e.g., food safety to oneself) and altruistic risk perceptions (e.g., food safety risks to animal, risks to industry and economy). Public incentives to control CWD could be driven by priming and information provision.

A national survey was used to collect data from which probit and tobit regression models were estimated to explain factors affecting the individual risk perceptions. The survey was designed with 10 treatments representing exposure to different combinations of risk perception questions. The results showed heterogeneity in risk perceptions across sociodemographic characteristics and attitudes to wildlife, for example. Risk perceptions were related to meat eating preferences, knowledge of CWD, and public perception and relationship to wildlife and the environment. A set of referendum questions on programs to increase CWD surveillance were also used to investigate the factors influencing the public's willingness to pay additional taxes to support CWD surveillance. Results suggested that risk perceptions, willingness to pay additional taxes depends on sociodemographic characteristics, venison consumption behavior, wildlife perceptions, and views of the environment. Individuals who have eaten venison are more likely

to vote yes for the referendum. Positive perceptions of wildlife, venison consumption, concern for nature and participation in more wildlife related activities are associated with higher willingness to pay taxes. Willingness to pay for CWD surveillance is also dependent on exposure to different types of risk questions. Individuals who were exposed to questions related to all three risks had the highest willingness to pay for additional CWD surveillance. Also, individuals who were exposed to questions related to animal health and economic risk were willing to pay slightly more in taxes than individuals who were exposed to food safety risk questions.

Preface

This thesis is an original work by Merlin Uwalaka under the supervision of her graduate supervisor Dr. Ellen Goddard. The research protocol for this study was approved by the University of Alberta Research Ethics Board (Pro00081014).

The research conducted for this thesis forms part of a social science research collaboration led by Drs. Vic Adamowicz, Ellen Goddard, Marty Luckert, Brenda Parlee and John Pattison-Williams, as well as several grad students and post-doctoral researchers in the Department of Resource Economics and Environmental Sociology at the University of Alberta.

This work is dedicated to my parents,
Merlin and Franklin Uwalaka,
my siblings,
Mary Offurum, Franklin, Monica, Arthur, Michael and Marvin Uwalaka,
and all the communities that welcome me with love.

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CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

Chronic Wasting Disease (CWD) belongs to the family of diseases known as transmissible spongiform encephalopathies (TSEs) or prion diseases. This specific prion disease is known to affect deer, moose and elk in Canada. CWD has also been found in reindeer in Europe. Other examples of TSEs include Bovine Spongiform Encephalopathy (BSE) in cattle, Scrapie in sheep, and Creutzfeldt-Jakob disease (CJD) in humans, however CWD is a distinct disease only known at this time to naturally affect members of the cervid family (Alberta Agriculture and Forestry, 2017).

The first discovery of CWD in Canadian cervids occurred at the Toronto zoo in 1978, with the next independent incident occurring on a Saskatchewan elk farm in 1996. This 1996 finding was 29 years after it was first discovered in Colorado in a joint study between Colorado University and the University of Wyoming. By 2002, the disease had spread from Saskatchewan and was identified on an Alberta elk farm. CWD was discovered in the wild in Alberta in 2005. As of February 2019, the disease has spread to 24 American states and the Canadian provinces of Saskatchewan, Alberta and Quebec and continues to increase in prevalence (Centers for Disease Control and Prevention [CDC], 2019; Canadian Food Inspection Agency [CFIA], 2019).

In the 2018/2019 hunter surveillance samples, CWD was discovered in five new Wildlife Management Units (WMU) in Alberta. The disease was detected in seven new wildlife management zones (WMZs) in 2019-20 in Saskatchewan (Saskatchewan Environment, Public Health and Safety, 2020). The yearly total number of positive cases of CWD in wild-white tail and mule- deer in Alberta has risen exponentially from 4 in 2005, to 579 in 2018. The annual total number of domestic cervid herds confirmed to be infected with CWD in Canada peaked at 21 in

2001. Domestic herds continue to test positive for CWD with an average of 4 herds per year testing positive until 2020 when there were 12 herds testing positive. In addition, a new red deer herd tested positive in Quebec in 2018. The increased prevalence of CWD could cause concerns for different stakeholder groups.

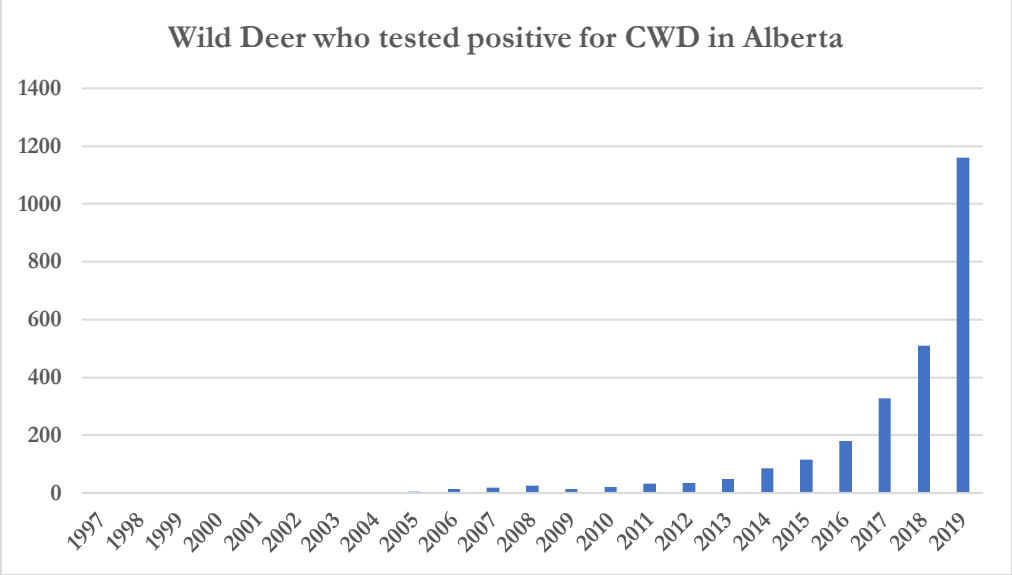


FIGURE 1.1: NUMBER OF POSITIVE CASES OF CWD IN WILD DEER IN ALBERTA WILDLIFE MANAGEMENT UNITS FROM 2005-2019. SOURCE: ALBERTA ENVIRONMENT AND PARKS (AEP), 2019.

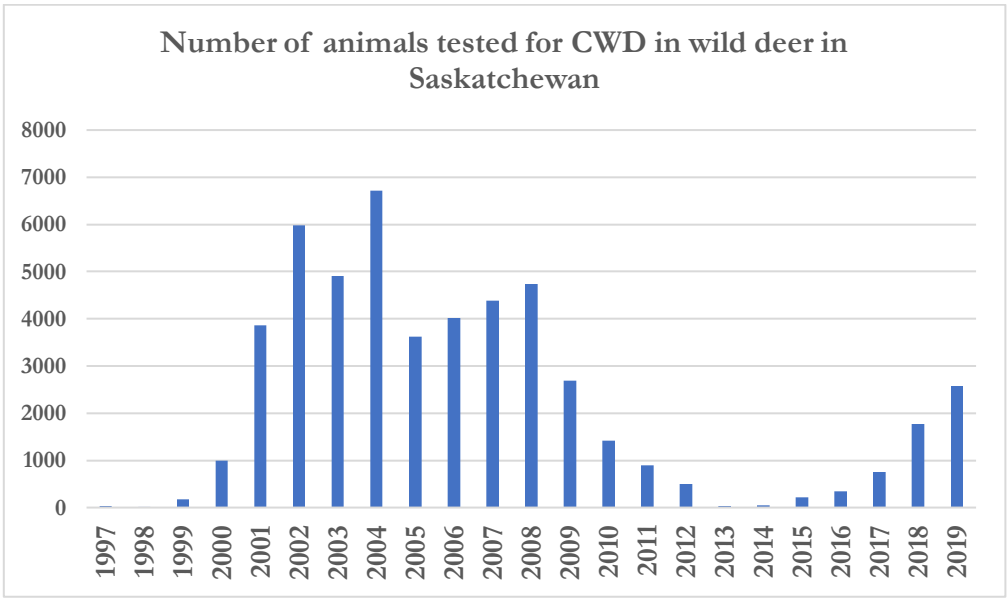


FIGURE 1.2: NUMBER OF POSITIVE CASES OF CWD IN WILD DEER IN SASKATCHEWAN WILDLIFE MANAGEMENT ZONES FROM 1997-2019. SOURCE: CANADIAN WILDLIFE HEALTH COOPERATIVE, 2019.

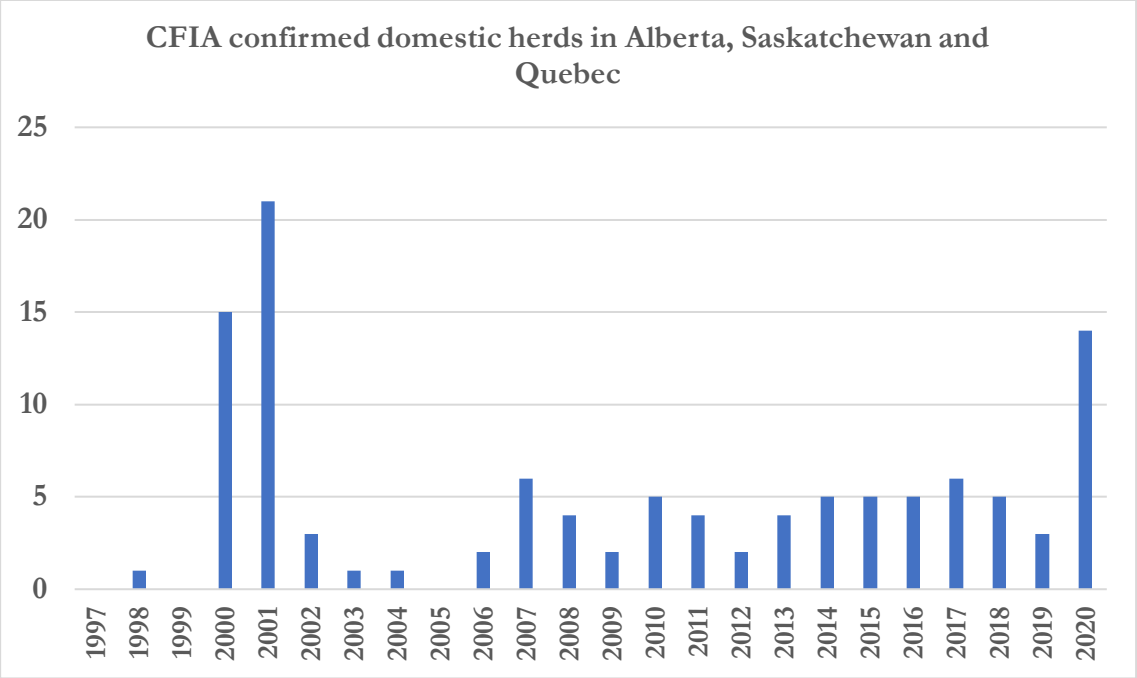


FIGURE 1.3: DOMESTIC CERVID HERDS CONFIRMED TO BE INFECTED WITH CWD IN CANADA. SOURCE: CANADIAN FOOD INSPECTION AGENCY (CFIA), 2020.

1.2 POTENTIAL RISKS POSED BY CWD

Since the discovery of CWD in Canada, there has been nuanced debates and continuous research on the potential impact of CWD on human health, animal health and the Canadian economy (Needham and Vaske, 2008; Bishop 2004; Maye, 2015).

In the case of animal health risks, there is the concern that CWD will be transmitted from the currently susceptible species of cervids to other animals, including other cervids, other wild animals, farm animals and pets (AEP, 2019; Mathiason et al., 2013). If the disease is transmissible across species barriers, potentially to other mammals, then humans may be at risk of being infected with CWD possibly through venison consumption (Needham and Vaske, 2008; Muringai and Goddard, 2018) or animal handling. The behavioral changes and market responses to the animal health and human health risks posed by CWD might have economic impacts on deer-

related -industries-deer and elk farming, outfitting firms, tourism, hunting, - both directly and indirectly (Bishop 2004; Maye, 2015).

In the following sections, I will explore these risks in detail.

1.2.1 Animal Health Risk

With an increasing number of positive cases and a prion-contaminated environment, there is an increased chance of domestic animals, wild animals, and other cervids coming in contact with infected deer, elk, moose and CWD contaminated environments (Kurt and Sigurdson, 2016; Beringue et al., 2012; Mathiason et al., 2009).

In the western regions of North America, CWD primarily occurs in wild mule deer, farmed elk and farmed white-tailed deer (AEP, 2019). Usually, transmission happens from deer to deer or through environmental contamination (Miller et al., 2004). CWD is now well established in four species of cervids but it is not impossible for other cervid species to contract CWD (Herbst et al., 2017; Barria et al., 2018). Infected cervids are also in close proximity to other wildlife species and domestic animals, and pets. Immediately, CWD raises concern for the susceptibility of other species- other wild animals, farm animals, and domestic animals- to CWD (Mathiason et al., 2013; Kurt & Sigurdson, 2016). Research

Transmission between susceptible species is not difficult. Vertical transmission occurs from mother to offspring, and horizontal transmission occurs through bodily fluids (Nalls et al., 2013). Cervids that carry the disease shed prions into the environment through saliva, feces, and urine. These prions persist in the environment for years and can be sources of infection to other animals who come into contact with them (Bartelt-Hunt and Bartz, 2013). In the case of farm animals' studies in the US it was shown that CWD spread is accelerated by fence line interaction between wild and farmed cervid populations (Fischer et al., 2011; VerCauteren et al., 2007).

Experimental infection shows that other domestic animals such as goats, sheep, cats, rodents, and cattle are susceptible to Chronic Wasting Disease and there could still be potential risk of transmission associated with the spread of CWD to other species. CWD has been experimentally transmitted through various routes (e.g., intracerebral inoculation) to various species, including hamsters, cats, cattle, and nonhuman primates (Race et al., 2009; Hamir et al., 2007). Species seemingly more susceptible to CWD include goats, cattle and farm animals that have come in contact with infected herds (captive or wild) over a long period of time (Williams, et al. 2002).

1.2.2 Food Safety Risks

With CWD spreading geographically, and an increased number of positive cases, human exposure to CWD prions is more possible. Canadians are exposed to cervids, and materials derived from cervids through a variety of sources, and routes of exposure, including in their diet, through animal handling in hunting and through the use of natural health products that contain antler velvet (Lazo et al, 2004; Angers et al., 2009).

CWD could be a specific food safety concern for known subpopulations, including rural and Indigenous populations that have a higher dietary exposure to venison and who rely on cervids as a vital source of protein (CFIA, 2018). The food borne transmission of BSE from cows to humans implies that humans may be susceptible to other prion diseases (Needham & Vaske, 2006, 2008; Vaske et al., 2004; Myae and Goddard, 2010; Muringai and Goddard, 2018; Kurt and Sigurdson 2016). Studies have examined the potential of CWD prions causing

Health Canada issued a report in April 2017 to warn about the potential human health risks from Chronic Wasting Disease. The report highlighted findings from a research project (Czub et al. 2017) whose results indicated that CWD had been transmitted to a primate species

closely related to humans through oral exposure. The Health Canada report recommended a "precautionary approach to the management of the potential risks of exposure through food…" (Health Canada, 2017).

The potential food safety and human health impact of CWD has led provinces like Alberta and Saskatchewan to implement mandatory CWD programs. These programs require the testing of farmed cervids older than 12 months, that die from any cause (CFIA, 2020). Depending on the province, hunters are also expected to participate in mandatory or voluntary head submission for CWD testing. Testing of hunted heads is mandatory or voluntary depending on wildlife management unit or zone. In Manitoba, head submission is also mandatory or voluntary depending on Game Hunting Area. In provinces like BC and Ontario, head submission is only voluntary and passive and sometimes incentivized.

Since only the provinces of Alberta, Saskatchewan, Manitoba, Quebec and the Yukon, require the mandatory testing of farmed animals before entering the food chain, there is a possibility of CWD infected venison being allowed to enter the food chain in provinces where mandatory testing doesn't exist (Roussy, 2019; Rieger, 2019). While individuals may purchase venison from certain establishments licensed by the provincial or federal government, eating venison in provinces where mandatory testing is not implemented or from hunted deer may raise concerns about the food safety risks associated with venison consumption.

For individuals who consume venison from hunting (hunters and Indigenous populations), through retailers, or in restaurants, there is the concern of eating meat contaminated with CWD (Roussy, 2019). According to a CBC article written by Rieger (2019), elk meat from 21 herds where CWD was found had been released into the food chain between 2015 and 2019 from farms in Alberta and Saskatchewan, even though both provinces require mandatory testing. According to a 2011 survey of Canadians, 55% of households had someone who had eaten

venison (Myae, 2015). In the 2018 survey conducted for this study, 80% of respondents had at least one member of their household who had ever consumed venison. Most of these individuals have consumed venison either in restaurants or through retailers. Since the meat consumed is not labelled as "CWD free" or "CWD tested", the possibility of CWD infected venison, or venison from infected herds entering the food chain especially from provinces where mandatory testing is not implemented is of concern (Rieger, 2019).

Traceability and testing are useful in surveillance. Surveillance measures are put in place to ensure evidence of disease freedom for cervid farmers. Testing is also a way for cervid producers and individuals like hunters to prove that their products and food are free of CWD. CWD surveillance and monitoring is important for the understanding and avoidance of the risks posed by the disease. CWD surveillance is useful for individual producers and marketers to show disease freedom in herds of origin. The producers are expected to produce samples for testing from elk, deer and reindeer that die for any reason. (Government of Alberta, 2020). Programs like these are useful for disease detection and surveillance, providing a level of assurance of CWD freedom, as well as an indication of potential CWD risks. These surveillance programs exist to help mitigate public concerns of food safety and health risks from either venison consumption or contact with other cervid materials.

Schroeder et al. (2007) showed that government regulatory practices like surveillance depend on consumers concerns/ preferences for attributes. Food safety attributes like traceability and testing can be useful to improve consumers' confidence. Studies have tried to measure how the presence of an animal disease may affect food safety concerns to evaluate attitudes towards risk management (Pennings et al., 2002; Schroeder et al., 2006; de Jonge et al., 2008).

Specifically, for Canada and CWD, Myae (2015) explored how risk perceptions of venison in the context of CWD affects willingness to pay (WTP) for CWD related food safety attributes-

traceability and testing. Her study and others (Forbes, 2011; Muringai 2016; Yang and Goddard 2011a) found that concerns about CWD and varying levels of perceived disease prevalence affected people's behavior including willingness to pay for disease monitoring. Concerned respondents with higher CWD risk perceptions, were willing to pay higher amounts for traceability and testing in venison purchases. Unsurprisingly, these changes in behavior were influenced by their perceived risk of CWD in their lives.

Currently, there is no evidence to show that CWD has been transmitted to humans. Past studies investigating the potential of CWD transmission to humans using two different species of nonhuman primates- squirrel monkeys and cynomolgus marquees (Kurt and Sigurdson, 2016; Race et al., 2014). CWD could be transmitted to squirrel monkeys through intracerebral infection however, this does not hold true for cynomolgus macaques up to 13 years post inoculation. (Race et al., 2014; 2018). Results from these studies show that the chances of CWD infecting humans is low however, the possibility of CWD infecting humans may cause public health concerns (Williams and Miller, 2002, 2003; Williams et al. 2002; Belay et al., 2004; MaWhinney et al., 2006).

1.2.3 Economic Risks

Since human health concerns are tied to behavioral changes, animal disease incidents can also affect sales, reputation of businesses, consumer perceptions and economic behaviour (Myae, 2015). Concerns about animal health and infection from venison consumption would result in behavioral changes for different groups- hunters, restaurant goers, and tourists (Petchenik, 2003; Bishop 2004). These activities have economic value for the local economy, those employed in the industry, and increased CWD prevalence could reduce these values. If research shows that there is an increased potential for human and animal infection, there would be an increased economic effect felt by cervid related industries (Lazo et al., 2004).

The economic impact of an animal disease like CWD could vary across areas, ecosystems, people, species and experiences (Petigara et al. 2011; Geist et al., 2017). For example, the deer and elk farming industry were affected by international trade restrictions that reduced demand for their products. More negative impacts can result due to changes in consumer behavior in adjacent industries like hunting and tourism.

The direct impact on cervid farmers includes losses from death or reduced productivity of infected livestock. There is also additional cost of management practices like mandatory testing and carcass disposal. In addition to the direct economic effects to cervid farming industry, prudent policymaking would find it in its best interest to consider the indirect economic costs for other stakeholders. Examples of stakeholder issues loss of revenue for outfitting firms who generate income from hosting and advising hunters, increased food security issues for Indigenous communities who use deer, elk or moose as a source of protein, and lost tourism revenue for national parks and towns due to declining cervid population.

The economic impact analysis conducted by Lazo et al., 2004 suggested that in Wisconsin, a 5% to 25% reduction in hunting days as a result of CWD could mean a two to eleven million dollars reduction in hunting expenditure- accommodation, food, equipment, transportation. In early 2002, the economic losses from CWD to the Wisconsin economy were estimated to be over $50,000,000 in that year (Bishop et al., 2004). For example, Erickson et al., (2019) explored the effect of Chronic Wasting Disease on Resident Deer Hunting Permit Demand in Wisconsin and found that CWD decreased permit demand by 5.4% following the 2002 outbreak. Petigara et al., (2011) explored the effect of CWD on the economy in Alberta and the rest of Canada. Their results found that CWD not only affected the cervid industry, but also other industries that are linked directly or indirectly.

Since management strategies can be expensive, it is crucial that there be public approval and participation in proposed control/surveillance schemes. Therefore, it is important to understand public incentives to control the disease. Understanding the public's incentive regarding disease management ensures that policies align with risks that the public view and rank as essential and agencies are addressing the public's most pressing concerns. This is to ensure the efficacy of resource allocation and optimum value for money invested in disease management. Therefore, it is essential to answer the question of how the public would like to invest in reducing the spread of an animal disease like CWD in a valued wildlife population like cervids (Bicknell et al., 1999, Horan and Wolf, 2005).

1.3 Factors Influencing Individual Member of the Public's Decision Making regarding CWD management

Several studies have shown that for prion diseases like CWD, risk perceptions and risk attitudes, influence preferences for interventions needed for CWD management (Decker et al., 2006; Vaske and Lyon, 2010; Myae 2015; Vaske et al, 2006; Vaske et al., 2018 Hanisch-Kirkbride et al., 2013). This study focuses on risk perceptions and how exposure to the potential existence of these risks, are expected to influence preferences for CWD management. In our case, increased CWD surveillance is considered as a first step.

1.3.1 Risk Perceptions and Risk Attitudes

Public willingness to support the management of Chronic Wasting Disease (in this case, supporting a CWD surveillance program) could be driven by how individuals view the different risks that CWD poses. The public's risk perception and understanding these risks may affect their

choice of management approaches and decision-making concerning cervid products (Myae, 2015; Pennings et al., 2002).

Risk perceptions are related to the level of concern an individual has about the CWD risk and assumed chances of that risk occurring. Risk perception is the subjective assessment of the probability of a specified type of incident happening and how concerned we are with the consequences (Sjöberg et al., 2004). On the other hand, risk attitude is an individual's predisposition towards the risk of concern. The underlying risk attitude traits are risk propensity and risk aversion, i.e., cautiousness. Risk attitudes are people's intentions to evaluate a risk situation favorably or unfavorably and to act accordingly (Rohrmann, 2008).

Because risk perceptions and risk attitudes have been shown to affect behavior and voting decisions, it is, therefore, vital to understand how the Canadian public perceive the risks posed by CWD. For example, how does the presence and interaction of multiple risks affect decision making regarding management or surveillance? What risk types have the most influence on economic behaviour? Furthermore, given the presence or awareness of multiple risks, it is possible that individuals may rank these risks based on levels of risk perception and each risk may have a different effect on decisions made. Therefore, to ensure effective management strategies, understanding public risk perceptions towards animal health, food safety, and economic risks posed by CWD are necessary.

Risk elicitation methods are usually grouped into whether or not the instrument is simple or complex. Simple methods provide respondents with the incentive to think carefully about the problem which eliminates noise. We characterize elicitation methods according to their complexity (Charnes et al., 2012). There are advantages and disadvantages to different risk elicitation methods. Choice of risk elicitation methods depends on the questions to be answered, the nature of the research, and the characteristics of the sample population. Other factors that

affect risk elicitation method include, the type of information available, the type of risks involved, and the general knowledge of the respondents. Simple methods are best used when trying to capture treatment effects and differences in individual risk preferences (Charness et al, 2013). The most common risk elicitation method is the questionnaire or with the use of Likert scale questions. However, there are other methods that could be used to elicit risk perceptions like risk ladders and pictorial scales (Persoskie and Downs, 2015; Lloyd-Smith et al., 2018).

1.3.2 INFORMATION PROVISION

When considering support for CWD surveillance and risk management, the perceptions about all of the animal health, human health and economic risks may factor into the assessment. This study uses stated preference methods to determine the public's support in terms of willingness to pay taxes for a surveillance program defined as "the ongoing observation of disease within a wild population designed to assist disease management" (Artois et al 2009). The respondents are informed that surveillance and monitoring can be useful for disease management being carried out by hunters, farmers, vets, CFIA employees and researchers. They are informed that disease surveillance requires funding to cover the cost of testing, man-power, and public incentives.

Referendum-style stated preference questions are often used in valuing public goods or programs. Individuals are expected to make choices based on their knowledge, experience and information provided. Forbes (2011) used contingent valuation to elicit WTP for CWD management in Alberta. This method was applied because a referendum is a familiar and logical approach to policy decision making in a democratic country like Canada. Moreover, current CWD control measures are funded through tax dollars. Forbes (2011) asked the question:

How would you vote in a referendum on the proposed CWD management program that reduced infection rates to from the levels of the map on the left to the infection rates in the map on the right but resulted in a $25 increase in annual taxes for the next 10 years?

Studies aimed at investigating the effect of information provision on respondents stated willingness to pay found that the more information that was provided to the respondents, the higher their willingness to pay for the gain or loss of an environmental attribute (Bergstrom et al., 1990). Studies have shown that the quality and quantity of information provided to respondents may affect their responses to a referendum question. However, the types of questions asked in a survey may also prime respondents to respond in different ways to later valuation questions. While not directly providing information sets to respondents – the fact that questions are asked may encourage respondents to think about things differently than they might have without the questions. Priming, order and context of information may influence respondents' responses (Hjortskov, 2017).

Knowledge about the existence of these three risks, food safety, animal health and economic, may play an essential role in the decision making of respondents with respect to willingness to pay taxes for CWD surveillance. In our survey recognizing that CWD might not be familiar to all survey respondents, all participants are provided with a common block of CWD information prior to the surveillance question being answered. In other research, information provision is part of the experimental design, for example, providing specific information on the food safety risks posed by CWD. This could include data or quotes from relevant authorities. Sometimes the respondent may be given the choice to opt for more information if they want additional details. This could be in the form of a link to more text, image or chart. But, in our case, we are interested in exploring the priming effect of being asked certain CWD risk questions on respondent's willingness to pay taxes to support more CWD surveillance. The questions in and

of themselves are important but our experimental design concerns how many of the three types of CWD risk question groups you are asked. In this case eliciting risk perceptions on food safety, for example, may flag that potential risk to survey respondents, inspiring a higher willingness to pay additional taxes for CWD surveillance. In our case, the information provided is embedded in the questions asked and those questions may prime responses to the willingness to pay taxes for CWD surveillance question. Although the design of a study should exclude processes, ordering etc. issues which could influence outcomes, that they are possible is not in question. In this study we wish to understand more about how the exposure to different sets of questions may influence the responses to the surveillance question. In this case, when we elicit risk perceptions related to food safety risks, for example, we may be flagging the potential importance of food safety risks of CWD to the respondent. This may encourage respondents to think more carefully about those risks in responding to the surveillance question.

In addition, the order in which questions (in particular the three different risk perception groups of questions) are asked might flag to survey respondents that there is an important issue (one or other of the risks) which they may not previously have thought of. The priming of respondents using certain risk perception questions, and the order of priming may be important in explaining individual preferences for our policy action to stem the disease.

Therefore, in this study we test the effect of question priming or risk signaling by dividing our study sample into 10 treatments. Each treatment represents a different level/type of information provision. The information provided varies by type, quantity, and order. First, in each treatment respondents are presented with questions related to varying types of risks, which may signal the existence of those risks to the survey respondents. The number of risks also varies between treatments. Respondents are "exposed" to either one, two or all three risks. For respondents exposed to two risks, the risk order is asked both ways to create another set of

treatments. This would be the difference between treatment 4 and treatment 5 in the table below with all 10 treatments.

When designing choice experiments, it is important to determine the number of risks to consider. In our study, there are three risks or attributes- exposure to questions related to animal health, food safety and economic risks. Then, we might consider letting these risks interact with each other. Here the levels may be defined by exposure to different combinations of questions provided to the respondents; questions on a given risk by itself, questions on a given risk and one of the two other risks, and questions on all three risks. Therefore, their choice of whether to pay taxes related to surveillance is a function of the risk questions (food safety, animal health and economic risks) and the number of risks a respondent is exposed to.

As exposure to more and different types of risk questions occurs in different subsamples of respondents, we might expect the desire to pay for some form of intervention by respondents to grow or vary depending on the treatments – with surveillance being the first step in intervention to manage the disease spread. The 10 treatments are described in Table 1.1.

TABLE 1.1: RISK PERCEPTION TREATMENTS USED IN THE STUDY.

	Risk Perception Treatments					
Single Risk						
1		2		3		
Food Safety		Animal Health		Economic		
Two Risks						
Order	4	5	6	7	8	9
	Food Safety	Animal Health	Food Safety	Economic	Animal Health	Economic
	Animal Health	Food Safety	Economic	Food safety	Economic	Animal Health

Three Risks	
Order	Food Safety
	Animal Health
	Economic

1.4 PROBLEM STATEMENT

The animal health, human health and economic risks that CWD poses, amplify the need for effective management and control. The disease has no cure or vaccine and therefore is difficult to control spread without culling infected animals or herds, something often unpopular with the public. The CWD prions can persist in the soil and environment for several years even after the animal has died (Miller et al., 2004). So, there is a risk of reinfection in the same areas. These factors are related to the potential extent and impact of disease spread. Culling deer and elk herds in CWD concentrated areas has been proven to be the most effective method to slow down disease progression (Forbes, 2011). Other management programs that have been considered in the past include support for mandatory or voluntary submission of deer samples for testing, including providing hunters who submit heads with additional tags, public education campaigns (Myae, 2015; Forbes, 2011). From current research it may be possible to develop vaccines, live animal tests and to use genomic information to more accurately predict disease spread. However, all methods require investment and also adequate surveillance to ensure management is effective (Lazo et al., 2004; Petigra et al., 2011).

Because disease management is expensive, the success of most management strategies depends on the awareness and support of the public (AEP, 2018). So, it is important to understand factors that may influence public support for CWD management. Understanding the role of different risk perceptions may be essential because the more risks the public perceives, the

more willing the public may be to support public investment to protect themselves and future generations from these risks. Furthermore, if members of the public are risk averse towards CWD, they may be more likely to be concerned about risk reduction (Myae, 2011; Pennings et al., 2002; Schroeder et al., 2007 Tonsor et al., 2009; Lusk and Coble 2005).

Therefore, eliciting risk perceptions may be useful for proposing and implementing effective control strategies that guarantee the support of the Canadian public. Eliciting risk perceptions may help identify segments of the population holding different risk perceptions - no risk, slight risk, moderate risk, and high risk - in order to compare how each segment differs in reaction to CWD and support for management investments (Miller and Shelby, 2009).

It could also be useful to know how informed the public is on CWD and how they rank the risks (animal health, human health, and economic risks) associated with CWD. It may be useful for the government to understand the public concerns and preferences for CWD surveillance as a first key element to disease management. This information could also be useful to industries that may be affected by change in consumer behavior because of CWD. The government seeks to improve social welfare, while the public concerns may be about the health and personal effects of risk and risk management practices. Consequently, the government and the public may have different objectives and preferred responses to risks. There could be possible differences between actual government intervention in risk management and society's expectations. A good example is public aversion to culling, a very effective CWD mitigation strategy (Forbes, 2011).

Regardless of the management option supported by the public or implemented by government agencies, disease surveillance is important. Disease surveillance is the ongoing observation of disease within a population designed to assist in disease management (Artois et al. 2009). CWD surveillance was first initiated to provide evidence of disease freedom in farmed

cervid populations. However, disease surveillance can help to identify the spatial distribution of a pathogen, measure disease "intensity" in areas where information is known to occur and monitor both existence and intensity over time (Samuel et al. 2003). Since surveillance is needed for efficient disease management, in this study we would be looking into public willingness to support taxation for increased CWD surveillance instead of support for taxation for specific management options. Surveillance can increase the efficacy of disease management regardless of chosen management strategy.

1.5 STUDY OBJECTIVES

The intent of this study is to examine the Canadian public's perceptions of CWD risks and how these risks influence their willingness to pay taxes to have government agencies undertake a broader CWD surveillance program.

The risks of interest are animal health, food safety and economic risks. The animal health concerns regarding CWD are about the potential danger of this disease on several cervid species, other farm and wild animals, and pets that may come in contact with CWD prions either directly (through contact with infected animals) or indirectly (through the environment).

For human health/ food safety risks, the Canadian public might be worried about the potential effect of CWD on their personal health, either through diet or contact with cervid related materials. Human health concerns range from the risk of contracting a human variant of the disease to more altruistic concerns about scarcity of protein for individuals (e.g., members of Indigenous communities) who rely on cervids as their main source of meat. For this study we will be focusing on the personal food safety risks associated with CWD.

Animal health and food safety risks can lead to behavioral changes for different stakeholder groups- hunters, consumers, farmers, outfitters, restaurant owners and the government. Hunters may hunt less, cervid farmers may be subjected to trade barriers, individuals may participate less in wildlife related activities and so on. These behavioral changes are expected to have economic implications (risks) in the form of costs to governments and farmers for regulatory policies, and possible trade barriers, reduction in tourism revenue and consumer demand in terms of meat consumption, hunting participation, and wildlife-related recreational activities.

How the Canadian public perceives all three of these risks (animal health, food safety and economic) could influence public behavior regarding disease management. Hence it is important to analyze the roles risks and public perceptions of these risks play in decision making concerning CWD mitigation. In this case of this study, we are investigating the impact of risk perceptions on public decision to support CWD surveillance.

Because the different risks posed by CWD are connected, complex and multi-dimensional, it is important to understand what sociodemographic and attitudinal factors affects perceptions of these risks. Also how do these risks affect each other and how does knowledge of multiple risk dimensions play into public decision making about taxation to support more CWD surveillance?

Specific study objectives include:

1) Measuring public risk perceptions of the different risks posed by CWD (economic, human health, and animal health),
2) Accessing how sociodemographic factors, other risk perceptions and behavioral factors are related to the public's perceptions of animal health, human health and food safety risks associated with CWD.

3) Examining factors affecting the Canadian public's decision to support surveillance programs to help manage the spread of CWD.
4) To study if information provision, or question priming within the survey, influences voting for increased surveillance program using multiple data treatments.

To address these objectives, WTP for the surveillance program based on regression results is estimated. We will also look at how sociodemographic variables and information provision across treatments affect regression results (probability of voting yes for surveillance) and WTP levels.

1.6 CONCLUSION

The remainder of this thesis is laid out in the following manner. In Chapter 2 we discuss the theory and methods of the study. A particular focus of the literature review is on information provision, risk perception and risk management. In Chapter 3, we will discuss the design and implementation of the survey, methods and research variables. Chapter 4 contains the results of the analysis conducted, and in Chapter 5, the thesis is summarized.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

This study is an attempt to understand how public perceptions of Chronic Wasting Disease risks have evolved and how those risk perceptions affect public support for investment in surveillance to enhance disease management practices. The main risks considered in the research are potential food safety risks associated with the consumption of venison, animal health risks to other species that may come in contact with CWD prions from other animals or the environment, and finally the direct and indirect economic risks incurred by different sectors of the Canadian economy in the face of disease incidence and spread.

In addition to exploring the impact of risk perceptions on decision making, this research explores the question of whether awareness of multiple risks (economic, animal and human health) influence the public's decision on whether or not to support public investment in disease surveillance. As mentioned in chapter 1, regarding information priming in a survey design, we explore a risk experimental design for the three different risks. Respondents were exposed to different combinations of the risk questions in different orders. To assess public willingness to invest in CWD management and to determine whether exposure to different risk questions influences that investment, we need to collect and analyse primary data.

The literature review provides the support for the empirical and methodological approaches used in this study to identify risk perceptions and their influence on public support for investment in surveillance. This includes a review on survey methods, risk perception elicitation, information provision and risk management and what previous people have found and modelled.

2.2 Data Collection Method

Data to estimate the models were obtained through an online survey delivered through a market research company. Surveys are an important tool for eliciting subjective public opinion/ risk perception on a wild variety of issues ranging from health concerns to environmental and animal health risks. There are many ways to carry out a survey and they all have advantages and disadvantages.

Face-to-face interview

These are usually conducted as household interviews, in the streets, mall, anywhere with a lot of foot traffic. The advantages of face-to-face interviews are that the data can include longer explanations of why people respond the way they do and it may be easier to maintain the interest of a respondent for a longer survey if you are there to encourage them. Disadvantages include difficulty to organize data collection efficiently. It is not suitable for surveys that cover a huge geographical location (e.g., Canada). The geographic coverage makes it very expensive and time consuming. (Hague et al., 2016).

Telephone interview

This solves the problem of conducting a survey over a large geographical area. It also costs less than in person surveys. However, it requires interviewers to have good interpreting and typing skills, enthusiasm, and knowledge about the subject to be able to hook and maintain the interests of respondents. It is not suitable for respondents who cannot be reached via telephone and databases of cell phone numbers are difficult to find. However, the questions have to be short

and simple. Hence, this method is not ideal for relaying of supporting materials and information (Hague et al., 2016).

Mail in

With mail-ins, respondents can take their time to reflect on questions that need extra thought. Most importantly, it can contain graphs and images in the survey. However, with mail in surveys there is usually a low response rate and hence, may not work for surveys that require a high number of respondents. (Hague et al., 2016).

Online surveys

Since the survey for this study requires thousands of respondents from the general population, electronic (internet) surveys are ideal for conducting large-scale data collection. There are many advantages associated with internet surveys. It is quicker and less expensive than manually collecting and entering data (Hague et al., 2016). There is also less chance of making data entry errors. There can also be a high response rate by getting access to a panel, which consists of participants who agree to provide information on a continuous basis to a market research or polling company. There are issues associated with how representative of the population the maintained panels may be (Boyle et al., 2016). Internet access is not equitably distributed. In Canada, less educated and older individual are less likely to have access to the internet (Statistics Canada, 2019). Moreover, in the case of volunteer or opt-in panels, individuals with particular interest and similar socio-demographics may self-select in their decision to participate in an online survey (Bethlehem, 2010).

An internet survey offers a large sample size at a relatively low cost. There are a fewer non-response and one has the ability to make questions conditional on previous answers in the survey in a way that's undetectable to the respondent (Bonnichsen et al., 2015), while also making

it impossible for the interviewer to bias results, through their expression or way of asking questions.

However, data collection for economic valuation using internet surveys and pre-recruited panels can be associated with disadvantages. Sample selection bias may occur if respondents to the survey have an observable characteristic that makes them more inclined to answer the survey, which affects their responses. People can choose whether or not to participate in a survey; this could present an element of self-selection/ selection bias. A careful comparison of multiple demographic characteristics between the survey sample and the population is one way to attempt to minimize this possibility.

Sample selection problems are expected as computer and internet access are not typically available to every single individual in a population, problems concerning sample coverage and sample representativeness may be expected when using an internet panel as a sampling frame. This holds true for surveys covering the general population. Just over 90% of the Canadian population has access to the internet in their households, and almost all Canadians under 45 recently reported using the internet every day or almost every day (Statistics Canada, 2019). The high level of internet penetration in Canada holds promise for the suitability of internet surveys. Older and less educated people may not use the internet every day, but this doesn't mean they do not have internet access. If they are left out of the survey, this could mean non-random sampling. Sample selection bias caused by missing observations is a well-known problem also in traditional postal/mail in surveys (Heckman 1979; McFadden et al. 2005).

Online panels have become a popular way to collect data. The most common online panels are general population panels. General population panels are mostly large, diverse panels of the general population including individuals in hard-to-reach subpopulations (Callegaro et al., 2014). The participants join the panel voluntarily and do agree to participate in market research

and surveys. However, their willingness to participate may reflect the fact that they are different than the general population. These panels by market research companies are beneficial because they are quick and easily accessible. Panels have pools of people ready to be surveyed and this can aid the collection of large amounts of data quickly.

Participating in surveys or market research is usually incentivised to increase participation and improve data quality (Callegaro et al., 2014). Incentives range from prepaid (given before participation) and postpaid (given only after the survey has been completed) cash or gifts. However, postpaid incentives are the most used in online panels. Incentives could either be monetary (cash, cheques, gift cards, etc.) or points that can be redeemed for rewards in goods and services.

Because these market research panels are incentivised, there are issues with respondents whose goal is to receive the incentives. Specifically, for opt-in panels, the credibility of data and responses collected could be negatively impacted by fraudulent and inattentive respondents. Some respondents may try to take advantage of the process by not providing accurate responses. They participate in "straight lining" (response non-differentiation), random responding, "speeding" (responding more quickly than expected), using a lot of "don't know" options, item non-response (skipping questions) (Baker et al., 2010; Fricker et al., 2005).

2.2.1 CONTINGENT VALUATION

Contingent Valuation (CV) draws on economic theory and survey research to elicit directly from respondents the value they place on a good or service, including public goods. CV is considered the most used stated preference method in environmental economics. Stated preference methods are used when eliciting the value placed on non-market goods like CWD surveillance (Carson et al., 2000). Contingent valuation is useful when implemented alone or

jointly with another valuation technique for a non-market good. Stated preferences studies, where people respond to a question about how they would behave, are generally less efficient than revealed preference studies such as travel cost analysis and hedonic pricing.

An issue that arises with stated preference, is reliance on the self-reported information as opposed to observed behavior. The accuracy of the information provided by respondents cannot be validated. The choices rely on the accuracy of the definition of the goods and services provided by the survey.

Furthermore, contingent valuation lends itself to "Hypothetical Bias." Respondents may answer differently than they would act in reality (given that there are no actual costs for their decision). Unlike revealed preferences, there is no chance in the studied scenerios to observe real-world behaviour. There is a possibility of biased responses either due to poor survey design or motives of respondents. Biased responses would consequently bias study results. Contingent valuation is highly effective when the environmental improvement to be valued is outside a range of available data. CV creates a market for the good in question, in this case, the surveillance of CWD spread. The survey respondents are presented with a vote for the change in environmental goods or services. This allows the measurement of an economic welfare shift associated with the change in the environmental good or service presented. This approach requires respondents to report their willingness to pay for a "hypothetical" environmental good or service (Grafton et al. 2008).

There can also be strategic responses provided by survey respondents. Respondents who do not intend to support the referendum in a real-life scenario may vote yes in the survey to make it more likely for an environmental good to be provided. There are also issues of social desirability bias or naysaying. Respondents choose or behave differently in different social

contexts. Respondents are more likely to support socially desirable options and are less likely to support socially undesirable outcomes (Gregg and Wheeler, 2018).

However, biases may be reduced through focus groups and survey pretesting. Focus groups may be able to identify if there is signaling in the survey. That is, if the questions and information provided pushes respondents to answer in a certain way. In addition to the choice questions, ex post debriefing questions can be used to reveal which respondents may have been exhibiting possible naysaying or social desirability biases. The debriefing question responses are analyzed, and respondents that show evidence of either nay- or yea-saying may be removed from the dataset. For this study, two focus groups were conducted and were used to ensure that the elicitation tools were free of signaling while being clear and easy to understand (Carson, 2000).

Numerous approaches to contingent valuation have been developed and tested including efficient use of elicitation formats. Contingent valuation has several elicitation methods including bidding games, open-ended bids, referendum style and payment card formats. The bidding game has a process that is identical to auctions and therefore is likely to be familiar for the respondents.

A good valuation technique should also be clear and remain neutral by not informing participants of the optimal bid. It also doesn't give respondents the opportunity to behave strategically. A single, binary dichotomous choice – a yes/ no valuation question- with a mandatory closed-ended bid amount should be used (Hoehn and Randall, 1987; Johnston et al., 2017). When choosing a bidding mechanism, Carson and Hanemann (2005) recommends that it be incentive compatible. That is, the decision rules motivate respondents to report their "true" valuations. In order for this to happen, the respondent needs to think their response could possibly influence real life outcomes (Wiser, 2006; Carson and Groves, 2007; Arrow et al., 1993; Adamowicz et al., 1998).

There have been many tools developed to tackle hypothetical bias in stated preference studies. In the case of biases like "nay-saying" (where a respondent vote "no" to send a message), "Yay-saying" (where a respondent vote "yes" because it's the right thing to do) and social desirability biases, follow up questions eliciting the reasons for respondents' votes can be useful in determining of the respondents were exhibiting either of these biases.

Using certainty follow-up questions is another common way to correct for hypothetical bias in stated preference studies (Fifer et al., 2014). Certainty questions are applied ex-post as a follow up question to the referendum question. The certainty follow-up question is asking how confident the respondent is in their previous referendum response. That is, how certain they are that they would vote the same way in an actual referendum. The response to this question can be incorporated into the modelling and evaluation criteria. The idea is that respondents who are uncertain about their referendum are less likely to follow through with their referendum in reality. Certainty of respondents can be elicited through numeric or Likert scale question ranging from "very uncertain" to "very certain". Where a certainty question is elicited after a valuation question, the responses to the valuation question can be recalibrated to reflect the certainty of the respondents. Champ et al. (1997) recoded all 'yes" responses as a 'no' if the respondent was not completely certain about their answers.

Consequentiality is another issue that arises in a hypothetical survey. Carson and Groves (2007) defines consequentiality in the following way:

"Consequential survey questions: If a survey's results are seen by the agent as potentially influencing an agency's actions and the agent cares about the outcomes of those actions, the agent should treat the survey questions as an opportunity to influence those actions.

Inconsequential survey questions: If a survey's results are not seen as having any influence on an agency's actions or the agent is indifferent to all possible outcomes of the agency's actions,

then all possible responses by the agent will be perceived as having the same influence on the agent's welfare." (Carson and Groves, p. 183)

Essentially, consequentiality is defined as a scenario where the respondents believe to some extent that their responses may influence decisions related to the referendum and that they will be required to actually pay the cost of the referendum, if the policy is implemented. Consequentiality could be affected by other aspects of survey design like the plausibility of prices and details about how the goods will be provided (Carson and Groves, 2007). In order to address consequentiality issues, follow up questions, cheap talk, focus groups and survey pretests are used. The consequentiality questions are questions that ask respondents to state the extent to which they believe that the referendum voting results will be taken into consideration by policy makers. If the Carson and Groves (2007) criteria are correct, using only the responses of individuals who think their responses are consequential may resolve hypothetical bias issues (Broadbent, 2012).

Some studies have been conducted totes the validity of consequentiality questions and their effectiveness in combating hypothetical bias. One of those studies was conducted by Lloyd-Smith et al. (2019) where they tested the effect of varying the order of the valuation and consequentiality questions in their survey and also addressing the potential endogeneity of consequentiality questions. Their results showed that while varying the order of the consequentiality and valuation questions has an impact on consequentiality perceptions, referendum consequentiality perceptions do not have a significant impact on voting decisions. Hence, their study provides evidence that the use of consequentiality question is not a magical solution to the hypothetical bias issues of stated preference studies. Lloyd-Smith et al. (2019) concluded that more focus should be on designing consequential surveys through processes like focus groups and pretests.

2.2.2 TRAP QUESTIONS

Respondents, in online surveys of market research company panelists, may have the primary goal of receiving incentive offers, without focusing on the questions in the survey at all. They may incorrectly answer screening questions or may even use auto complete software (Jones et al., 2015). On the other hand, an inattentive respondent's goal may be to simply complete the survey but they become bored or tired and pay little attention to the actual questions or their wording. Therefore, they may have biased partial or no cognitive processing when answering survey questions. That is, they are not paying attention to and processing the information included in the survey.

Both inattentive and fraudulent respondents threaten the validity of survey results and could be detrimental to survey quality. It is estimated that 8-25 percent of survey samples are impacted by fraudulent and inattentive participants. Research in fields like psychology have looked at different ways to identify and deal with inattentive or fraudulent behavior in surveys (Berinski et al., 2014; Curran, 2016; Malone and Lusk, 2018). Some researchers have looked at excessive item non-response or don't knows, however that might just be an indication of honesty rather than inattention (Baker et al., 2010). Also, looking at survey completion time to "catch" respondents who are speeding through the survey is another option. This makes sense as studies indicate that faster survey completion times are associated with more random responses. However, this does not account for completions within a normal time frame by inattentive respondents.

However, due to the nature of online surveys, it is possible to deal with fraudulent and inattentive respondents in real time rather than in data analysis. To improve data quality, real time filters like trap questions are strategically placed before the most important parts of surveys

although they can be placed anywhere in the survey (Oppenheimer et al., 2009). Trap questions place a simple answer directive within the survey to distinguish respondents who are paying attention from those who are not reading and considering questions. For example, the following questions might be included in the survey;

"Please verify where you are in the survey by marking a '2' for this item" (Miller & Baker-Prewitt 2009), or "For quality assurance purposes, please select 'strongly agree'" (Downes-Le Guin et al. 2012).

This trap question can either be a stand-alone short trap question, a short trap question embedded in a list, or a long trap question. For example, the following question might be included in a survey;

"Recent research on decision making shows that choices are affected by context. Differences in how people feel, their previous knowledge and experience, and their environment can affect choices. To help us understand how people make decisions, we are interested in whether you actually take the time to read the directions; if not, some results may not tell us very much about decision making in the real world. To shoe that you have the instructions, please ignore the question below about how you are feeling and instead check only the "none of the above" option as your answer. Please check all the words that describe how you are currently feeling." (Malone and Lusk, 2018).

Trap questions are also useful in situation where the survey is too long or complex. A respondent would fail a trap question if the respondent either intentionally answered incorrectly or did not adequately read and process the directive, questioning an individual's potential data quality. Because there is a single correct answer, the results of a trap question are binary-pass or fail. Results from the study conducted by Lusk and Malone (2018) to explore the effect of prompts on survey inattention bias showed that removing participants who fail the trap question improves data quality. Higher willingness to pay, inconsistency in responses and response bias are a few of the issues that arise with respondents who fail trap questions (Malone and Lusk 2018; Jones, House and Gao, 2015). Malone and Lusk (2018) separated the survey participants into two

groups- those who pass the trap questions and those who do not. When used in economic surveys and choice experiments, participants who fail trap questions have been shown to have significantly different willingness to pay for attribute chances in choice experiments (Gao et al., 2015).

In certain instances, individuals who fail trap questions are immediately removed from the survey analysis and sometimes, further survey questions (Oppenheimer et al., 2009). However, this reduces response rates and does not consider the fact that some individuals often make inattentive food choice decisions in everyday life (Berinsky et al., 2016; Malone and Lusk, 2018). Malone and Lusk (2018) also recommend not throwing away respondents as data collection is costly and that is akin to throwing money away. Instead, they suggest including multiple trap questions in the survey and then weighting the quality of the responses on an attentiveness scale as done in Berinsky et al (2015) or providing feedback to incorrect responders, allowing them to revise their responses, if they don't, then their responses can be deleted.

What Malone and Lusk (2018) did in their study was to compare results from the whole sample, the correct group, and the incorrect group. Their results showed that inattention bias exists in choice experiments; people who respond differently to trap questions respond differently to choice experiment questions. Compensating variation estimates were highest for the incorrect participants, and lowest for the correct participants. Inattention bias is a serious issue for survey-based research, respondents who fail trap questions may respond to the contingent valuation choice questions differently and may inflate policy relevant estimates. Inattentive respondents could result in biased results.

2.2.3 REFERENDUMS

The NOAA panel (Arrow et al. 1993) recommended that stated preference questionnaires should frame questions in the form of referendum votes especially in considering non-use value of public goods. The referendum was developed by Bishop and Heberlein (1979). Stated Preferences using referendums/dichotomous choice elicitation methods are commonplace (Forbes, 2011; Carson et al. 2000). This is because it is expected that respondents would have an easier time responding yes or no to a specific bid amount, as opposed to coming up with an amount in an open-ended question. The referendum makes use of a dichotomous question that asks respondents to vote for a specific taxation level as would occur in a real referendum (Arrow et al., 1993). The respondents are asked to respond "yes" or "no" to their willingness to participate in supporting the preservation of a specific environmental resource or the provision of a public good.

Researchers could either use a single dichotomous question or provide one or more follow-up questions. A single closed ended question is known as a single bound discrete choice model and two question, is known as a double bound, and so on. In a double bound format, the respondent is asked a follow up question. If they accept the initial bid, they are asked to vote on a higher amount, if they rejected the initial bid, they are presented with a lower bid in the subsequent question.

Closed ended valuations work better than open-ended valuations because valuing non-market environmental goods can be difficult, unreliable and discourage responses. With referendum votes, the respondent like any other consumer has to make a choice with a single price. An advantage of this method is that it simplifies the respondents' decision without having multiple iterative properties. The problem with this method is that it requires many more observations for the same level of statistical precision in sample willingness to pay (WTP)

estimates. Johnston et et al., (2017) also noted that logistic or probit regression curve could be fitted to the percentages of respondents' willingness to pay at the randomly assigned prices.

2.2.4 Information Provision

Valuation of environmental goods is usually done in a hypothetical market, since there are no markets for environmental goods. Researchers use stated preference methods to determine the utility derived from environmental good attributes because it is impossible for respondents to reveal their actual preferences for an increase in utility from an ecological good or service.

The hypothetical nature of stated preference analysis presents several issues. The respondent's willingness to pay depends on how they perceive the service being provided. The respondents' risk perception may not align with the objective measure of risk a researcher may have access to. It is important that their quality perceptions are accurate or equal to the objective quality the researcher has in mind. The respondents' perception of the good or service quality and that intended by the researcher should be as similar as possible to ensure accuracy of WTP estimates from regression models. In the case where the survey, this ensures that their stated WTP is exactly their true WTP.

This is where information provision can become important. Information is included in the surveys to increase the "objectivity" of respondent's perceptions. Information provision has a significant impact on valuing environmental resources. This is usually because respondent might not have any reason to seek out knowledge on environmental issues prior to participating in the survey (Bishop and Welsh, 1992). However, the respondents understanding of the information provided depends on a few factors starting with the motivation of the respondents to pay attention. Respondents with higher motivation are more likely to absorb the information

provided, while low motivation respondents may ignore the information and base judgements on external factors not related to the content of the survey.

Consequentially, the content and quality of information are factors that may influence responses to valuation questions. The valuation by the respondents can be influenced by how much information they are presented with. Too much information may be too cognitively tasking and could lead to respondent fatigue, confusion and misinterpretation of information. All of these can bias the valuations provided.

An overload of information can also make the respondents ignore the information all together. In this case there would be no difference between a group provided with information and the group without any information. Bergstrom and Dillman (1985) studied how stated WTP for prime-land preservation in the United States was affected by information provided. They split their sample into two halves- one-half of the sample received information on the potential scenic and environmental benefits of the preservation while the other half of the sample did not receive any information on the benefits of preservation. The mean WTP for prime environmental land amenities the informed group was significantly higher than that of the uninformed group.

Hanley and Munro (1992) looked at whether providing more or less information to respondents provided affects valuation. They provided four information sets with different levels of information. The WTP for the samples with the least amount of information was 79% less than the sample with the most. However, no significant increase in WTP between the second and the third levels of information provided.

Brahic and Rambonilaza (2015) examined the effects of information on the value individuals placed on biodiversity using a choice experiment method. Their data was compared from two versions of an online survey. In one version, respondents were presented with barely any information. In the alternative version, respondents were provided with more detailed

information about the environmental attributes being considered. The additional information related to each biodiversity attribute was presented in a table. The respondents were randomly assigned to these two sub-samples; one with less information on the environmental attributes than the other. Results showed that information provision is a significant explanatory factor of decision-making.

Shapansky et al., (2008) tested the effects of information and respondent involvement-measured by the length of the survey and information provided-on their preferences for passive use values. It was hypothesized that varying information and involvement levels would have an effect on the magnitude and variance of preferences. The participants were put into one of three groups and each group participated in the valuation at different levels of involvement. For example, groups 1 and 2 completed the full attitude and belief survey, while group 3 only completed an abridged version. Group 1 had an explanation of the choice experiments (how they are developed, used, and the results made available) on two separate occasions, group 2 just once. Group 3 responded to the choice experiment with no explanation (how they are developed, used, and the results made available). According to this study, deliberate approaches to information provision has a few advantages. First, it provides a learning opportunity for survey participants. Second, it is a way to identify what attributes and information respondents may be valuing as well as seeking responses to parts of the problem to avoid overwhelming the respondents cognitively. Shapansky et al., (2008) found that participants in the most intensive/ more informed group had less variance in preferences than participants in group 2 with a similar but less intensive process.

Deryugina and Shurchkov (2016) also provided three different groups with varying amount of information (no information, vague scientific information and detailed scientific information) before asking respondents to state their perceived consensus on climate change. All respondents answered questions to elicit general attitudes towards climate change and climate

change knowledge. The respondents were randomly assigned to one of three equal groups (no information, hard, information and soft information) after they all answered the same key question of interest which elicited their willingness to pay for a program that mitigate climate change effects. Their results indicated that information provision does not affect beliefs about policy actions concerning climate change.

Smith et al (1990) looked at how providing different information explaining radon risks affected people's perceptions of these risks. Over the course of a year, they sent 6 different types of surveys to 6 different information treatments. The first set of treatments presented qualitative and quantitative risk charts. The second set had either a "command" or "cajole" eversion of the Environmental Protection Agency (EPA) guidelines for radon risk. The first four sets of treatments were created to correspond with each variation – command/quantitative, command/qualitative, cajole/quantitative, cajole/qualitative. The other two information treatments in the design were either presented the official EPA brochure or a one-page fact sheet. Their results showed that people will use information provided to them to update their risk perceptions. They concluded that this could be relevant for effective risk communication as their results indicated that providing single information is not effective to achieve the goals of an information program.

Hjortskov (2017) tested whether prior questions can affect subsequent responses in a survey regarding perceptions of crime and safety in their neighbourhoods. They theorize that the structure, question order, and whether the proceeding items belong to the same topical cluster may influence respondents. Priming in the form of prior items in survey may influence answers to later questions in a survey and the context framing of prior questions may matter in evaluations.

They included two differently framed set of questions about crime and the police. The respondents were made to answer two sets of question-a positive and a negative version. The idea

was that the negative and positive versions of the questions may prime respondents in two different directions. The study results showed that positively framed statement about the police had an effect on citizens evaluation while priming and negatively framed questions about the police had a limited effect on the evaluation made by the study respondents. Their results also showed that in the case of salient issues, priming influences attitudes by bringing out attitudes that may not be factored into the valuation.

Thau et al. (2020) investigated question order bias in citizen satisfaction surveys. The cognitive task of understanding and responding to a survey question may be influenced by context effect like question order bias. Survey respondents my answer differently to questions based on the order in which they are presented. The level of question order bias may be influenced by recency of activation (preceding questions may have priming effects that spill over to subsequent questions), frequency of activation (more or repetitive information on a topic make it easier for said topic to be used as a reference), relation (the relevance of the information provided), ambiguity (when evaluations are complicated and hard to make, or not specific, the respondent is more susceptible to biases) and background of the respondents. This study found evidence of question order bias. Question order bias influenced how respondents interpreted survey questions as well as their final judgements on the issue at hand.

What we aim to do in this study, is to apply this method of grouping survey participants into different 'priming' groups with reference to multiple dimensions of risk perceptions regarding a single issue- Chronic Wasting Disease. This study aims to understand how survey design (asking certain questions or not, changes in the order of questioning) which is indirectly providing different levels of priming affects individual responses to the referendum question. At the same time, we recognize that CWD may not be widely understood by the population so there is a need

to provide certain basic information about the disease and its spread to ensure that respondents can make informed judgements.

For this study, we are not necessarily varying the amount of information provided, (each respondent is provided with a basic set of information about CWD) but varying the type and order of questions the respondents are asked. In effect we are looking at whether the asking of questions prior to the referendum question influences the direction of response to the referendum. We are doing an experimental design with participants being exposed – or not exposed- to varying types of risks indirectly through the questions they are asked. The idea is that individual preferences are subjective and may not be well-informed and so can be revised with learning or introduction of a new set of ideas; in our case provided through different exposure to groups of questions. Priming respondents using risk perception questions, will make people think about different aspects of CWD when they are making their referendum vote. While, priming in research experiments is controversial (Chivers, 2019), priming in this study is used to investigate how awareness to different aspects of CWD risk might influence public willingness to support CWD surveillance.

2.3 Risk Management

Risk management refers to the activities that might eliminate the effects of risk or the probability of risk occurring or reduce these to a manageable level. Risk management involves a number of steps. The first step involves identifying the issue and initially assessing key risk areas. That is, identifying how the risk affects members of the population. This makes it possible to identify the main objective of risk management (Palinkas, 2011).

Secondly, the risks need to be identified, as well as the source of the risk, current effects of the risk, and future impact. At this point, the likelihood and impact are measured. Even if the probability of the risk and the effects are seemingly negligible, the risk still needs to be registered. The next step is risk analysis. With risk analysis, probability of occurrence and effects of risks are assessed.

Risk can be analysed objectively or subjectively, as in the case with this study using judgement on probability and magnitude of risk. Assessment of the risks in terms of acceptability of risk and the risk management methods already in place. Desired results of risk management need to be established in the light of currently existing risk management options. Risk assessment makes it possible to determine priorities and appropriate techniques for risk management. The last step is monitoring, evaluating, and adjusting the strategy. This includes feedback. Palinkas (2011) argues that it is important to keep in touch with stakeholders. This makes sure that stakeholders are not passive sufferers but active participants in the management process.

Risk management is always influenced by subjective elements, either subjective risk perceptions or subjective risk attitudes. Risk perceptions can be defined as "the consumer's perception of the uncertainty of a threat while risk attitude is the consumer's predisposition towards risk" (Pennings et al., 2002). Risk management includes risk identification and risk analysis. The method of risk analysis depends on the nature of the risk being observed.

Since no vaccine is available and the disease has long incubation periods, the control of CWD is inherently problematic. In farmed populations, management is limited to prevention, quarantine or depopulation (Carlson et al., 2018). In wild populations, CWD management involves disease surveillance, public education and communications (Alberta Environment and Parks, 2018).

Studies have examined hunter's acceptability of CWD management using both current and potential strategies (Holsman and Petchenik 2006; Vaske et al. 2006). In most studies, testing harvested animals for CWD and using hunters to reduce deer and elk herds were acceptable. Based on previous studies done in Canada, it is usually unacceptable to take no action towards CWD management (Forbes, 2011; Myae, 2015). However, using hunters to reduce CWD herds is controversial. Hunters are generally in support of management practices that would help control the spread of CWD.

The list of management options considered in Forbes (2011) and Myae (2015) include:

- Take no action toward CWD and simply allow it to run its natural course
- Providing additional hunting tags for hunters
- Freezer locations for deer head submission
- Mailouts and advertisements in local newspapers
- Open public meetings to discuss CWD issues
- Educational materials placed on the AB SRD webpage
- Voluntary submission of heads for the entire province
- Mandatory submission of heads for testing in certain WMUs
- Culling (reduction) of deer herds in areas where CWD is most concentrated
- Culling (reduction) of elk herds in areas where CWD is most concentrated

The public acceptability of management practices for CWD have also been examined by a number of Canadian and American studies (Williams et al., 2002; Vaske et al., 2004; Myae, 2015; Forbes, 2011). These studies have found that the members of the Canadian public do not favor culling as much as other management options although a majority of the population agree that taking no action towards CWD management is not acceptable. For this study, we would be

analyzing respondent's support for a surveillance option that makes it easier to take effective management actions that are supported by the respondents.

2.3.1 CWD Surveillance and Management

"Disease surveillance is the ongoing observation of disease within a wild population designed to assist disease management" (Artois et al 2009). While they are separate issues, CWD surveillance is closely tied to CWD management. Current CWD management strategies involve: 1) CWD containment through reduction of herd sizes 2) "eliminating" CWD through herd eradication (Miller et al., 2000; Forbes, 2011) and 3) monitoring prevalence, distribution and mortality in cervids populations e.g., through random sampling (Samuel et al., 2003).

While the goals of CWD surveillance are detection, assessment, and monitoring and these are related to different management goals. Disease detection can be useful in preventing and eliminating CWD occurrence. CWD surveillance helps to identify disease prevalence (the regions of occurrence), disease intensity (frequency of occurrence, how many animals are infected). Over time, observed trends in prevalence and/or intensity is may be useful to control programs or help inform CWD research. Sources of CWD surveillance samples include hunter harvested animals, clinically suspected cases (reported by the public or found by agency staff), road kill, herd reductions (in areas where the disease has been found or is expected, predator- killed cervids, and poached or confiscated cervid remains Nobert, Pybus and Merrill 2014). Surveillance methods of detecting CWD will give the best opportunity to control/ eliminate the disease in the detected area. If CWD is detected, being able to assess prevalence and geographic spread will factor into deciding the type and intensity of management responses to partake in.

Monitoring disease existence and spread can be helpful in detecting patterns of exposure and spread of CWD, understanding the nature of the disease, and assessing the effectiveness of

management programs. Williams and Miller (2003) argue that CWD history is incompletely documented. While the disease was first recognized in captive deer held for research in Colorado in the 1960s, it is possible that cases occurred in Colorado or elsewhere before this time (Williams and Young 1980; Williams and Miller 2003). This is demonstrated by experiences in Colorado and Wyoming, Saskatchewan, Wisconsin, and Arkansas where expanded surveillance disclosed additional cases within two months after their "first" case was diagnosed (Miller and Fischer, 2016).

Hence why we included the following information in our CWD risk perception survey:

One of the best things that can be done to manage the spread of CWD is to increase surveillance or monitoring. "Disease surveillance is the ongoing observation of disease within a wild population designed to assist disease management" (Artois et al 2009). From surveillance it will be possible to identify how far CWD has spread (how many regions have animals with CWD and how many do not), measure disease intensity (how many of the animals, of the total population, are infected in areas where the disease is known to occur) and over time identify trends in prevalence/intensity or geographic spread to evaluate control programs and to inform needs for research. The types of surveillance for wild cervid populations utilize four main and two rare sources of cervid samples for CWD testing:

- *Hunter harvested animals*
- *Clinically suspected cases (reported by the public or found by agency staff)*
- *Road kill*
- *Herd reductions (in areas where disease has been found or is expected)*
- *Predator – killed cervids (rare)*
- *Poached or confiscated cervid remains (rare) (Norbert, Pybus and Merrill, 2014)*

Without more surveillance, it will be possible for disease to spread into unexpected areas and become more prevalent potentially affecting other animals. The surveillance provides critical information for wildlife managers and government in general as to the significant effects of the disease on populations and whether more interventions are necessary to slow the spread. More surveillance will require funding for diagnostic testing (including more laboratories), for staff time, for incentives to encourage public participation (reporting of sick animals, for example), and for communication.

On the next page we provide you with some maps highlighting the CWD distribution in 2008 and 2018 to illustrate the spatial spread of the disease. We will then ask you whether or not you would vote for a surveillance program that will help in monitoring spread and infection rates of CWD but results in a certain increase in your annual taxes to pay for the costs of the program.

2.3.2 Risk Perception and Choice of Management Practice

As stated earlier, Chronic Wasting Disease currently has no cure or treatment. Therefore, most management practices involve geographic restrictions to prevent spread of disease and culling of infected animals. The most important part of disease management is early disease detection. Eradication and culling prevent further spread of CWD. Five years after intensive culling in New York, CWD failed to be detected in tested samples (Brown et al., 2005). When Wisconsin stopped culling in 2007, the prevalence of CWD increased (Manjerovic et al., 2014). Culling is only effective in the case of early detection.

Beyond infected animals, CWD contaminates the environment. For example, CWD prions can be found in the grass and feces of infected animals. The contamination of public wildlife areas, via excreta or decomposing carcasses, and the long-term quarantine of private cervid facilities where CWD has been found makes management increasingly difficult.

Therefore, the aim is to control and monitor the spread of infected free ranging animals outside of infection areas. Monitoring is essential to the success of control strategies. Although culling has been the most effective control strategy, the development and implementation of an effective clean-up strategy offering an alternative to farm depopulation and site condemnation is imperative.

In some cases, hunters have been incentivized to help monitor CWD prevalence and distribution. Holsman et al (2010) found that hunters did not actually increase their hunting frequency despite government motivation, indicating that incentivising hunters may not be an effective strategy for CWD management. In Canada, provinces like Alberta and Saskatchewan use management strategies such as mandatory testing of hunted heads in certain areas, providing information for hunters and other stakeholders to prohibit risky behaviour (Zimmer et al., 2011; Truong et al., 2017).

Consequences of CWD depend on where the disease is detected and what response action is taken (Lazo et al., 2004). However, not all management options are equally acceptable and /or effective. Understanding stakeholder risk perceptions is important because risk management strategies should integrate perceptions and acceptance of these strategies. Myae (2015) showed that risk perception definitely affects the reception of management options, especially risk perceptions on the potential of human health impact.

Experts opinion have been used as a proxy for evidence needed to make appropriate risk management decisions (Tyshenko et al., 2011). The experts found that effective decontamination, vaccine development, ante mortem diagnostic test, 100% farm depopulation, cervid identification, and traceability programs are the predominant control measures for spread of CWD within and between farms. The experts rank vaccination, post mortem testing and depopulation as risk management options (Monello et al., 2013). This contrasts with the public who are not fans of

culling and depopulation of deer and elk herds. The public is more supportive of non-lethal and educational management options like open public meetings, mail outs and advertisement in newspapers, additional tags given to hunters who submit heads, and so on (Myae, 2015).

Research has sought to predict hunter responses to CWD and its management. Most studies have shown that education and awareness is important to any CWD management plan (Gigliotti, 2004; Miller, 2003; Needham et al., 2004, 2006; Petchenik, 2003). Hunters need to have the most current and accurate information about chronic wasting disease. Hunters may believe that mixed messages suggest that wildlife agencies are uncertain about CWD, which may influence trust and risk evaluations (Needham & Vaske, 2008; Vaske & Lyon, 2011). This is consistent with other studies, results showed that risk perceptions and trust in managing agencies can influence support or opposition toward management (Vaske, 2010; Vaske et al., 2007). Needham et al. (2007) showed that more experienced hunters are less likely to express negative perceptions toward CWD and less likely to change their behaviour.

Risk perception has to do with the extent to which a risk is understood, the degree of dread evoked in the subject, and the number of people exposed to the risk. The more a person dreads the consequences of an event, the higher the perceived risk and the more the person wants the risk reduced. For management practices to work, it is important to know what the public is willing to support with their time, energy and money. Understanding how they view the risks posed by CWD is important.

2.4 Risk Perception

Perceived risk is the extent that an individual believes he or she may be exposed to a particular hazard (Sjöberg, 2000; Slovic, 2010; Thompson & Dean, 1996). It is a subjective judgement that people make about the characteristics and severity of a risk (Slovic, 2000). Risk perceptions are beliefs about the potential harm or possibility of a loss. Hence, risk perception can be divided into two parts: the probability of a risk and the severity of the consequences of outcome (Slovic, 2000). Subjective risk perceptions are important to many health and wildlife studies because they are useful to predict risk mitigating behaviour and choice concerning risk reduction in the case of uncertain risks (Decker et al., 2010).

Studies have shown that risk perceptions affect consumption of meat in relation to animal diseases; the higher the risk perception, the less likely the individual/group is to consume meat. Individuals who choose to consume meat are more likely to reduce consumption by a higher amount in the event of a food safety issue (Myae 2015; Muringai and Goddard, 2018; Pennings et al. 2002; Schroeder et al. 2007; Tonsor et al., 2009; Lusk and Coble 2005).

Research on human perceptions of wildlife diseases with human transmission potential has been limited. Usually, when considering risk perceptions regarding zoonotic diseases, previous research has focused on risk perceptions concerning risks among specific groups of the public for single diseases. For example, concerns about rabies among recreational cavers or about chronic wasting disease among hunters (Vaske et al, 2009).

However, in this study, the impact of CWD on different segments of the population is potentially important given the nature of the disease. In some cases, an individual's desire to support investment in further surveillance might be influenced by risk perceptions about disease impact. Given that society's preference for management and behavioural changes are affected by their risk perceptions, a major focus of our research is to determine and measure risk perceptions towards CWD.

2.4.1 ELICITING RISK PERCEPTION

Risk perceptions differ across individuals based on their understanding of risk, the objective risk they have been exposed to and their subjective interpretation of risk information. Risk perception is expected to be domain specific. For example, some economists have elicited risk perceptions of food safety incidents to use in accessing factors affecting consumer behavior regarding risky foods while others elicit risk likelihood perceptions as inputs in calculating value of statistical life (Liu & Hammitt, 1999).

Factors that may influence elicited risk perception include respondent judging risk frequency instead of probability (Persoskie and Downs, 2015), eliciting risk perception alongside other risks (Slovic, 2010) and using visual scales with stretched portions on the lower end (Woloshin et al. 2000). The same question elicited in different formats will lead to underestimates or overestimates of risk perceptions when asked in different formats. The problematic nature of numeric scales is what led Weinstein (1999) to assert that "Asking survey respondents to place a numeric probability on the occurrence of a health outcome and comparing their answers to objective data is one of the least meaningful and least reliable measures of risk understanding" (p.17).

Especially like in the case of CWD where the objective food safety risk, animal health risk and economic risks are not as well-known and difficult to quantify, respondents are likely to think about risk in comparative risk that may not reflect the objective risk.

The most common type of risk elicitation method is asking respondents to state the likelihood of a risky event happening on a numeric scale. The way risk perceptions are presented could take several forms including total deaths, an individual's chance of dying based on personal risk factors and other quantifiable expression of perceived risk. However, asking the same question in different ways will elicit different values for risk perception. For example, in Fischhoff

and Macgregor (1983), different ways of eliciting cancer risk perceptions saw the public estimating lethality between 0.2% to 40% depending on risk elicitation method.

Risk perception or preference elicitation methods are usually grouped into whether the instrument is simple or complex. Simple methods such as questionnaires provide respondents with the incentive to think carefully about the problem, which eliminates noise. Complex methods demand more understanding and mathematical sophistication from the subjects, or else comprehension suffers and the results may be less meaningful (Charness et al, 2013).

There are advantages and disadvantages to different risk elicitation methods. Choice of risk elicitation methods depends on the questions one wants to answer, the nature of the research, and the characteristics of the sample population. Other factors that affect risk elicitation method include, the type of scientific and public information available on the risk involved, aspects of risk perception to be measured, and the general knowledge of the respondents.

For example, for CWD, is there information on the objective level of CWD risk to human health? How many dimensions of CWD risk are being measured - single risks, multiples risk or both? Are we intending to measure risk susceptibility, risk magnitude or both? How much information needs to be provided to the respondents? For risks with multiple dimensions like CWD, risk elicitation methods that are simple are easier for respondents to understand. Simple methods are most useful when trying to capture treatment effects and differences in treatment effects and individual risk preferences (Charness et al, 2012). However, risks are difficult to elicit qualitatively, there may be issues that arise from subjective interpretation of wordings this is why risk elicitation methods like risk ladders are used.

Comparing methods of measuring risk is difficult because researchers conceptualize risk in unique ways. However, the most common way of conceptualizing risk perception for animal diseases with multiple dimensions, uncertain risk probability and magnitude, including CWD, is

using questionnaires. There are many methods to elicit observable dimensions of risk like risk attitudes (risk loving or risk averse) and risk preferences (choosing one risk over the other) including "The Balloon Analogue Risk Task" (Lejuez et al., 2002; Crosetto and Filippin, 2012), questionnaires (Weber et al., 2002), the Gneezy and Potters Method (Gneezy and Potters, 1997) and the multiple price list method (Binswanger, 1981; Charness et al 2013). However, when it comes to eliciting risk perceptions (subjective judgement of probability and severity of risk), due to the subjective and unobservable nature of risk perceptions, researchers must pick between questionnaires and a visual risk elicitation tool, such as risk ladders.

Questionnaires allow the elicitation of qualitative risk perceptions which is useful in scenarios where the risk being observed is minute or unfamiliar. However, there is the issue of inaccurate risk perception elicitation due to subjective factors like the respondent's interpretation of wordings, Risk elicitation tools like risk ladders are especially useful for the elicitation of very small risks and risks that people have little to no information about because they can be quantitative and precise (Lloyd-Smith et al., 2018).

Risk Ladder

A risk ladder is an example of a visual risk elicitation tool. Risk ladders differ from numeric scales because they express risk in a relative sense as opposed to absolutely. The public might have difficulty understanding and communicating risk in frequencies, odds and probabilities however, they seem have consistent views about relative risk of hazards. (Persoskie and Downs, 2015). The public does not know if cancer kills 5% or 40% of its victims but they know it is more lethal than other causes of death (Fischhoff & MacGregor, 1983).

Risk ladders have been used in survey research to present unfamiliar hazards in the context of more familiar hazards and have been found to aid in the elicitation of respondents' subjective risk judgments. (Hammitt, 1990; Buzby et al., 1995). Risk ladders are primarily risk communication

tools. However, they can be used to elicit personal risk likelihood or perception of risk from respondents. While risk ladders have been evaluated as a tool for communicating risk, little work has been done to evaluate risk ladders as a risk elicitation method. In addition, risk ladders are usually used in expressing perceived likelihood of risk More research has to be done on the potential framing effect and effectiveness of risk ladders as risk elicitation tools because while risk ladders may be helpful in putting risks in the context of commonly known risk, risk ladders may not be effective in communicating and eliciting subjective risk consistently. Hence this is why questionnaires are the most widely used method to elicit risk perceptions (Persoskie and Downs, 2015). A risk ladder for the human health and animal health risks of CWD was developed but not included in this study (See Appendix 2).

Risk perceptions are subjective. While risk ladders can be used to elicited quantitative values or risk perception, modifying the range covered by a "risk ladder" can alter risk perception numbers (Weinstein, 1999). Even in the case of using risk elicitation tools like risk ladders, the general public may not be familiar with odds and percentages that form scientists risk language. Individuals may use different types of cognitive structures to understand even quantitative risks. Some respondents may think in terms of comparative risks while others may relate more to the magnitude of the absolute risk.

QUESTIONNAIRES

Studies have elicited risk perceptions of food safety risks relating to an animal disease using questionnaires (Pennings et al., 2002; Setbon et al. 2005; Muringai and Goddard, 2017). In the case of Mad Cow Disease, Setbon, Raude, Fischler, and Flahault (2005) used a question with a Likert scale set of answers to elicit the perceived risk of Mad Cow Disease, individual knowledge about BSE and the risk of contracting a human version of the disease, social trust in public

authorities, attitudes and beliefs regarding MCD related risk and reported changes in beef consumption patterns, preferences for red meat and socio demographic variables. (Setbon et al., 2005; Pennings et al., 2002). Some studies use questionnaires to measure and report unidimensional measures of risk, namely a single statement that either measures overall risk, the probability component, or the consequence you perceive. e.g.

"Identify the current level of prevalence (infection rates) of CWD in each WMU in the study area: None, low, medium, and high" (Zimmer et al., 2011).

However, risk perceptions can be investigated with multiple items. Vaske and Lyon (2011) assess individuals' perceived risk regarding CWD was assessed using a 6-item index:

1) *To what extent do you agree or disagree that because of CWD, you have concerns about eating deer meat: (1) strongly disagree to (7) strongly agree.*
2) *"How concerned are you about your own personal health?" Responses were measured on a 9-point scale from: (1) not at all concerned to (9) extremely concerned."*

3-6) How much risk do you associate with"?

a) Inadvertently eating meat from an animal infected with CWD

b) Contracting a disease caused by CWD

c) Becoming ill as a result of contracting a disease caused by CWD, and

d) Death as a result of contracting a disease caused by CWD.

Similarly, Penning's, Wansink, and Meulenberg (2002) developed a psychometric measure to capture perceived risk of food products. In Pennings et al. 2002, the measures of risk perception (defined as subjective evaluation of the severity and consequences of risk) consisted of the following 5-point items:

1) When eating beef, I am exposed to (1. very little risk ... 5. high risk).
2) I think eating beef is risky (1. strongly disagree ... 5 strongly agree).

3) For me eating beef is (1. not risky ... 5. risky)

For risk attitudes (defined as the individual's intention to evaluate a risk situation favorably or unfavorably and to act accordingly, the following questions were asked:

4) I accept the risks of eating beef (1. strongly disagree ... 5. strongly agree).
5) For me eating beef is worth the risk (1. strongly disagree ... 5. strongly agree).
6) I am ... the risk of eating beef (1. not willing to accept ... 5. Willing

The responses to these questions are used to calculate risk perceptions and risk attitude scores. Pennings et al., 2002 calculated risk perception and risk attitude scores by taking the averages of responses in each category. They also created an interaction term between the risk perception and risk attitudes to show their combined effect on consumer behaviour. The interaction identifies whether risk averse individuals will engage in risk reducing behavior and this becomes more evident as the individual's risk perception increases.

Although these questions were developed for beef (Pennings et al. 2002; Schroeder et al. 2007; Muringai and Goddard 2011) they have been applied to more recent studies in the US and Canada regarding risk perceptions for venison (Myae, 2011; Murungai and Goddard, 2017; Yang and Goddard, 2011). Myae (2015) used Likert scales to elicit the perceived food safety risk of CWD, individual knowledge about CWD and the risk of contracting a human version of the disease, social trust in public authorities, attitudes and beliefs regarding CWD related risk, preferences for red meat and socio-demographic variables. Although Pennings et al. (2002) had these measures on a 10-point scale, Yang and Goddard (2011a, 2011b) used five-point scales.

The table below shows studies that have elicited animal health and food safety risk in the context of animal diseases:

TABLE 2.1: RISK PERCEPTION ELICITATION QUESTION IN WILDLIFE DISEASE STUDIES.

Citation	Objective	Methodology	Questions
Chronic Wasting Disease in Wisconsin: Hunter Behavior, Perceived Risk, and Agency Trust **Vaske et al., 2004**	To examine the extent to which CWD influenced 2001 Wisconsin deer hunters who did not participate in the 2002 hunting season.	Individuals' perceived risk regarding CWD was accessed using a 3-item index.	Respondents were asked to rate: Concern about eating wild venison from a Wisconsin deer that was not tested for CWD Concern about eating wild venison from a Wisconsin deer that was tested and the result was positive. Concern about becoming ill from CWD Variables coded on a 4-point scale: (0) not at all concerned, (1) not too concerned, (2) somewhat concerned, (3) very concerned.
Wildlife disease and risk perception **Hanisch-kirkbride, Riley, and Gore, 2013**	1) Assess zoonotic disease risk perceptions; 2) identify sociodemographic and social psychologic factors underlying these risk perceptions; and 3) examine the relationship between risk perception and agreement with wildlife disease management practices.	Risk perception was measured using three conceptual elements: severity, susceptibility and dread. Calculated risk perception index score	**Severity:** if [you personally, people in your community, pets, domestic livestock, wildlife] were to contract [plague, rabies, west Nile virus disease], how serious do you think the consequences would be…?

		(severity + susceptibility + dread)/3	**Susceptibility:** if [you personally, people in your community, pets, domestic livestock, wildlife] were to contract [plague, rabies, west Nile virus disease], how serious do you think the consequences would be…? Variables were coded on a 4-point scale: (1) not serious, (2) somewhat serious, (3) serious, (4) very serious. **Dread:** do you worry about or feel fearful of [plague, rabies, west Nile virus disease] affecting…? Variables were coded on a 4-point scale: (1) not at all (2) rarely, (3) from time to time, (4) a great deal.

Trust and consumer risk perceptions regarding BSE and chronic wasting disease Muringai and Goddard, 2017	Assessing the relationship between trust and consumer perception regarding BSE and CWD food safety risk.	Risk perception was elicited using a two-item index.	1) Would you say that the following food issues are an important risk to human health in our society, are not a very important risk or no risk at all? The responses were coded as follows: 0. No risk, 1. Not very important risk, 2. Important risk, and 3. Don't know. 2) I, or my family, have concerns about eating elk and deer meat because of CWD. The responses are coded as follows: 0. Strongly disagree, 1. Somewhat disagree, 2. Neither agree, nor disagree, 3. Somewhat agree, 4. Strongly agree, and 5. Don't know.
Canadian Consumer Responses to BSE with Heterogeneous Risk			When eating beef, my household is exposed to… (*very little risk* to *a great deal of risk*

Perceptions and Risk Attitudes **Yang and Goddard, 2011**			Members of my household think eating beef is risky (*strongly disagree* to *strongly agree*) For members of my household, eating beef is … (*not risky* to *risky*) *
Consumer Food Safety Risk Perceptions and Attitudes: Impacts on Beef Consumption across Countries **Schroeder et al., 2007**	Using a Double-Hurdle model, they examine if consumers changed beef consumption behavior based on risk perceptions and risk attitudes.	The set of risk perception and attitude questions were each averaged to form a scale for risk perception and a separate scale for risk attitude (following Pennings et al., 2002).	I consider eating beef (1= Not at all Risky, …, 10 = Highly Risky). When eating beef, I am exposed to (1= No Risk at all, …, 10 = Very High Risk) Eating beef is risky (1= Strongly Disagree, …, 10 = Strongly Agree)
Risk Sensitivity and Hunter Perceptions of Chronic Wasting Disease Risk and Other Hunting, Wildlife, and Health Risks **Needham, Vaske and Petit, 2017**	This article examined relationships among hunter perceptions of personal health risks from chronic wasting disease (CWD), knowledge and information about CWD, and perceptions of other hunting, wildlife, and health risks.	Questionnaire form. Perceived personal health risks associated with CWD were measured with four variables.	Hunters reported how much risk they perceived was associated with two incidents happening to them: (a) "contracting a disease caused by CWD" and (b) "becoming ill as a result of contracting a disease caused by CWD." Responses were on a 9-point scale of 1 "no risk" to 9 "extreme risk." Hunters were also asked "because of CWD, how concerned are you about your own personal

			health" on a 9-point scale of 1 "not at all concerned" to 9 "extremely concerned." In addition, hunters were asked to respond to the statement "because of CWD, I have concerns about eating deer or elk meat" on a 7-point scale of 1 "strongly disagree" to 7 "strongly agree."
Exploring Perceptions About Chronic Wasting Disease Risks Among Wildlife and Agriculture Professionals and Stakeholders **Schuler, Bunting and Mohammed, 2016**	Orts to address divergences between expert-derived risk assessments and stakeholder risk perceptions. We examined perceived risks associated with CWD introduction and exposure among agricultural and wildlife agency professionals within and outside of NYS, as well as stakeholder groups (e.g., hunters and captive cervid owners).	We measured perceived risk using a single item in a risk assessment questionnaire	They asked respondents who reported a higher than minimal amount of familiarity with CWD to rate the probability of a hazard on a scale of 0–10 with 10 being the highest probability for each of 9 distinct hazards for hypothetical disease pathways.
An Assessment of Hunters' Perceptions of Chronic Wasting Disease in Illinois' Deer Herd: Impacts of	This study examines hunter attitudes, perceived risks, and planned behavioral changes due to chronic wasting disease (CWD) in white-tailed deer (Odecoileus virginianus) in Illinois.	Measure risk perception using a single item questionnaire	"Please give your opinion of the risk of the following: "Becoming ill from Chronic Wasting Disease"

Hunter Participation in 2002-2003 and 2003-2004 **Miller et al., 2006**			No risk 2. slight risk 3. Moderate risk 4. High risk 5. Undecided

Studies have also examined economic / financial losses/ risks by using questions such as "how much financial risk is involved with [potential scenario for a potential stakeholder]?" This method attempts to measure overall amounts of loss without getting into specific monetary details like the number of dollars. However, this requires respondents to be briefed regarding the nature of economic risks (Mitchell and Greatorex, 1993).

Using Likert scales is a method that relies on the individual's self-reported qualitative risk perception (for example, on a scale of not very risky to very risky); therefore, there is a trade-off between simplicity of the method and the possibility of gratuitously expressed preferences for risk (Charness et al., 2013). While simple to understand, questionnaires are typically not directly incentivized. Hence, it is up for debate whether the elicited risk preferences reflect an individual's true attitudes toward risk. Again, it is important to note that interpretation of qualitative statements is subjective and hence the questions could be misinterpreted or interpreted differently by individual respondents.

In turn, when choosing to use simple risk elicitation methods like questionnaires, researchers should be aware of the trade-off between the simplicity of the method and the possibility of gratuitously expressed preferences for risk.

2.4.2 Factors Related To Risk Perceptions

The Social Amplification of Risk Framework (SARF) (Pidgeon et al, 2003) is the most important theory about the importance of societal response in affecting individuals risk perceptions. According to the SARF, risk perception starts with the communication of a risk event, once people are aware of a risk, a range of psychological, social and institutional factors influence risk perceptions.

Societal responses have to do with the quantity and quality of media coverage, the actions of risk assessment agencies and how the public perceives these agencies. Results in previous studies also showed that risk perceptions are influenced by demographic variables

such as gender (Finucane et al., 2000; Siegrist et al., 2005; Tonsor et al., 2009; Dosman et al., 2001), age of the respondent (Tonsor et al., 2009; Dosman et al., 2001), number of children in the household (Dosman et al., 2001), income (Dosman et al., 2001; Tonsor et al., 2009) and education of the respondent (Dosman et., 2001). Other factors that influence risk perceptions are personal experiences (Tonsor et al., 2009), generalized trust (Siegrist et al., 2005; Viklund, 2003; Muringai and Goddard, 2017), and trust in different the government or different information sources (Siegrist, 2000; Tonsor et al., 2009; Muringai and Goddard, 2017). Media coverage of risks was also found to influence risk perceptions (Wåhlberg and Sjöberg, 2000).

Another factor affecting risk perceptions is the nature of the risk itself. The characteristics of the risk determines the public's reaction to the risk and in turn could help determine the characteristics of the risks which are most important and the public place most emphasis on (Decker et al., 2010). Risk characteristics include the spatial proximity and prevalence of the risk, the visibility, prevalence and severity of the risk, and who and what the risk affects.

Studies of food product related risk have shown that perceived risks of food products are associated with a wide variety of influences from socio-demographics, personality and physiological constructs to behavioural factors. The public is not always rational. As opposed to experts they use a broader definition of risk when deciding which risks are of the most concern to them (Slovic, Fischhoff, & Lichtenstein, 1985). Public concerns regarding risk are affected by a combination of values, beliefs, attitudes, whereas experts assess risks based on scientific evidence and probability and expert judgement.

The public perceives risks through several filters; community, culture, societal response and the characteristics of the risk itself. The risk characteristics include the ability to manage the risk, and also the educational efforts of the government agencies and other actors. Although public risk perceptions may not align with that of experts, their views are still important in influencing decisions. Assessing and measuring risk perceptions is important for

economic analysis and policy recommendations on CWD risk surveillance and management. For diseases like Chronic Wasting Disease, risk perceptions may be especially important to understand an individual's desire to invest in behavioral changes (Decker et al., 2006; Miller & Shelby, 2009; Needham & Vaske, 2009) and can assist in planning for the next potential wildlife disease outbreak (Vaske et al., 2009).

Stakeholder risk perceptions can influence their support for management, including lethal control (Cooney & Holsman, 2010). Hunters who did not hunt because of CWD had a higher risk perception about CWD than their counterparts (Vaske et al., 2009). Needham and Vaske (2006, 2008) found that the majority of hunters agreed that CWD poses an unspecified threat to humans, should be eliminated, and may cause disease in humans and they and their families were concerned about eating deer or elk. Specifically, in Alberta, Canada, proposed management actions received positive responses from the public. Qualitative and quantitative analysis by Forbes (2011) showed that there is widespread concern about CWD and hence, widespread support of control programs. Her study investigated the value the Albertan public places on the controlling CWD in wildlife populations. The estimates of willingness to pay to mitigate CWD per annum over 10 years was found to be statistically significant. While WTP varied by gender, income, age and if the individual hunted, the estimated average willingness to pay was sufficiently significant to counter the potential cost of CWD.

CWD knowledge and Awareness

Familiarity and knowledge associated with a hazard can be related to risk perceptions (Fischhoff et al., 1978; Gupta, Fischer, & Frewer, 2012; Siegrist & Cvetkovich, 2000). People's perception of risks can be influenced by their proximity to the risk, its prevalence, the effects and the manner in which they are possible exposed to the risk (Slovic 1992). However, for these to influence the formation of risk perceptions, people need to be aware of them. This may depend on how government agencies, researchers, social media, and news media cover

and describe a risk like CWD. In the case of CWD, information that could be available to the public include awareness and knowledge about the existence of the disease, where it can be found, its effect on wildlife population and so on.

Whether the public believes or disbelieves publicly available information may be reflected in people's risk perceptions and intended behaviors (Muringai and Goddard, 2017). Muringai and Goddard (2011) analysed consumers' knowledge and human health risk perceptions about BSE and the effects of human health risk perceptions on consumers' agreement to pay for BSE tested beef. Results showed that knowledge of BSE significantly influenced human health concerns about BSE in Canada (negatively), U.S. (negatively) and Japan (positively).

The public may be more willing to support a healthy wildlife population if there is increased public awareness that protecting wildlife will also protect human health. Muringai and Goddard (2011) results showed that hunters had a relatively higher awareness of the disease and concerns about venison consumption than the public. This result is consistent with that of Lischka et al. (2010) who evaluated the knowledge of CWD in Illinois but in contrast with Muringai and Goddard (2017) whose study results showed that prior knowledge of CWD did not appear to have an effect on human health concerns about CWD.

However, in addition, the importance of CWD knowledge and awareness is similar to that of risk perception when it comes to decision making regarding supporting management options. The two are expected to impact the economic value respondents place on mitigating CWD related risks (Forbes, 2011). Risk perception and CWD awareness are both ways to measure if educational programs are working and where future efforts should be directed. Exploring CWD awareness is also a way to look at how willingness to support management might change if CWD risk becomes a more popular topic in news media and policy decision-making.

Many control strategies depend on the awareness and participation of the public. The public perception of human health risk is an assessment of the likelihood human infections and their concern about the consequences.

Studies have elicited knowledge and awareness of CWD in a variety of ways. For example, Vaske (2004; 2006) used nine true/false statements to measure respondents' knowledge about CWD. Respondents answered true, false, or unsure for each statement. Unsure responses were considered incorrect answers (Vaske et al., 2004; 2006).

Needham et al. 2017 also used 10 questions measuring factual knowledge about CWD (responses were true, false or unsure), and 12 questions measuring perceived information about CWD - Prior to receiving this survey, I feel I had enough information about-with responses on a 7-point scale. (1 = strongly disagree, 2 = moderately disagree, 3 = slightly disagree, 4 = neither, 5 = slightly agree, 6 = moderately agree, 7 = strongly agree.).

Forbes, 2008; Myae 2015; Muringai and Goddard, 2018 used the following set of questions to elicit CWD awareness and knowledge. For awareness, they asked:

Before responding to this survey, had you heard of CWD? 0. no. 1. Yes.

For knowledge, they asked;

Did you know that CWD can infect deer?

○ Yes

○ No

○ Don't know

Did you know that CWD can infect elk?

○ Yes

○ No

○ Don't know

Before responding to this survey, did you know that although CWD has been present in farmed elk and deer in Alberta in the past, it is currently only present in Alberta in wild deer?

○ Yes

○ No

○ Don't know

ENVIRONMENTAL VALUES AND CONCERNS

Cultural theorists argue that social values and worldviews play an important role in risk perception and behavior. That is, way individuals interpret the world and the information they receive is dependent on their worldview. Preferences for environmental risk management could be influenced by one's cultural biases, such as perceptions of the vulnerability of nature. Specifically, for environmental worldviews, cultural theorists distinguish four ways of life, defined by distinct perceptions of environmental risks. The views on the vulnerability of nature are defined as "myths of nature"- nature benign, nature tolerant, nature ephemeral, nature capricious (Schwarz & Thompson, 1990). These myths of nature are rooted in an individualistic, hierarchical, egalitarian, and fatalistic way of life, respectively (Peter and Slovic, 1996; Poortinga et al., 2003). Nature benign is the individualistic myth of nature. Natural resources are considered to be abundant and this goes along with a low environmental concern. This individual may consider government regulation as threats to free will and individual autonomy. Nature tolerant is the hierarchical myth of nature. Natural resources are seen as available but scarce. As a result, nature tolerant can be associated with a moderate environmental concern. Nature ephemeral is the egalitarian myth of nature. Nature ephemeral views nature as a fragile and precarious system. Natural resources are seen as limited and depleting. Therefore, nature ephemeral is associated with a high environmental concern.

This cultural theory has been applied to study cultural biases, risk perceptions, and environmental concern on an individual level, and a few studies found empirical support for the idea that environmental risk concern and preferences for management are related (Steg and Sievers, 2000; Poortinga et al., 2003). Poortinga et al., (2003) examined the relationships between environmental risk concern and preferences for environmental risk management strategies. They found that respondents with low environmental concern had the lowest preference for government regulation and respondents with the highest environmental concern had the highest preference for government regulation.

Goddard et al. (2018) examined food integrity and food technology concerns in Canada and found that environmental concerns, measured using the myths of nature influenced food integrity concerns. Hence, myths of nature could possibly influence food safety concerns regarding CWD.

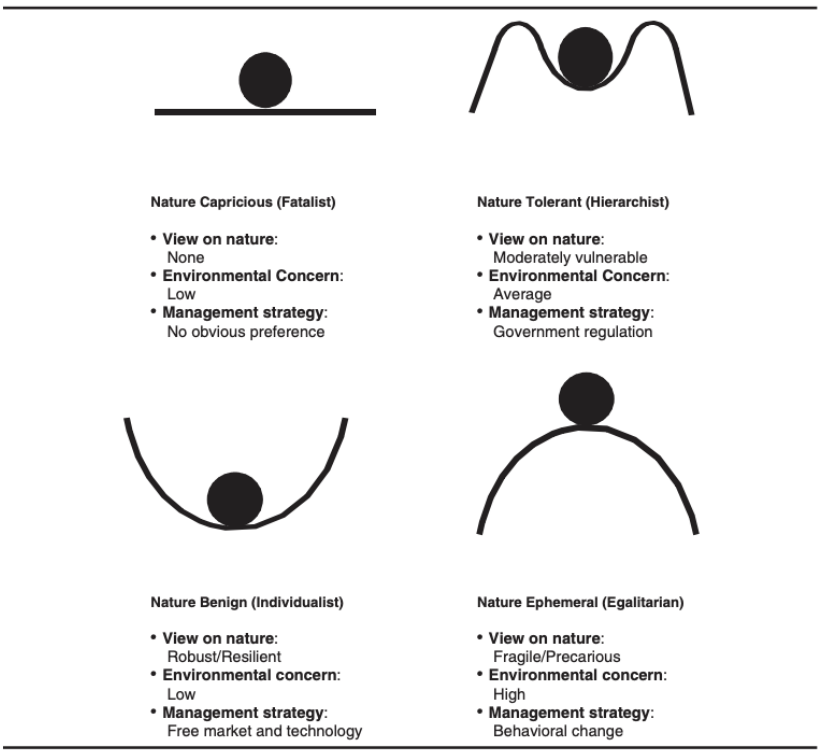


FIGURE 2.1: MYTHS OF NATURE. SOURCE: (POORTINGA ET AL., 2003, P.458).

WILDLIFE ATTITUDE

It has been established that Canadians care about wildlife (Canadian Wildlife Federation, 2019). One of the main objectives of this study is to assess the level of concern that the Canadian public has about wildlife, specifically the deer and elk populations. It is expected that a more positive perception of wildlife will be associated with an increased likelihood of support for CWD management (Decker et al. 2010). Decker et al. (2012) showed that since wildlife diseases may threaten human health, they might lead to a shift in attitude towards wildlife. Increased dread/worry among society towards wildlife among segments of society could lead to emotional and physical dissociation from wildlife. If physical and emotional dissociation exist, it could lead to negative outcome including decline in visitation to parks, reduced tolerance towards wildlife and wildlife conservations, and possible reduced interest in supporting a referendum to manage animal disease spread (Decker et al., 2012; Shadick et al., 1997).

VENISON CONSUMPTION

As stated in chapter 1, one of the concerns of CWD is the food safety risk to venison consumers. Whether people eat venison could influence their food safety risk perception concerning CWD. Chronic Wasting Disease raises the issue of personal concern for the safety of venison is among several stake holder groups (Myae, 2015). While studying hunter harvest behavior in Wisconsin's Chronic Wasting Disease eradication zone, Holsman and Petchenik (2007) postulated that one factor that could negatively impact CWD management efforts (hunter harvest) was the perceived risk of eating potentially infected venison. Hence, whether people eat venison, could influence their risk perceptions and willingness to support or participate in disease management efforts.

GENERALIZED TRUST

Generalized trust has been shown to be a factor affecting consumers' behavior concerning animal disease risk including CWD (Needham & Vaske, 2008; Setbon et al., 2005; Muringai, Goddard, & Aubeeluck, 2011, Muringai & Goddard, 2011; Muringai & Goddard, 2017). The importance of trust may be amplified in the absence of knowledge about a hazard (Siegrist et al., 2005). Trust is expected to reduce the perceptions of risk (Muringai & Goddard, 2017). Trust in a managing agency can be an important predictor of public acceptance of management actions (Perry et al., 2017; Stern & Coleman, 2015; Vaske et al., 2007). Risk perception is highly affected by trust. Needham and Vaske (2008), for example examined the relationship between trust and CWD risk across eight states in the US. Across all 22 states included in their investigation, hunters who trusted state wildlife agencies to manage CWD perceived slightly less risk from this disease. They found a negative relationship between trust and risk; those who perceived more personal risk from CWD were less likely to trust the agencies responsible for managing this disease.

2.5 SUMMARY

The literature showed that the risks (animal health, food safety, and economic) of animal diseases are interconnected and important to public decision-making behaviour regarding management and control of CWD. Risk perception can influence behaviour and can have an influence on the acceptance of management options. Sociodemographic factors can influence risk perception and so can the method of risk perception elicitation.

This study is interested in exploring how the Canadian public's perception of the risk associated with CWD specifically might affect their preference for CWD management in the

form of disease surveillance and how their sociodemographic and behavioral factors may affect their willingness to pay for disease surveillance.

Based on the above literature, frequently used methods for eliciting risk perceptions are stated preference surveys with questionnaires. Given that the study focuses on the support of proposed management options, some of which are not currently implemented, data is collected through a stated preference survey with questions that are designed to address the objectives of this study.

For this study I collected data on the public perceptions of economic, animal health and safety risks using stated preference survey data. In addition, I will collect data on risk perceptions, meat preferences, attitudes towards animals and environment, demographic characteristics, CWD knowledge, and questions about support for management practices.

The data collected will be analysed using descriptive statistics and regression analysis. Descriptive statistics would be used to categorize respondents into risk perception groups. Following previous studies by Meuwissen et al. 2001, Bishu et al., 2016, I would be using multinomial logit regressions to examine the factors affecting the response to CWD surveillance at an increased tax level. This regression will determine if risk perception and environmental attitudes affect the choice of risk perception management options, specifically CWD surveillance.

We are also interested in the factors that may affect the Canadian public's perception of the different risks posed by CWD. Some of these factors include the nature of the risks, CWD knowledge and awareness and information provision. For this study information provision is integrated into our experimental design. We will be exploring how providing different types and combinations of risk information to respondents may affect their measures of perceived risk as well as their willingness to support/ pay for a hypothetical referendum on CWD surveillance.

The next chapter will explore the data and methods in details.

CHAPTER 3: METHODS, DATA, AND DESCRIPTIVE STATISTICS

3.1 INTRODUCTION

The previous chapter includes a literature review of risk perceptions, risk perception elicitation methods, information provision, and animal disease (CWD) management. In this chapter, we describe the empirical framework to be used in this study, data sources, data collection methods and descriptive analysis of data collected.

This study aims to

(1) Measure public risk perceptions of the different risks posed by CWD (economic, human health, and animal health),

(2) Identify factors affecting risk perception levels,

(3) Identify how exposure to the possibility of different risks in the survey design influences choice and support for surveillance options, and

(4) Compare results from multiple different data treatments.

3.2 EMPIRICAL FRAMEWORK

The conceptual framework is used to guide the empirical approach and choice of variables included in the models and survey. The conceptual framework presented in this study would show how risk perceptions could influence the support for surveillance options to be implemented to help manage the spread of CWD. The model includes demographic characteristics, environmental attitudes, risk perceptions and other determinants of risk behavior.

The conceptual framework used in this study, was adopted from Valeeva et al. (2011) and Flaten et al. (2005). Valeeva et al. (2011) developed their framework to demonstrate the effects of risk perceptions on risk management responses to animal disease. The core of the

Valeeva et al. (2011) framework is derived from the Health Belief Model (HBM) (Rosenstock, 1974; Green and Murphy, 2014). The HBM is one of the most widely recognized conceptual frameworks for human health education and behavior. The health belief model identifies four aspects of individual choice assessment: perceived susceptibility to ill-health (risk perception), perceived severity of ill-health, perceived benefits of behavior change, and perceived barriers (potential cost, money, time involved in taking action) to taking action.

This is correlated with the framework developed by Flaten et al. (2005). They use a descriptive approach to characterize how Norwegian farmers perceive and manage risk. The framework is based on the idea that the best way to understand an individual's decision-making behavior is to understand their frame of reference for evaluating choices with uncertain outcomes. That is, demographic characteristics and risk perceptions. The individual's perceptual world is that the person's reality forms the basis for their choices (Flaten et al., 2005: Slovic et al., 1982). It is expected that more significant levels of perceived threat combined with strong perceptions of the benefit of action will lead to increased motivation to act in a risk-reducing manner or support management practices that reduce risk occurrence. It is expected that individual characteristics, risk behaviour, and environmental attitudes would be heterogeneous and are also expected to influence risk perceptions and support for management options.

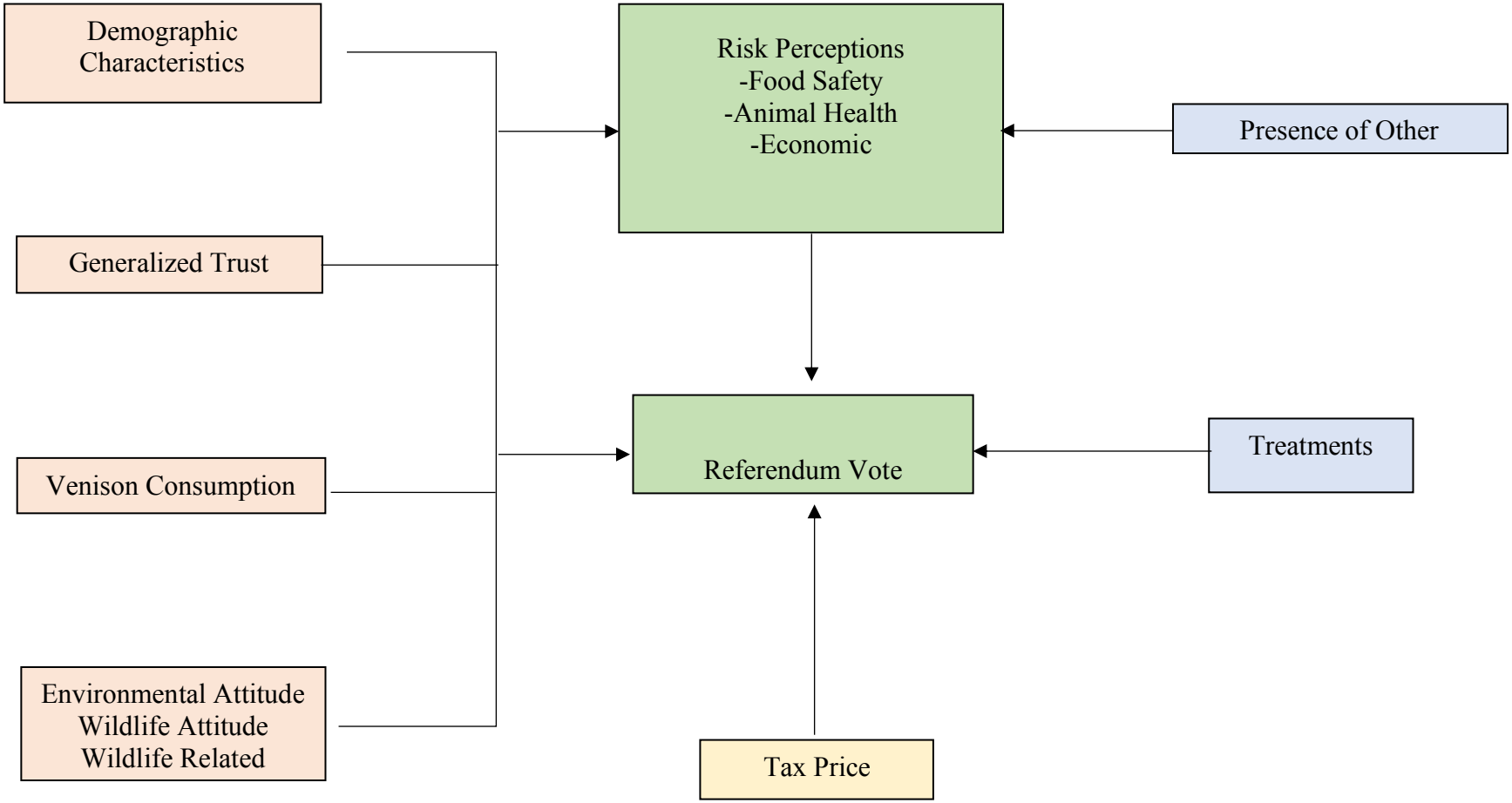
As highlighted in the previous chapter, the concepts developed in the HBM model are vital in the analysis of the public's choice of management strategies to control diseases related risks. Several researchers have evaluated the perception of the probability of animal diseases' occurrence (susceptibility) and the potential seriousness of animal disease risks (severity) and their effect on risk management decisions (Zwart et al., 2009; Meuwissen et al., 2001; Forbes, 2011; Needham et al., 2008).

For our study this general framework is followed. In Figure 3.1, for this study, the referendum vote regarding CWD surveillance is then influenced by demographic

characteristics, CWD knowledge and awareness, attitudes towards wildlife and the environment, and risk perceptions-as captured in our experimental design. Risk perceptions on the other hand are also influenced by demographic characteristics, CWD awareness and knowledge, generalized trust, consumption behaviors and attitudes towards wildlife and the environment. The reasons for the inclusion of these variables were discussed in the literature review.

In the sections to follow, we will explore data collection for the referendum votes and risk perceptions as well as the factors affecting these variables. We will discuss the survey instruments used to elicit all variables of interests, how the data was recoded for analytical purposes, and what the final variables included in the regression are.

FIGURE 3.1: CONCEPTUAL FRAMWORK OF VARIBALES INCLUDED IN THE STUDY



3.3 Survey Design and Data Source

Data was collected in 2018 with a national online survey, which was conducted using a market research company (Asking Canadians). There were 5326 complete responses to the survey from a total number of interviews initiated of 10,052. 4,726 respondents partially completed the survey and 1526 tried to complete the survey after the sample quota was reached. The survey was targeted at respondents 18 years or older. Also, there was an oversampling of rural residents, based on the assessment that CWD could have more direct influence on rural residents. More respondents from rural areas were recruited because more rural individuals were needed to analyze property rights for CWD management in a separate analysis of some data in the survey (Durocher, 2019). Hence, this sample has 11% more people living in the countryside compared to the census data.

Household income data is not included in the regression analysis because 17.7% of the respondents had missing values for the variable

Given the collected data, we compared the sample means of the general Canadian public from the 2016 census to the sample of survey respondents to ensure that the data is representative of the Canadian population for the demographic variables. The comparison is presented in Table 3.11 below.

All the variables included in this study were selected and defined through an extensive literature review in Chapter 2. This survey was designed to elicit information about CWD risk perceptions and the Canadian public's decision to support taxation for surveillance to reduce wildlife diseases. The data was developed based on previous surveys (e.g., Forbes 2011); and the literature review. The data set contains information on economic, food safety and animal health risk perceptions concerning CWD (Vaske et al., 2004; Myae, 2011; Kurt and Sigurdson, 2016;

Bartelt-Hunt and Bartz, 2013; Lazo et al., 2004). The development and definition of risk perception questions are described in the details in the empirical specification section below. The survey was designed in a way that the risk perception elicitation questions also functioned as primers and ways to provide information about CWD risks to the respondents. The study investigates the potential impacts of exposure to different risk perceptions on the possibility of voting yes, to a referendum on CWD management. The treatment groups are designed for variations in the number of priming questions, types of priming questions and order of priming questions received by respondents (Thau et al., 2020; Hjortskov, 2017).

Also included in our data set are data on CWD knowledge, venison consumption, environmental attitudes, attitudes towards disease management, and socio-demographic characteristics as established These variables are expected to influence decisions to support surveillance management practices (Muringai et al., 2011; Muringai and Goddard, 2017; Vaske et al., 2006; Steg and Sievers, 2000).

We also included consequentiality, certainty and trap questions to deal with issues of hypothetical bias, and bias from inattentive respondent behavior in the survey (Carson and Groves, 2007). The consequentiality question asked *"How certain are you that this survey might actually influence government surveillance policy for CWD?"* This is done to capture hypothetical bias and how seriously the respondents took the referendum questions. Trap questions are designed to spot respondent who are either not paying attention or straight lining on the survey. They are questions with obvious answers and respondents who answer them incorrectly are deemed to have failed the trap and maybe removed from the sample (Liu and Wronski, 2018).

3.4 Survey Experimental Design

In chapter 1, we hypothesized that different types of risk perception priming through questions might lead to different responses to the referendum on CWD risk surveillance. So, in order to measure and understand the effect of the availability of different risk perceptions - knowledge of CWD risks- on the referendum vote decision, we created a risk perception experimental design.

Survey experimental design may consist of the same question asked in multiple versions of a similar survey. There is a variation of treatments prior to when outcomes are measured. A particular survey deliberately imposes a single treatment on the responding group. In this experiment, the treatment groups are dependent on the type(s) of risk perception elicited (through questions) and the order in which they are elicited. Risk type and risk question order were the factors of this experiment. With this experimental design the goal is to understand how the type of risk information/ question asked affected the choices in the referendum vote.

For this study, the individuals were randomly assigned to an experimental group or treatment. The only factor defining the treatment assigned is the information provided. That is, each treatment includes a combination of the three risks (food safety, animal health, and economic risk) they are responding to and in what order the risk perceptions are presented as they responded. Since information provision may influence a respondent's perceptual world and frame of reference for evaluating choices in decision-making, it could influence respondents' risk perceptions and therefore their willingness to support CWD surveillance and control (Bergstrom et al., 1990). Each treatment was assigned to 523/524 respondents to add up to the total number of survey respondents in the study (5236). The risk treatments were presented in Table 1.1.

3.5 Descriptive Statistics for demographic variables

The data for some of the variables were recoded for analytical purposes: adjusting the income variable into a continuous variable at the mean of the income categories, rescaling education and age into numbers of years. The gender (female dummy variable), place of residence (urban dummy variable), province of residence (province dummy), and if children live in household variables were included as dummies. The table below contains a list of dummy variables and their definitions.

Table 3.1 presents the descriptive statistics on mean, standard deviation, minimum and maximum for the demographic variables -gender, age, income, education level, and province of residence and whether or not there are children in the household. Table 3.1 summarizes and compares the demographic statistics with frequencies from survey respondents and the Canadian census information from 2016.

The survey sample was 49% male and 51% female and is consistent with the 2016 census data. The sample consisted of respondents ranging from 19 to over 65 years old, with an average age of 41, the same as the 2016 census. However, the proportion of survey respondents living in Alberta was slightly (3%) less than in the census. The other provinces population was consistent with census data. In general, the respondents had a mean level of education of 15 years, which is approximately equivalent to a college degree. Respondents from the survey generally had a higher educational level than the census population, 35% of respondents graduated university compared to 11%. (Statistics Canada, 2018).

TABLE 3.1: DESCRIPTIVE STATISTICS COMPARED TO THE CANADIAN CENSUS. SOURCES: SURVEY DATA (2018); STATISTICS CANADA, (2019).

		Survey	**Census (2016)**
Gender	Male	48.70	49.11
	Female	51.30	50.89
Age	18 -20	2.51	3.64
	21-24	3.63	5.12
	25 -29	9.78	6.50
	30 -36	10.50	9.28
	37 -45	13.26	11.63
	46 -55	22.37	14.53
	56 -65	21.75	13.59
	65+	16.19	16.89
Children under 18 living in household	Yes	20.84	26.5
	No	79.16	73.5
Province	Live in Quebec	23.11	23.22
	Live in Manitoba	3.78	3.64
	Live in Alberta	9.76	11.57
	Live in Ontario	38.71	38.26
	Live in British Columbia	13.64	13.22
	Live in Saskatchewan	3.13	3.12
	Live in New Brunswick	1.59	2.13
	Live in New Nova Scotia	3.80	2.63

	Live in Prince Edward Island	1.28	0.41
Urbanization	Live in City	72	83.16
	Live in town or countryside	28	16.84
Education Level	Elementary School	0.86	18.29
	High School	17.48	26.45
	Technical/Business School/ Community College	30.75	24.80
	University	35.26	19.02
	Post Graduate Studies	15.66	5.46
Income	$ 24,999 or under	4.9	14.02
	$ 25,000 - $ 34,999	5.15	8.12
	$ 35,000 - $44,999	6.51	8.55
	$ 45,000 - $ 64,999	12.38	15.50
	$ 65,000 - $ 79,999	17.26	10.14
	$ 80,000 - $ 99,999	12.85	11.25
	$ 100,000 - $ 119,999	10.65	10.45
	$ 120,000 or more	19.09	21.97

It is important to note that due to our interest in the effect of CWD on rural areas, we requested an oversampling of the rural population in our respondent group. Hence, the rural population in our sample is 28% of the total compared to 17% in the Canadian 2016 Census. Urban dwellers are individuals who live in a city (>100,000 inhabitants) while rural dwellers live in the countryside, rural district or a town with less than 10,000 inhabitants. The table below shows the distribution of rural proportion in the survey sample compared to the 2016 Canadian census.

TABLE 3.2: RURAL AND URBAN PROPORTION OF SAMPLE COMPARED TO THE CANADIAN POPULATION. SOURCE: STUDY SURVEY DATA (2018).

Region	Urban	Rural	Total	% Rural (Survey)	% Rural (Canadian census 2016)
Newfoundland	24	39	63	61.90	42
Prince Edward Island	7	60	67	89.55	55
Nova Scotia	67	132	199	66.33	43
New Brunswick	36	47	83	56.63	51
Quebec	573	637	1,210	52.64	19
Ontario	1,217	810	2,027	39.96	14
Manitoba	98	100	198	50.51	27
Saskatchewan	64	100	164	60.98	33
Alberta	313	198	511	38.75	16
British Columbia	391	323	714	45.24	14
Whole Sample	2790	2446	5236	46.72	17

Given that our survey population is faced with ten different survey treatments we also examined the demographic characteristics by treatment group to see if there was any bias in the groups. That information is provided in Appendix 4. From a quick look at the data there did not

seem to be any significant differences between the demographic characteristics across treatment groups.

3.6 Variables Affecting Risk Perceptions and Referendum Vote

First, socio-demographic and behavioral characteristics are expected to impact risk perceptions. Insight from prior research and study objectives were used in the selection of variables. Measuring risk perceptions can be challenging but because we are trying to understand the factors affecting public behavior, it is necessary to make sure that the measures are robust by contextualizing the issue in multiple ways.

It has been proposed in chapters 1 and 2, an animal health disease like CWD might affect people's concerns about food safety, animal health, and/or the economy. The concerns are related to the consumer's risk perceptions. Furthermore, demographic characteristics play a role in individual behavior and choice. Previous studies have shown that socio-economic attitudes influence risk perceptions and in turn consumer behavior (Dosman et al., 2001; Schroeder et al., 2007; Muringai and Goddard 2011; Muringai and Goddard, 2017; Yang and Goddard, 2011).

Risk perceptions are tied to the understanding of risk exposure (quantity of risk) and the individual's subjective interpretation of the chances of risk exposure. Risk perception is subjective and dependent on individual factors. It is expected that individuals with higher risk perceptions would be more willing to support and actively engage in risk management. Hence, the hypothesis that perceived risks could significantly influences intentions to implement risk reduction strategies. The type and number of risks that individuals perceive may also have an effect on their decision-making regarding responding to a threat.

3.6.1 CWD Awareness and Knowledge

This section of the survey was used to understand how many respondents knew about CWD before the survey and how much they knew. To measure the respondents' awareness of CWD, a simple "yes" or "no" question was asked. These were simple yes/no questions about CWD awareness that have been used in previous surveys in 2009 and 2011 testing the Canadian public's awareness of CWD in deer and elk (Forbes, 2011; Myae, 2009). The data from this study is compared with data from the 2009 and 2011 studies.

TABLE 3.3: CWD AWARENESS IN 2009. 2011.2018. SOURCE: SURVEY DATA (2009); SURVEY DATA (2011); STUDY SURVEY DATA (2018).

Statements used to assess Chronic Wasting Disease Awareness	**Mean (Standard deviation)**		
	2018	2011	2009
Before responding to this survey, had you heard of Chronic Wasting disease?	0.29 (0.454)	0.387 (0.487)	0.393 (0.49)
Sample Size	5236	6916	1243

For the survey used in this study, most of the survey respondents were not aware of CWD. Only 29% of the sample had ever heard of the disease. There appears to be a decline in CWD awareness over the years.

To measure the respondents' familiarity with CWD, four questions were asked. The responses are summed to obtain a single CWD knowledge score (ranging from 0 to 4) for each of the respondents. Because each of the statements was true, the higher the score, the higher the respondent's knowledge of CWD. To measure if there is a statistically significant relationship between CWD knowledge and awareness between CWD knowledge and awareness, we calculate

the spearman rank correlation. With a Spearman rho of 0.74 and a p-value of 0.00, we reject the null hypothesis that CWD awareness are independent. Because CWD knowledge and awareness are significantly correlated, we would only be using CWD knowledge in our analysis.

The table below breaks down CWD awareness and knowledge for Alberta, Saskatchewan and other provinces:

TABLE 3.4: CWD AWARENESS AND KNOWLEDGE BY PROVINCE. SOURCE: SURVEY DATA (2009); SURVEY DATA (2011); STUDY SURVEY DATA (2018).

Statements used to assess Chronic Wasting Disease Knowledge and Awareness				
	Mean (Standard deviation)			
Awareness	AB	SK	Others	Whole Sample (Canada)
Before responding to this survey, had you heard of Chronic Wasting disease?	0.48 (0.50)	0.387 (0.487)	0.26 (0.44)	0.29 (0.45)
Knowledge				
If you had heard of CWD before this survey, did you know that CWD can infect deer, before responding to this survey?	0.35 (0.48)	0.49 (0.50)	0.14 (0.34)	0.17 (0.38)
If you had heard of CWD before this survey, did you know that CWD can infect elk, before responding to this survey?	0.34 (0.47)	0.50 (0.50)	0.12 (0.33)	0.16 (0.36)

Before responding to this survey, did you know that CWD has recently been found in both farmed and wild deer and elk in Saskatchewan?	0.23 (0.42)	0.29 (0.45)	0.05 (0.22)	0.08 (0.27)
Before responding to this survey, did you know that CWD has recently been found in both farmed and wild deer and elk in Alberta?	0.19 (0.39)	0.40 (0.49)	0.04 (0.22)	0.07 (0.26)
Sample Size	511	164	4561	5236

The results show that 78.5% of the sample has a knowledge score of (0) the lowest possible score and just 5.70% scored the highest possible score, 4. Only 20% of the population scored higher than the mean score of 0.53. This is not surprising given the CWD awareness in the sample.

Our data presented inconsistencies when it came to the CWD knowledge responses. 157 individuals who "had" no awareness of CWD admitted having some knowledge of the disease. The CWD knowledge score is expected to be zero for respondents who are unaware of the disease. For respondents who answered yes to any of the knowledge questions, their responses were re-coded as Nos to correct this inconsistency. We re-coded their responses as "Nos" because individuals who claim to have no prior awareness of CWD should also not have any prior knowledge of the disease.

CWD awareness and knowledge are highly and significantly correlated, with a Spearman's rho of 0.7397 and a p-value of 0.000. Therefore, we only use CWD knowledge in the regressions.

TABLE 3.5: CWD KNOWLEDGE SCORE FOR THE WHOLE SAMPLE FOR THE 2009 SURVEY AND CURRENT STUDY SURVEY (2018). SOURCE: SURVEY DATA (2009); STUDY SURVEY DATA (2018).

CWD Knowledge	Unaware of CWD (Original)	Unaware of CWD (recoded)	Aware of CWD	Total
2009				
0	683	705	294	977
1	9	0	44	53
2	10	0	111	121
3	2	0	73	75
4	1	0	61	62
Total	705	705	583	1288
2018				
0	3,558	3715	553	4,111
1	71	0	152	223
2	62	0	394	456
3	13	0	130	143
4	11	0	292	303
Total	3,715	3715	1,521	5,236

The knowledge score with the highest frequency is still 0. Only 18.5% of the respondents have some knowledge about CWD compared to 30% who have heard about the disease.

The table below summarizes the CWD knowledge of the respondents given their demographic characteristics of the 1521 respondents who have heard about. Men in this sample are slightly more knowledgeable about CWD than their female counterparts. Individuals who are in the age group 65 and above have the highest CWD knowledge scores, followed by individuals who are in the age group 56-64. With respect to education, the CWD knowledge score does not increase with the level of education. Interestingly, the group with the highest knowledge score is the group with the least amount of education- elementary school education. This might be due to the oversampling of rural populations who are more likely to be aware of CWD and hence have more knowledge about the disease.

TABLE 3.6: DISTRIBUTION OF CWD KNOWLEDGE BY DEMOGRAPHIC CHARACTERISTICS, URBANIZATION AND PROVINCE. SOURCE:STUDY SURVEY DATA (2018).

Demographic Characteristic	**Definition**	**Distribution of CWD Knowledge**				
		Obs	Mean	SD	Min	Max
Gender	Male	2,550	0.49	1.12	0	4
	Female	2686	0.47	1.09	0	4
Age	Under 18					

	18 -20	127	0.48	1.15	0	4
	21-24	192	0.53	1.21	0	4
	25 -29	520	0.47	1.08	0	4
	30 -36	564	0.48	1.07	0	4
	37 -45	699	0.50	1.13	0	4
	46 -55	1175	0.45	1.11	0	4
	56 -64	1131	0.49	1.10	0	4
	65+	828	0.47	1.08	0	4
Education	Elementary school	45	0.22	0.88	0	4
	Secondary (high) school	915	0.44	1.06	0	4
	Technical/ business school/Community college	1610	0.44	1.06	0	4
	University	1846	0.52	1.13	0	4
	Post graduate studies (Masters or PhD)	820	0.52	1.17	0	4
CWD Awareness	Aware of CWD	1521	0.57	1.20	0	4
	Not Aware of CWD	3715	0.44	1.06	0	4
Urbanization	Urban	2790	0.46	1.09	0	4

	Rural	2446	0.49	1.12	0	4
Region	Saskatchewan	164	0.45	1.03	0	4
	Alberta	511	0.55	1.20	0	4

3.6.2 GENERALIZED TRUST

Following the approach of previous studies, Glaeser et al. (2000); Muringai and Goddard (2011), we measured generalized trust levels by asking respondents the following question: "Generally speaking, would you say that most people can be trusted?" The responses were points on a Likert scale as follows: (1) people can be trusted, (2) can't be too careful with dealing with people, (3) don't know. The responses are then recoded into one variable for "generalized trust" so that that option 1 becomes "yes" and the other two are "no".

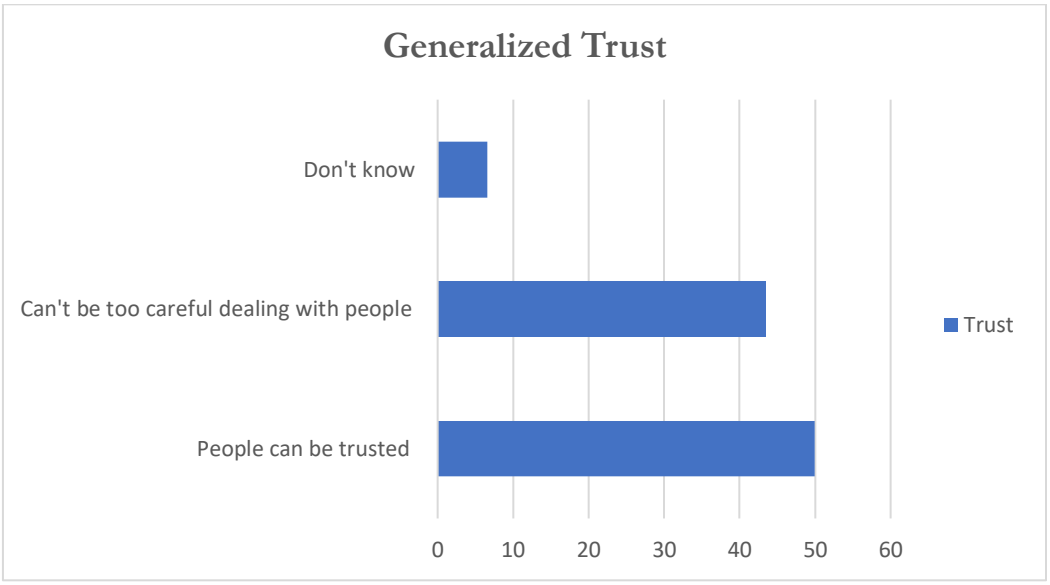


FIGURE 3.2: RESPONSES TO GENERALIZED TRUST QUESTION. SOURCE SURVEY (2018).

With a mean of 0.50, 50 % of respondents in this survey believe that people can be trusted in general. This is consistent with the results of the study by Muringai and Goddard (2011) also conducted on the Canadian population.

3.6.3 VENISON CONSUMPTION

For this study we are interested in seeing how a history of venison consumption might influence risk perceptions about CWD and the effect this might have on decision making concerning CWD management. The variable 'eat' in the models was measured by asking people about their consumption of venison. The following question was asked: 'Have you, or has any member of your household, ever eaten venison (meat from deer, elk or moose)?" 0. Yes 1. No.

TABLE 3.7: MEAN RISK AWARENESS AND KNOWLEDGE SCORE FOR RESPONDENTS BY "VENISON CONSUMPTION". SOURCE: STUDY SURVEY DATA (2018).

	Have consumed venison			
	Mean	SD	Min	Max
CWD Awareness	0.32	0.47	0	1
CWD Knowledge	0.54	1.16	0	4
Sample Size	4181			
	Have never consumed venison			
	Mean	SD	Min	Max
CWD Awareness	0.16	0.37	0	1
CWD Knowledge	0.22	0.78	0	4
Sample Size	1055			

Respondents who have consumed venison are on average more aware and knowledgeable about CWD than respondents who have not consumed venison. Personal experiences have been

found to influence risk perceptions about meat consumption, and food safety risk (Tonsor et al., 2009). The goal is to see if venison consumption actually affects risk perceptions and decision making regarding CWD.

The table below shows the proportion of venison consumers in three separate survey samples. The number of venison consumers in the 2018 sample is relatively high, 80% compared to 59% and 54% in 2009 and 2011 respectively. This might be due to oversampling of rural respondents.

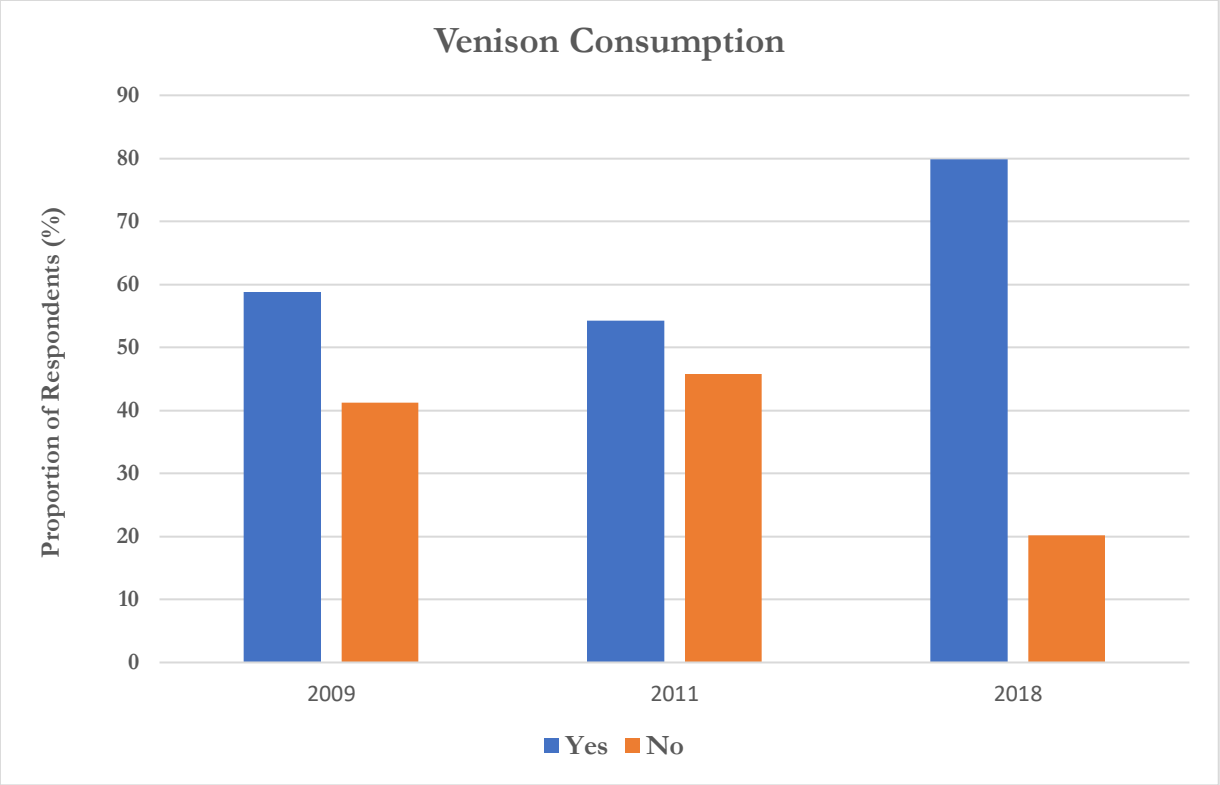


FIGURE 3.3: PROPORTION OF RESPONDENTS WHO HAVE EVER CONSUMED VENISON. SOURCE: MYAE, (2015); STUDY SURVEY (2018).

For further analysis, whether or not the respondent had ever consumed venison is used as a dummy explanatory variable for risk perceptions and referendum votes.

3.6.4 WILDLIFE TOLERANCE

It has been established that Canadians care about wildlife (Canadian Wildlife Federation, 2019). One of the main objectives of this study is to assess the level of concern that the Canadian public has about wildlife, specifically the deer and elk populations. It is expected that a more positive perception of wildlife will be associated with an increased likelihood of support for CWD management (Decker et al. 2010). Decker et al. (2012) showed that since wildlife diseases may threaten human health, they might lead to a shift in attitude towards wildlife. Increased dread/worry among society towards wildlife among segments of society could lead to emotional and physical dissociation from wildlife. If physical and emotional dissociation exist, it could lead to negative outcome including decline in visitation to parks, reduced tolerance towards wildlife and wildlife conservations, and possible reduced interest in supporting a referendum to manage animal disease spread (Decker et al., 2012; Shadick et al., 1997).

Therefore, included in this survey are a set of questions regarding wildlife in Alberta and Canada and how wildlife influences the natural environment, human health and the Canadian economy. These set of questions are used to measure the Canadian public's attitude towards wildlife. These set of questions were also used in a study examining the impact of CWD on the Alberta economy (Forbes, 2008).

Responses to these questions were recorded on a five-point Likert scale ranging from 1(strongly Disagree) to 5(Strongly Agree).

TABLE 3.8: DESCRIPTION OF QUESTIONS USED TO ASSESS WILDLIFE RISK PERCEPTIONS. SOURCE: SURVEY (2018).

	Description of questions used to Assess Wildlife Risk Perceptions			
		Mean (standard Deviation)		
		Forbes (2012)	Survey (2018)	
	Item	Alberta	Alberta	Full sample
Attitude towards wildlife	1. Wildlife is an important part of the natural environment	4.77(0.81)	4.55 (0.83)	4.58 (0.78)
	2. Wildlife is an important part of the Alberta and/or Canadian economy	1.93(0.97)	4.19(0.92)	4.16 (0.88)
	3. Wildlife is more of a nuisance than a benefit to my life	1.63(1.01)	4.23 (0.98)	4.26 (0.97)
	4. Diseases seriously endanger wildlife	3.43(1.06)	3.96(0.89)	3.97 (0.88)
	5. Wildlife diseases can seriously affect people's health		2.33 (0.95)	2.30(0.96)
	Sample Size		511	5236

Cell entries are means on a five-point scale: 1=Strongly Disagree, 2-Disagree, 3=Neither Agree nor Disagree,4=Agree,5=Strongly Agree

This survey question was sourced from a study on the economic value placed on containing CWD by Alberta residents conducted by Forbes (2011). The responses to these questions show that the Canadian public care a lot about the wildlife populations and have positive beliefs about the impact of wildlife on the environment, economy. The respondents mostly believe that wildlife is an important part of the natural environment and strongly disagree that wildlife is a nuisance to their life. This is consistent with the results from the study done by Forbes (2011) on Alberta residents.

The responses to the individual statements were used to develop a new variable of "perception of wildlife" that is used to explain public decision-making regarding CWD surveillance and behavior. This new variable was calculated by taking the average of the five statements.

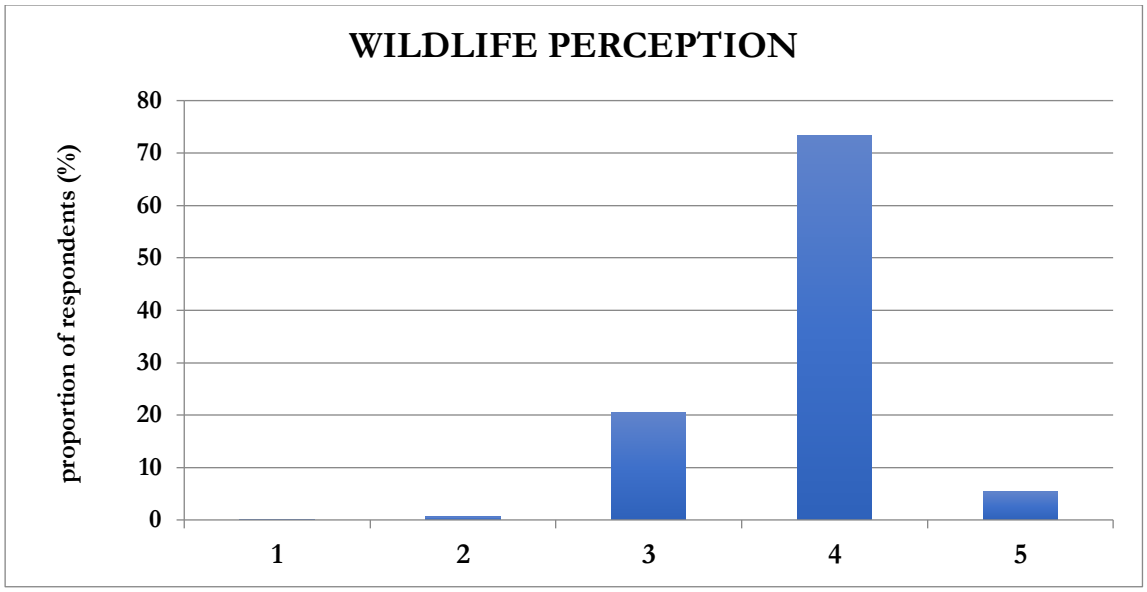


FIGURE 3.4: DISTRIBUTION OF WILDLIFE PERCEPTION INDEX. SOURCE: STUDY DATA (2018)

3.6.5 Environmental Attitude and Concerns

CWD is an animal disease with direct environmental impact. Wildlife health is and indicator of environmental and life quality and concern for wildlife and wildlife diseases are tied to

environmental concerns (Manfredo, 2008). Therefore, for this study we wanted to explore how environmental attitudes may influence perceptions of risk posed by an animal disease like CWD as well as how environmental attitudes may influence individual's decisions concerning disease management.

Environmental concerns are measured using myths of nature (Steg and Sievers, 2000; Goddard et al., 2017). The myths of nature represent four distinct attitudes towards nature and the environment (Steg and Sievers, 2000; Goddard et al., 2017; Mcneeley and Lazarus, 2014). Myths of nature describes the ways in which the relationship between society and the environment is formed. Myths of Nature broadens the understanding of environmental risks, influence food integrity concerns, and are closely linked to preferences for appropriate risk management strategies (Dake, 1992; Mcneeley and Lazarus, 2014; Goddard, Muringai & Boaitey, 2018). Individuals who identify with different myths of nature are expected to have different perceptions of CWD risks and inclination to support disease surveillance.

Respondents are asked to indicate which one of the following statements corresponds most with their view on nature. Their response is then coded as a dummy variable with a value of 1 for the option selected. Therefore, four dummy variables are developed from this question. The mean of each variable is the proportion of the sample that identifies with nature ephemeral, nature perverse, nature benign or nature capricious.

TABLE 3.9: INSTRUMENT FOR ENVIRONMENTAL ATTITUDE. SOURCE: STEG AND SIEVERS (2000), CWD SURVEY (2018); GODDARD ET AL., (2017); STEG AND SIEVERS, (2000).

Variable		Proportion of respondents who chose each response (Standard Deviation)			
		Survey (2018)	Steg and Sievers (2000)	Muringai & Goddard (2016)	Muringai & Goddard (2017)
Myths of nature	Myth of nature 1: environmental problems can only be controlled by enforcing radical changes in human behavior in society as a whole (nature ephemeral)	0.40 (0.49)	0.47	0.49	0.44
	Myth of nature 2: environmental problems are not entirely out of control, but the government should dictate clear rules about what is and what is not allowed (nature perverse/tolerant).	0.49 (0.50)	0.27	0.39	0.41
	Myth of nature 3: we do not need to worry about	0.02 (0.14)	0.09	0.02	0.03

	environmental problems because, in the end, these problems will always be resolved by technological solutions (nature benign).				
	Myth of nature 4: we do not know whether environmental problems will magnify or not (nature capricious).	0.09 (0.29)	0.18	0.09	0.11
	Sample Size	5236	513	1633	1618

As shown in the table above, the results are compared to previous studies conducted by Steg and Sievers (2000) and Goddard et al (2017). The majority of the respondents in this sample believe that nature is either perverse (49%) or ephemeral (40%) while only 2% and 9% believe nature is benign and capricious respectively This is consistent with the results by Steg and Sievers (2000), of 413 Dutch respondents, 47% agreed that nature ephemeral 26 percent nature perverse, 9 % nature benign, 18% nature capricious.

3.6.6 Participating in Wildlife Related Activities

. There are numerous wildlife related activities available to Canadians and foreigners in Canada every year. As discussed in the first two chapters, cervids and more generally wildlife is associated with recreation and tourism

Interest in wildlife is not restricted to those who engage in outdoor activities, like hunting. Engaging with wildlife is tied to wildlife conservation and other leisure activities like photography. Regardless of selected activity, the existence of indoor or outdoor wildlife related activities depends on the continued existence of wildlife. Hence, CWD poses a threat to wildlife related activities, so the number of activities participated in may affect perceptions of CWD risks and motivation to support disease management.

Results from Baird, Leslie and McCabe (2009) suggested that proximity to parks have a strong effect on the type and severity of perceives risk.

Participating in outdoor related activities might increase awareness of cervids and cervid related issues, affect perceptions of risks and how these perceptions may affect behavior.

The responses to the question "*Which of the following activities do you participate in?"*, used to elicit wildlife related activities are listed below:

TABLE 3.10: RESPONDENTS PARTICIPATION IN WILDLIFE RELATED ACTIVITIES. SOURCE: CWD SURVEY (2018).

Wildlife Related Activity	***Percentage of respondents (SD)***
Feeding wildlife at my house with table scraps or special food (including bird seed) for wildlife	27.02(0.44)
Photographing, studying or recording wildlife	24.81(0.43)
Observing, collecting or creating wildlife related art or literature	8.96(0.29)
Being a member of any wildlife related organization	6.38(0.24)
Contributing to an organization that protects endangered wildlife	11.36(0.32)
Contributing to an organization that promotes wildlife conservation	12.68(0.33)
Other general outdoor recreation (e.g., camping, hiking, backpacking, biking, cross country skiing, canoeing, rafting)	56.22(0.50)
Motorized outdoor recreation (e.g., all-terrain vehicle driving (ATVing), snowmobiling, boating	16.88(0.37)

For this study, the activities of concern include outdoor recreation and tourism, supporting wildlife conservation, hunting and photographing wildlife. In previous studies, photographing and feeding wildlife have been used as a proxy for consumer's valuation of wildlife (Myae, 2015). This

valuation is also tied to economic revenue generated from tourism and outdoor activities centered on wildlife.

So, we created a variable "wildlife related activities" which is defined as the number of wildlife activities (out of 8) that the individual participates in. The more activities, the respondent engages in, the higher the value of this variable. The average number of wildlife activities participated in is 1.64 with a standard deviation of 1.53. The chart below shows the distribution of the wildlife related activities variable.

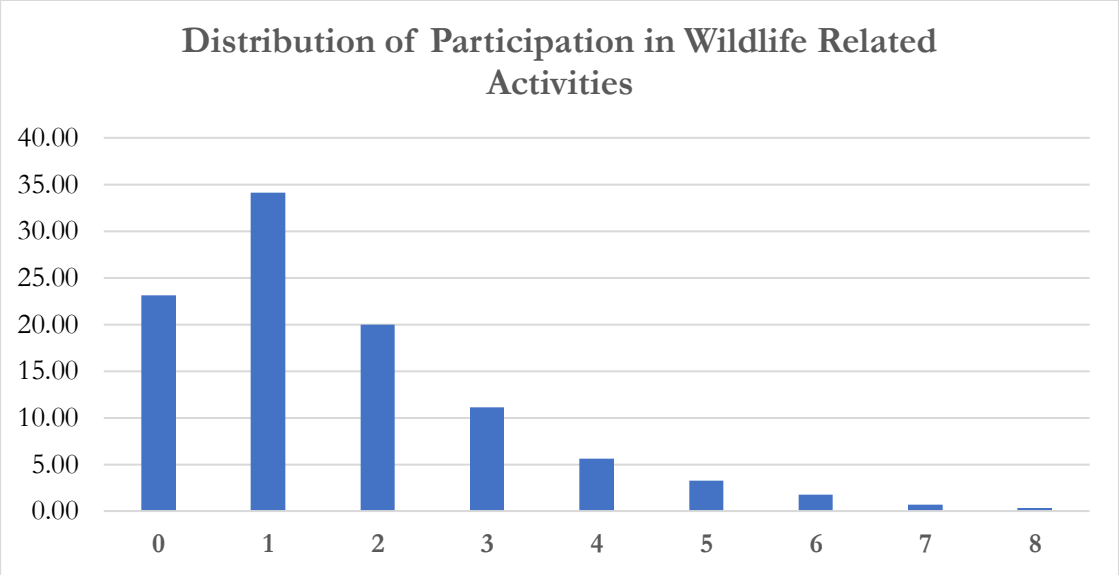


FIGURE 3.5: DISTRIBUTION OF VARIABLE SHOWING THE NUMBER OF WILDLIFE RELATED ACTIVITIES A RESPONDENT PARTICIPATES IN. SOURCE: STUDY SURVEY DATA (2018).

3.7 DEFINITION OF RISK PERCEPTION COMPONENTS OF SURVEY

3.7.1 FOOD SAFETY RISK PERCEPTION

This section was designed to measure respondent's perception of food safety risk associated eating unsafe meat from deer, elk or moose with CWD relative to other members of the Canadian public and come up with a single variable for food safety risk perception. Questions used to elicit relative risk perception are represented in the table below

Only respondents in the food safety treatments got to answer question on the perception of food safety risk to the Canadian population. The table below shows the demographic characteristics of respondents in the food safety risk treatments.

TABLE 3.11: DEMOGRAPHIC CHARACTERISTICS ALL RESPONDENTS WHO WERE EXPOSED TO FOOD SAFETY RISK PERCEPTION QUESTIONS. SOURCE: STUDY/SURVEY DATA (2018).

	Mean	SD	Min	Max
Age	47.59	14.21	19	65
If Children in Household	0.21	0.41	0	1
Household Size	2.31	0.99	1	4
Male	0.49	0.50	0	1
Years of Education	14.91	2.00	8	18
Income	77850.62	29976.97	24999	120000
Rural Resident	0.27	0.44	0	1
Saskatchewan Resident	0.03	0.18	0	1
Alberta Resident	0.09	0.29	0	1
CWD Awareness	0.28	0.45	0	1
CWD Knowledge	0.46	1.09	0	4
Sample Size	3141			

The questions are taken from general questions used in literature for the assessment of food safety risk and optimism bias. The questions are explicitly modified to consumption of meat from deer, elk or moose (Sparks & Shephard, 1994). Responses to these questions were recorded on a five-point scale: 1=Insignificant, 2-Very Little, 3= Minor, 4=some, 5=A great deal.

TABLE 3.12: ITEMS FOR FOOD SAFETY RISK PERCEPTION. SOURCE: SURVEY DATA (2018); LIM ET AL., (2012).

Questions		Percentages (no. of respondents)				
		1	2	3	4	5
How much risk do you think there is to **you personally** of experiencing negative consequences from eating unsafe meat from deer, elk or moose?	2018	25.66	24.36	21.62	16.84	11.52
	2010	3.72	20.32	32.70	31.09	12.17
How much risk do you think there is to **the average Canadian person** of experiencing negative consequences from eating unsafe meat from deer, elk or moose?		7.96	24.99	30.56	23.72	12.77
How much risk do you think there is to **the average Canadian hunter** of experiencing negative consequences from eating unsafe meat from deer, elk or moose?		5.51	15.47	27.73	33.49	17.8
How much risk do you think there is to **the average Canadian First Nations person** of experiencing negative consequences from eating unsafe meat from deer, elk or moose?		5.00	12.35	24.20	34.67	23.78

For the food safety risk perception variable, we used the response to the item –*"How much risk do you think there is to you personally of experiencing negative consequences from eating unsafe meat from deer, elk or moose?"*- as the measure of the food safety risk perception by the individual respondent. The

results from this study were compared to a survey conducted in 2010 by Lim et al., (2012) on the perception of risk posed by eating unsafe foods in the context of BSE.

In measuring food safety risk perceptions, we are measuring a perception of personal risk from eating unsafe venison which may or may not have to do with CWD. This does not consider the health risks posed to other Canadians or stakeholder groups. Because we are using the response to the single item, the Likert scale responses do not undergo any transformation. Hence, the food safety risk perception index ranges from 1 to 5 with a mean of 2.64 and a standard deviation of 1.33.

3.7.2 Animal Health Risk Perception

This section was designed to measure respondents' perception of health risks faced by animals from interaction with infected animals or their prions. 3141 individuals responded to this section by experimental design. The demographic characteristics of this respondent group is shown in the table below:

TABLE 3.13: DEMOGRAPHIC CHARACTERISTICS FOR ALL RESPONDENTS WHO WERE EXPOSED TO ANIMAL HEALTH RISK PERCEPTION QUESTIONS. SOURCE: SURVEY DATA (2018).

	Mean	SD	Min	Max
Age	47.62	14.15	19	65
If Children in Household	0.20	0.40	0	1
Household Size	2.31	1.00	1	4
Male	0.49	0.50	0	1
Years of Education	14.98	2.03	8	18
Income	78006.40	30063.70	24999	120000
Rural Resident	0.28	0.45	0	1
Saskatchewan Resident	0.03	0.17	0	1

Alberta Resident	0.09	0.29	0	1
CWD Awareness	0.30	0.46	0	1
CWD Knowledge	0.48	1.12	0	4
Sample Size		3141		

This is a measure of the level of concern for one of three potential effects of CWD being considered in this study. Questions used to elicit animal health-related concerns risks presented in the table below.

To elicit perceptions of animal health risks, the two-component method was applied; the components being probability of an animal health problem and the degree of potential consequences (Slovic, Fischhoff, and Lichtenstein, 1982). Increased probability of occurrence, increased magnitude of occurrence, or a combination of both would increase the risk perception about the disease. We hypothesize that a higher perception of CWD risk, including the risk to the animal population might mean a higher inclination to support disease management through surveillance.

Therefore, to measure the public's animal health risk perceptions, we asked respondents to score perceived probability of risk on a five-point scale from very unlikely to very likely and the perceived impact from significant to insignificant.

TABLE 3.14: ANIMAL HEALTH RISK PERCEPTION INSTRUMENTS. SOURCE: SURVEY DATA, ADOPTED FROM HANISCH-KIRKBRIDE ET AL., 2013.

Severity Item	**Mean (Standard Deviation)**
If your pet were to contract CWD, how serious do you think the consequences would be?	3.55 (1.12)
If domestic livestock (cattle, bison) were to contract a version of CWD, how serious do you think the consequences would be?	3.87 (1.05)
If enough deer, elk and moose were to contract CWD that the populations of these wild animals were depleted, how serious do you think the consequences would be?	3.96 (1.03)
If other cervids, such as caribou, were to contract CWD, how serious do you think the consequences will be? If other wild animals (such as coyotes, snakes, and bears) were to contract CWD, how serious do you think the consequences would be?	3.85 (1.01)
	3.75 (1.10)
Mean and Standard Deviation of each probability Item	
Probability Item	**Mean (Standard Deviation)**
What is the likelihood of CWD transmission to pets?	2.88 (1.00)
What is the likelihood of CWD transmission to domestic livestock?	2.32 (0.95)
What is the likelihood of CWD transmission to a large enough group of deer?	3.48 (0.92)
What is the likelihood of CWD transmission to other cervid populations?	3.64 (0.83)
What is the likelihood of CWD transmission to other wildlife species?	3.12 (1.01)

Although animal health risk perception was broken down into two components, for this study both components are combined to give a single index for animal health risk perception. For each individual, "Perceived risk" score is calculated by multiplying the perceived probability of occurrence with the perceived consequences (Flaten et al. 2005; Van Winsen et al. 2014, Zwart et al., 2009; Hanisch-Kirkbride et al., 2013). To keep the risk perception variable on the original 1-5 scale, a square root transformation is performed as in Zwart et al. (2009). That is, both components are multiplied by each other. The square root of the resulting number is the animal health risk perception index for each animal group.

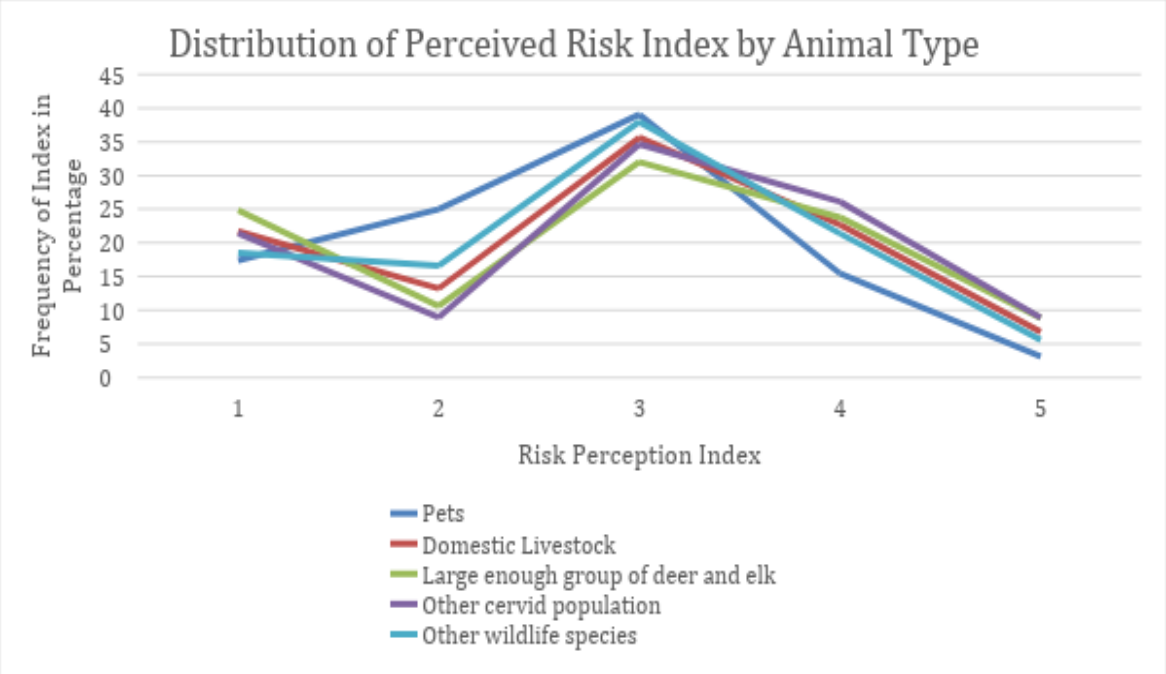


FIGURE 3.6: ANIMAL HEALTH RISK PERCEPTION BY ANIMAL SPECIES. SOURCE: SURVEY STUDY DATA

To come up with a single index for animal health risk perception. The square root transformation of the multiplicative average of the five dimensions of animal health risk perception was calculated (Hanisch-kirkbride, Riley, and Gore, 2013).

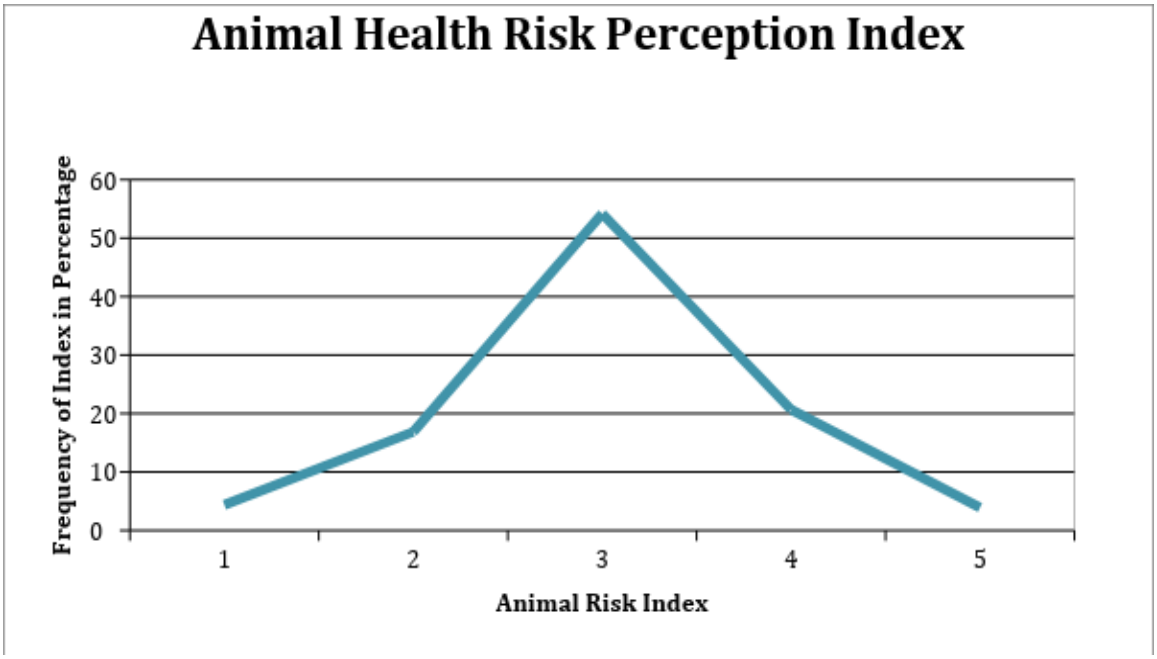


FIGURE 3.7: ANIMAL HEALTH RISK PERCEPTION FOR ALL ANIMALS FROM THE AVERAGE OF THE FIVE ANIMAL GROUPS

For comparison data, we have results from a similar question in the 2009 and 2011 surveys. In these surveys, we asked respondents to rate their concern for animal disease like CWD on a scale of 1-5 (not concerned to very concerned). The mean responses are recorded in the table below.

TABLE 3.15: CONCERN FOR ANIMAL DISEASE BY YEAR. SOURCE: SURVEY DATA (2009; 2011).

Concern for Animal Diseases by Year	
Year	**mean (SD)**
2009	3.44(1.049)

2011	3.447 (1.11)

The respondent group, in this study, has a mean risk perception of 3.04 and a standard deviation of 0.76.

3.7.3 ECONOMIC RISK PERCEPTION

From the literature review, we identified stakeholders that may be affected economically by the increased prevalence of CWD. After that, we developed a set of questions to elicit how the public might perceive the economic risks in seven scenarios concerning stakeholders- deer and elk farms, outfitting firms, tourism, and Indigenous communities. The respondents were asked on a six-point scale from (1) Not Severe to (5) very severe economic impact (including an option for (6) do not know), the potential effects of CWD on the mentioned stakeholders. The "don't know" option was only made available for the economic risk perception question. The question used to elicit economic risk perception is described below:

Deer, elk and moose are animals strongly associated with Canadian wilderness, tourists and hunters may visit Canada partly or mostly because of the existence of these animals. In addition, deer and elk farms are other economic activities associated with the animals. If CWD were to continue to spread throughout the country, please identify how severe you think the following economic impacts might be for Canada)

- *Economic trade barriers against the exports of venison or any products from deer and elk farms*
- *Economic costs for deer and elk farms when the disease is spread to the farmed animals from wild animals*
- *Economic costs for outfitting firms who generate income from hosting and advising hunters from other parts of North America and the world*
- *Lost tourism revenue from hunters who might not wish to hunt in Canada if the animal disease spreads*
- *Lost tourism revenue to national parks and towns from declining population of cervids.*

- *Economic costs for cattle or bison farmers if the disease spreads to livestock from wild animals*
- *Increased costs of food for Indigenous communities who might otherwise have used deer, elk or moose as a source of protein in their diets*

The demographic characteristics of this respondent subgroup are presented in the table below:

TABLE 3.16: DEMOGRAPHIC CHARACTERISTICS FOR ALL RESPONDENTS WHO WERE EXPOSED TO ECONOMIC RISK PERCEPTION QUESTIONS. SOURCE: SURVEY DATA (2018).

	Mean	SD	Min	Max
Age	47.66	14.11	19	65
If Children in Household	0.21	0.41	0	1
Household Size	2.29	0.98	1	4
Male	0.49	0.50	0	1
Years of Education	14.90	2.01	8	18
Income	77626.45	29861.01	24999	120000
Rural Resident	0.27	0.45	0	1
Saskatchewan Resident	0.03	0.17	0	1
Alberta Resident	0.10	0.30	0	1
CWD Awareness	0.29	0.45	0	1
CWD Knowledge	0.45	1.06	0	4
Sample Size		3141		

To illustrate the responses to economic risks, the net concern was calculated using the Roselius risk-ranking method (Roselius, 1971; Muringai and Goddard, 2017). The number of unfavorable responses (1 and 2) on the scale is subtracted from the number of favorable responses (4 and five on the scale) then divided by the total number of responses. 100 to give a net percentage of favorable responses, which is labeled as "net economic concern", then multiply the result by 100. The indicator ranges from +100 to -100 for most concerned to least concern respectively. This is only for descriptive data not for what will be used in regressions models.

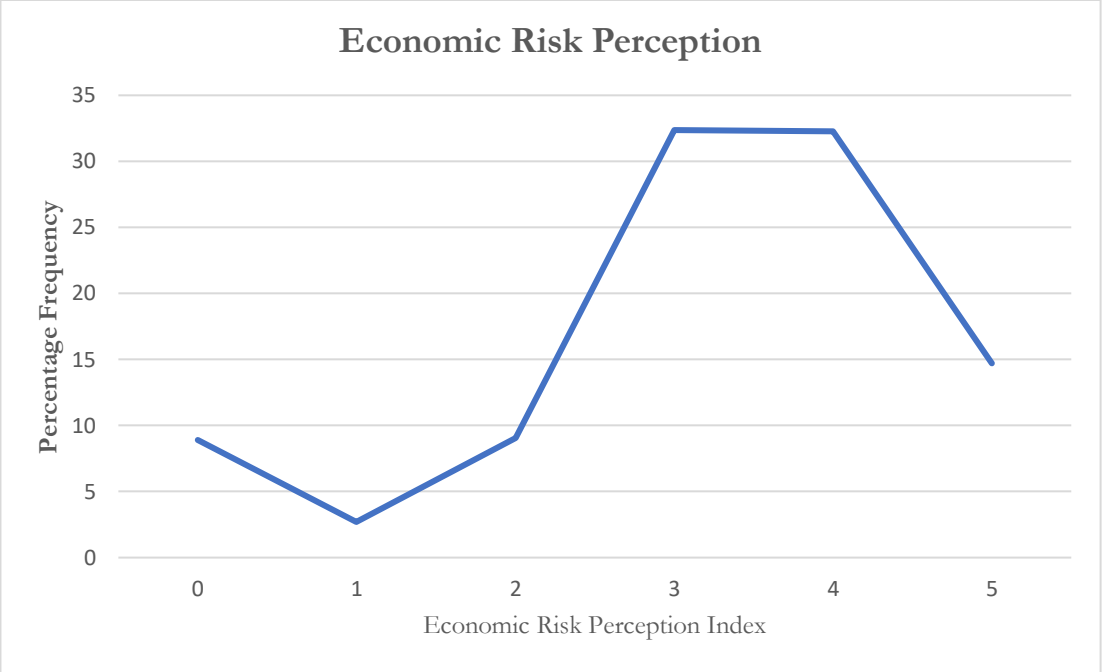


FIGURE 3.8: ECONOMIC RISK PERCEPTION INDEX. SOURCE SURVEY DATA (2018).

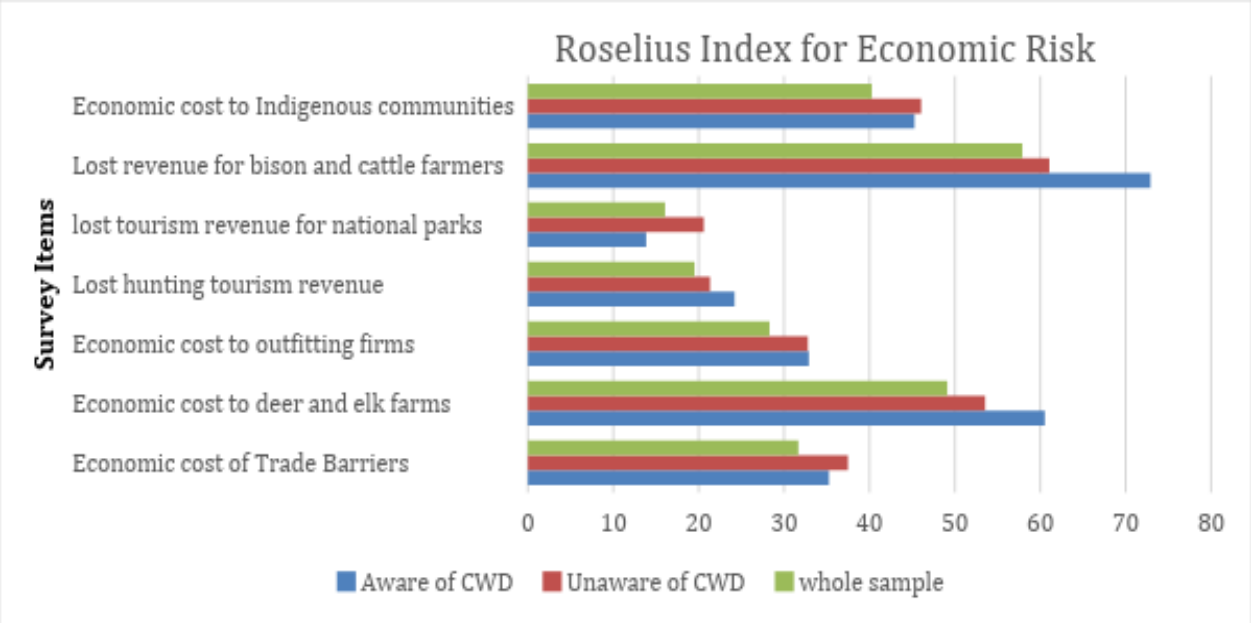


FIGURE 3.9: ROSELIUS/NET AGREEMENT INDEX FOR ECONOMIC RISK PERCEPTION, ROSELIUS (1971). SOURCE: SURVEY DATA, (2018).

For the actual risk perception variable, we took the mean value of the responses to the seven questions posed in this section of the survey. 2542 individuals responded to the question on economic risk perceptions. Because these set of questions had a "don't know" option, some respondents did not have an "economic risk perception". The "Don't Know" responses are coded as Zeros.

3.7.4 Risk Perception Dummies

We created three dummy variables for the food safety, animal health and economic risks. For example, the Economic Risk Perception dummy variable takes the value of 1 for the subsample of respondents who answered the economic risk perception question. This holds for animal health and food safety risk perceptions as well. The risk perception dummy variables were developed to be used as independent variables in the risk perception regression to investigate if

the level of risk perceived by a respondent is influenced by priming them of the presence of other risks.

TABLE 3.17: NUMBER OF RESPONDENTS WHO RESPONDED TO QUESTIONS ABOUT EACH RISK TYPE. SOURCE: SURVEY DATA, (2018).

Risk Perception	Number of Respondents	% of respondents
Food Safety Risk Perception	3141	59.99
Animal Health Risk Perception	3141	59.99
Economic Risk Perception	3142	60.01

3.8 DEFINITION OF REFERENDUM COMPONENTS OF THE SURVEY

3.8.1 REFERENDUM

As stated in Chapter 1, the disease has no cure, which makes control and management difficult, as there are not a lot of options for disease control and management. Of the currently available options, culling seems to be the most effective. However, this has produced strong negative response from the public both in Canada and the United States (Forbes, 2011; Myae, 2015).

However, previous research shows that he public and stakeholder groups agree that something needs to be done to ensure that CWD does not continue to have increased geographical spread (Holsman et al., 2010; Maye, 2011; Forbes, 2011). Understanding the management efforts that the Canadian public is willing to accept is important for evaluating the effectiveness of future management efforts. However, a key factor influencing the success of potential management programs are disease surveillance. Regardless of proposed management options, it is important to be able to measure the prevalence of CWD in endemic areas as well as

the geographical spread of the disease. Accurate and extensive disease surveillance is key to a successful management. Therefore, respondents were asked to vote in a hypothetical referendum to support CWD management through surveillance. The exact survey instrument is presented below:

41. HOW WOULD YOU VOTE?

There are defined surveillance programs that the provincial and federal government agencies could adopt to deal with CWD in the different regions of the country. Whether the additional surveillance will result in sufficient information to allow government agencies to develop control programs that reduce prevalence and spatial spread is unknown.

In the following screens, we provide you with two maps of North America

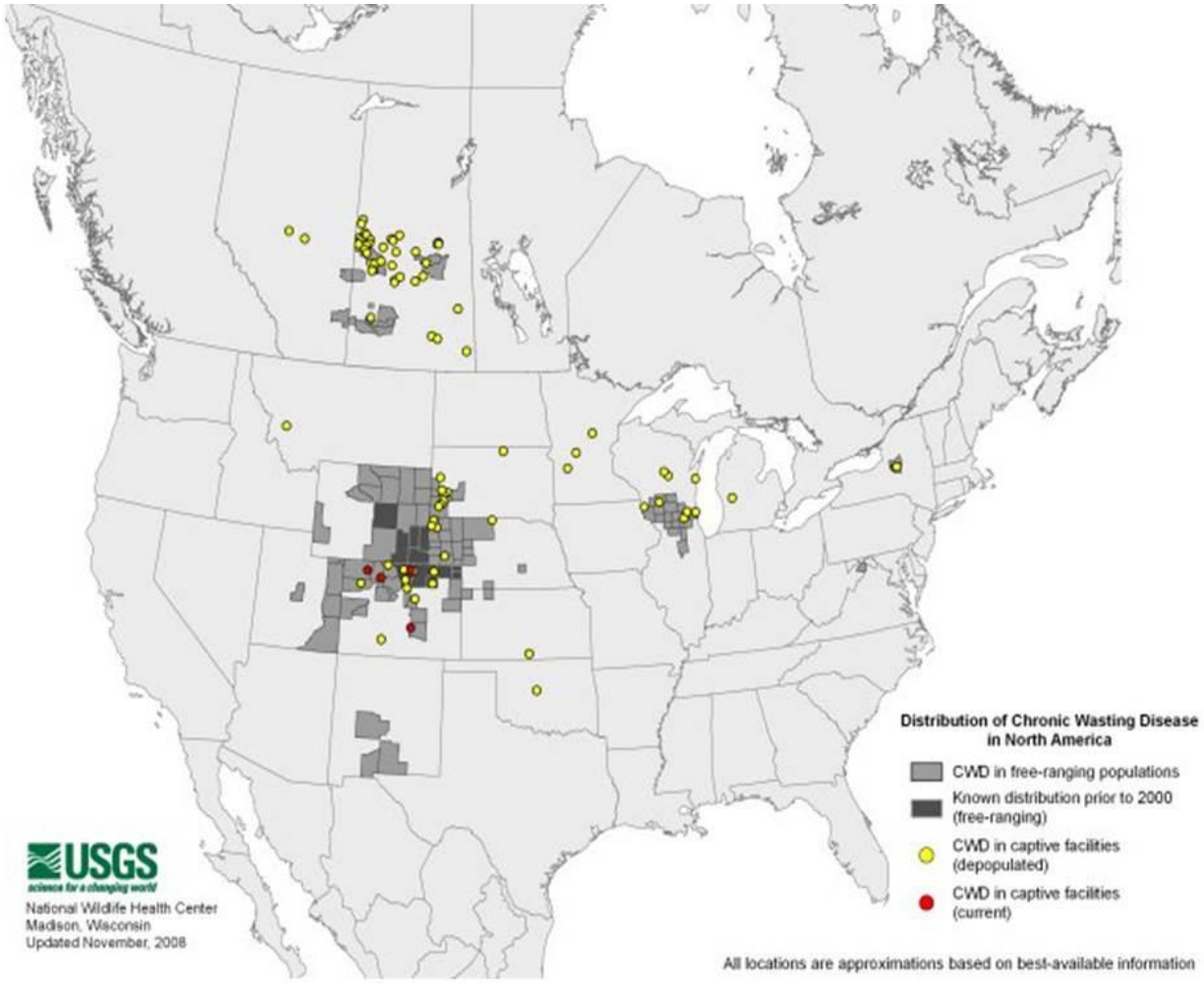
- *The map on the left side of the screen is the geographic distribution of CWD in 2008*
- *The map on the right is the current distribution of CWD in 2018*

It is very important that you vote as if this were ***a real referendum*** *being posed collectively by all of the provincial governments in the country.*

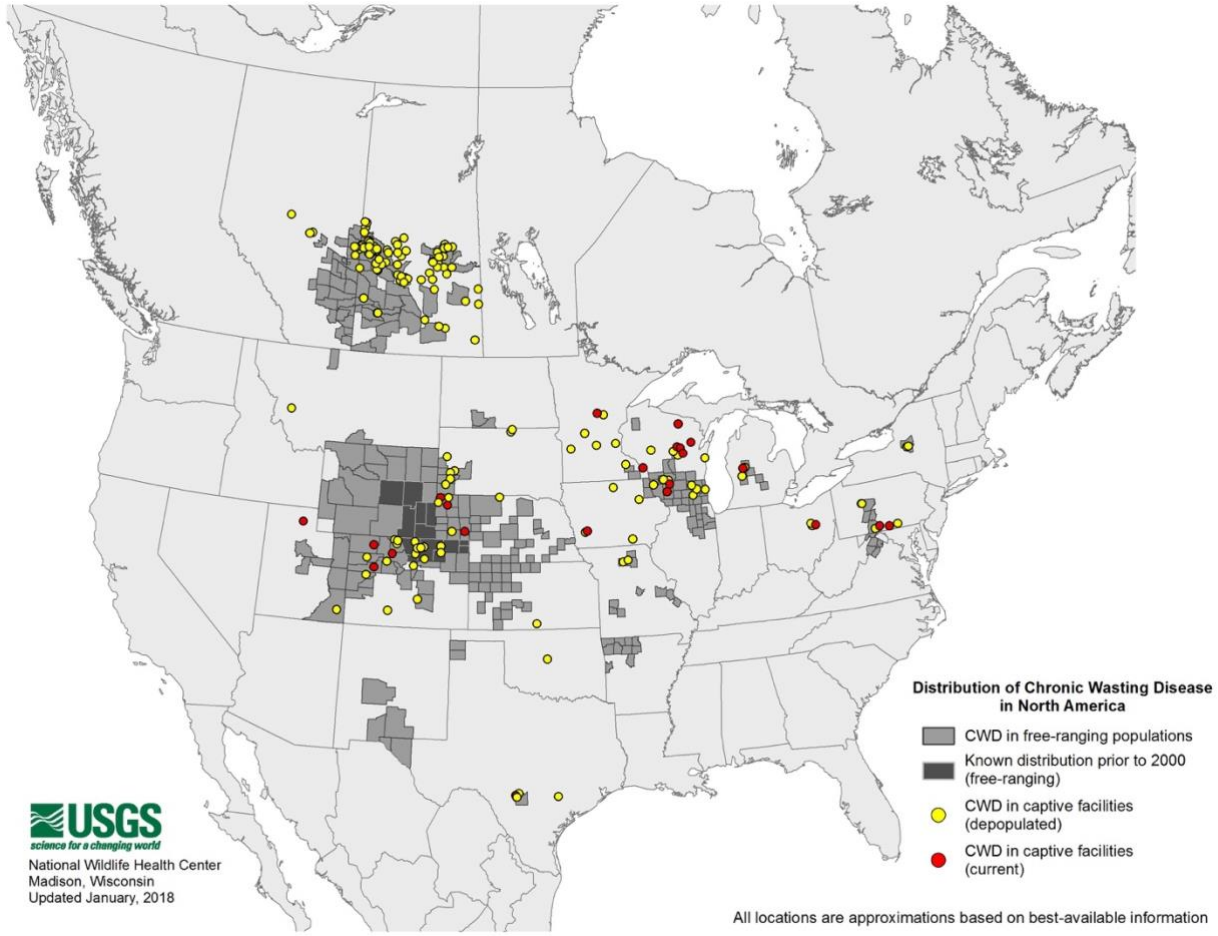
Please place your vote for the following proposed CWD surveillance program:

How would you vote in a referendum on the proposed CWD surveillance program that would allow government agencies to monitor spread and prevalence and to make informed decisions on more interventions to reduce spread but resulted in a $5 (25, 50, 100, 175, 300)) increase in annual provincial taxes for the next 10 years?

MAP A



MAP B



☐ **I vote YES for the proposed CWD surveillance program with a $25 (varying as above) tax increase**

☐ **I vote NO for the proposed CWD surveillance program**

The design of the referendum question was developed as a modification to the referendum question used by Forbes (2011) to measure the WTP of Albertan public to support CWD management. The Forbes (2011) version of the referendum reads:

Please place your vote for the following CWD management program:

How would you vote in a referendum on the proposed ***CWD management*** *program* ***that reduced infection rates*** *from the levels of the map on the left to the infection rated on the map to the right but resulted in* ***a $10 (25, 100, 250)*** *increase in annual taxes for the next 10 years?*

The referendum question in this survey reads:

Please place your vote for the following proposed CWD surveillance program:

How would you vote in a referendum on the ***proposed CWD surveillance program*** *that would allow government agencies* ***to monitor spread and prevalence*** *and to make informed decisions on more interventions to reduce spread but resulted in a* ***$ 25 (50, 100, 175, 300)*** *increase in annual provincial taxes for the next 10 years?*

The values of suggested increase in annual taxes for this study were modelled after and modified from Forbes (2011) who developed their bid prices through focus groups and pilot tests. We kept the $25 and $100 bid levels, included the $50 intermediate bid level and split the $250 bid level into $175 and $300. For the top 10% of earners in Canada, the $300 bid level would mean a 0.5% increase in tax rates while the $25 bid level is a 0.04 increase in annual tax rate. For the bottom 50% income earners, the $300 bid level is a 9.3% increase in tax rates while the $25 bid level is a 0.78% increase in tax rates (Statistics Canada, 2019).

There are a few differences in the structure and use of the referendum questions between both studies. The Forbes (2011) study is focused on Alberta while this study is focused on the Canadian population. The Forbes (2011) study presented the respondents with multiple CWD prevalence scenarios in Alberta and asked how much they were willing to pay for an unspecified

management program that achieves a certain reduction in prevalence levels (CWD impact). In Forbes 2008, the respondents were presented with hypothetical management scenarios. For this study, we presented the respondents with maps of CWD prevalence for 2008 and 2018 in North America. The maps showed the results of disease surveillance. We are considering CWD surveillance as a specific precursor to various management options and so the map of CWD prevalence shows the actual surveillance rate. Our study does not investigate investment in any specific management options. The scope of CWD surveillance also differs, since we are using a national Canadian survey. The maps used in our survey are from the distribution of chronic wasting disease in North America. United States Geological Survey (USGS) National Wildlife Health Center. (USGS, 2020).

3.8.2 Referendum results and Response Frequency

Each respondent answered one question in which they voted whether to support a CWD surveillance program to control the spread of CWD in the country. Respondent's decisions were based on a proposed tax increase for 10 years in the amount of one of five bid values ($25, $50, $100, $175, and $300). The respondents were presented with a map of the geographic spread of CWD in 2008 and a map of the spread in 2018 for them to understand the importance of surveillance, and to see the rate of disease spread. If the respondent voted no, they did not support the program at the given tax level, if they voted yes, then they did.

The tax level was selected at random for each respondent. However, the survey was set up to ensure that each information treatment (ten combinations of different risk questions) had an almost equal number of respondents (523 or 524). Each treatment was defined before the survey was administered. The treatments were defined based on the number of risks each respondent was

exposed to in terms of the questions provided. The tables below show the 10 different treatments included in the survey as well as referendum results by treatment.

TABLE 3.18: REFERENDUM RESULTS PER TREATMENT. SOURCE: STUDY SURVEY DATA, (2018).

Food Safety Risk Treatment 1					Animal Health Risk Treatment 2				
Price	**No**	**Yes**	**Total**	**P(Yes)**	**Price**	**No**	**Yes**	**Total**	**P(Yes)**
25	31	73	104	0.70	**25**	35	75	110	0.68
50	38	59	97	0.61	**50**	27	109	136	0.80
100	48	63	111	0.57	**100**	26	75	101	0.74
175	59	60	119	0.50	**175**	31	41	72	0.57
300	49	44	93	0.47	**300**	43	62	105	0.59
Sample	225	299	524	0.57	**Sample**	162	362	524	0.69
Economic Risk Treatment 3					**Food Safety then Animal Health Risk Treatment 4**				
Price	**No**	**Yes**	**Total**	**P(Yes)**	**Price**	**No**	**Yes**	**Total**	**P(Yes)**
25	41	73	114	0.64	**25**	25	63	88	0.72
50	33	93	126	0.74	**50**	25	92	117	0.79
100	33	64	97	0.66	**100**	32	69	101	0.68
175	42	62	104	0.60	**175**	38	55	93	0.59
300	37	46	83	0.55	**300**	53	71	124	0.57
Sample	186	338	524	0.65	**Sample**	173	350	523	0.67
Animal Health then Food Safety Risk Treatment 5					**Food Safety then Economic Risk Treatment 6**				
Price	**No**	**Yes**	**Total**	**P(Yes)**	**Price**	**No**	**Yes**	**Total**	**P(Yes)**

25	32	69	101	0.68		**25**	33	81	114	0.71
50	30	55	85	0.65		**50**	39	64	103	0.62
100	46	49	95	0.52		**100**	43	71	114	0.62
175	48	73	121	0.60		**175**	29	62	91	0.68
300	55	66	121	0.55		**300**	38	63	101	0.62
Sample	211	312	523	0.60		**Sample**	182	341	523	0.65
Economic then Food Safety Risk **Treatment 7**						**Animal Health then Economic Risk** **Treatment 8**				
Price	**No**	**Yes**	**Total**	**P(Yes)**		**Price**	**No**	**Yes**	**Total**	**P(Yes)**
25	40	72	112	0.64		**25**	31	67	98	0.68
50	29	76	105	0.72		**50**	27	83	110	0.75
100	38	76	114	0.67		**100**	41	70	111	0.63
175	43	44	87	0.51		**175**	43	70	113	0.62
300	57	49	106	0.46		**300**	42	50	92	0.54
Sample	207	317	524	0.60		**Sample**	184	340	524	0.65
Economic then Animal Health Risk **Treatment 9**						**All risks** **Treatment 10**				
Price	No	Yes	Total	P(Yes)		**Price**	No	Yes	Total	P(Yes)
25	30	75	105	0.71		**25**	28	74	102	0.73
50	28	60	88	0.68		**50**	17	63	80	0.79
100	41	55	96	0.57		**100**	33	74	107	0.69
175	55	65	120	0.54		**175**	51	76	127	0.60
300	44	70	114	0.61		**300**	47	61	108	0.56
Sample	198	325	523	0.62		**Sample**	176	348	524	0.66

TABLE 3.19: REFERENDUM RESULT FOR THE WHOLE SAMPLE. SOURCE: STUDY SURVEY DATA, (2018).

Price	No	Yes	% of Yes votes	Total
25	326	722	69	1,048
50	293	754	72	1,047
100	381	666	64	1,047
175	439	608	58	1,047
300	465	582	56	1,047
Sample	1904	3332	64	5236

The probability of voting yes to the referendum generally decreased as the tax price increases regardless of treatments. The voting decision for the whole sample is shown in the table above. The referendum results show that there is a strong support for the CWD surveillance program. In fact, the majority voted yes regardless of the tax level. This could be due to strategic behaviour – valuation of wildlife for example or due to the hypothetical nature of the question. We also included questions about how certain the respondents were about their vote and questions related to the reasons for voting yes which we will describe later. The percentage of positive votes to the referendum are expected to reduce with an increase in proposed tax payments. However, our data is inconsistent with this expectation between $25 and $50 referendum price points, but this happens sometimes.

3.8.3 Reasons for Respondents' Decisions

As established in section 2.2.3 of the literature review, we make sure to include consequentiality questions and elicit the reasons for respondents' responses. After completing the referendum questions, we asked respondents for the reasons why their choices were made. As is expected, the respondents are concerned about the prevalence rate of the disease, and the degree

of spread across the provinces. Some people also indicated that they are concerned about what is being done for CWD in other provinces, and the type of surveillance program to be implemented, but these were not as important as the disease spread and prevalence rate.

Important Factors affecting voting decision

Respondents were also asked to indicate important factors affecting their voting decisions using the following survey item:

When placing your votes, how important was each of the following to you:

- *CWD prevalence rate in infected areas*
- *Degree to which CWD has spread across the country*
- *Change in annual taxes because of CWD surveillance program*
- *Uncertainty about what is being done about CWD in other regions in Canada and in the United States*
- *The type of surveillance programs which might be implemented to deal with CWD (E.g., Encouraging culling of animals in particular areas to increases number of tested animals versus encouraging more mandatory submission of heads from hunter harvest)*

The first four items were from a survey about CWD which posed a question similar to the referendum in this survey (Forbes, 2008). The fifth question is included to account for the presence of multiple surveillance options. The responses to this question were recorded on a four-point Likert scale; 1-Not important at all, 2-Slightly Important, 3-Very Important, 4- Extremely Important. Following Roselius (1971), a net "importance" percentage was calculated in order to access the relative importance of several factors to the respondents voting decision. The Net "Importance" Percentage is calculated as follows: [(number of "important" [very important and

extremely important] responses-number of "unimportant" [no important at all and slightly important] responses)/sample size] *100.

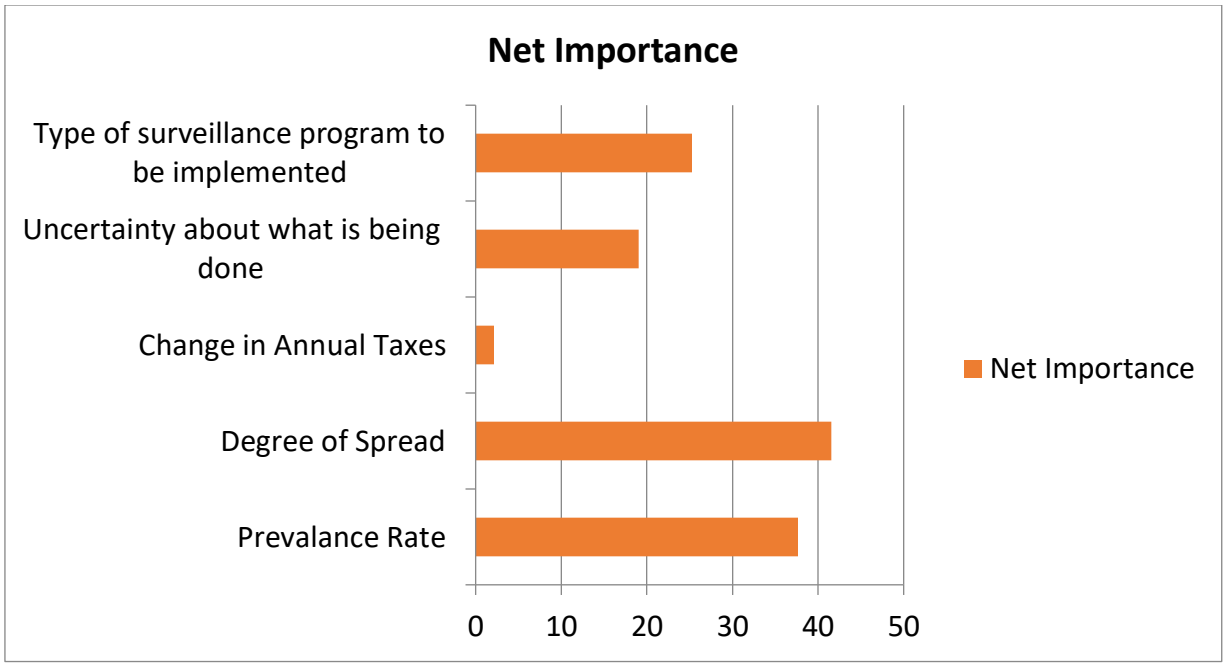


FIGURE 3.2: ROSELIUS NET IMPORTANCE INDEX FOR FACTORS AFFECTING REFERENDUM VOTE. SOURCE: SURVEY DATA.

A large positive Roselius index suggest that a large proportion of respondents consider the factor as really important. An index at zero or around zero suggests a balance across the sample and negative numbers suggest a lack of importance.

Surprisingly, the change in annual taxes has little effect on their voting decisions. This is contrary to the expected results. Only about 11% of the respondents who voted yes believe that the program would not cost them directly. The respondents' expectation of being taxed is high, however, the level of taxation is not the main factor affecting their referendum voting decision. Also, 53% think a tax increase is a small amount to pay for the benefits received, that being CWD surveillance.

Reasons for Yes votes

Respondents who voted "Yes" were asked to state the reason for the decision using the following question:

"If you voted yes why would you vote yes to a proposed surveillance program? Please check all that apply"

There responses are presented in the chart below:

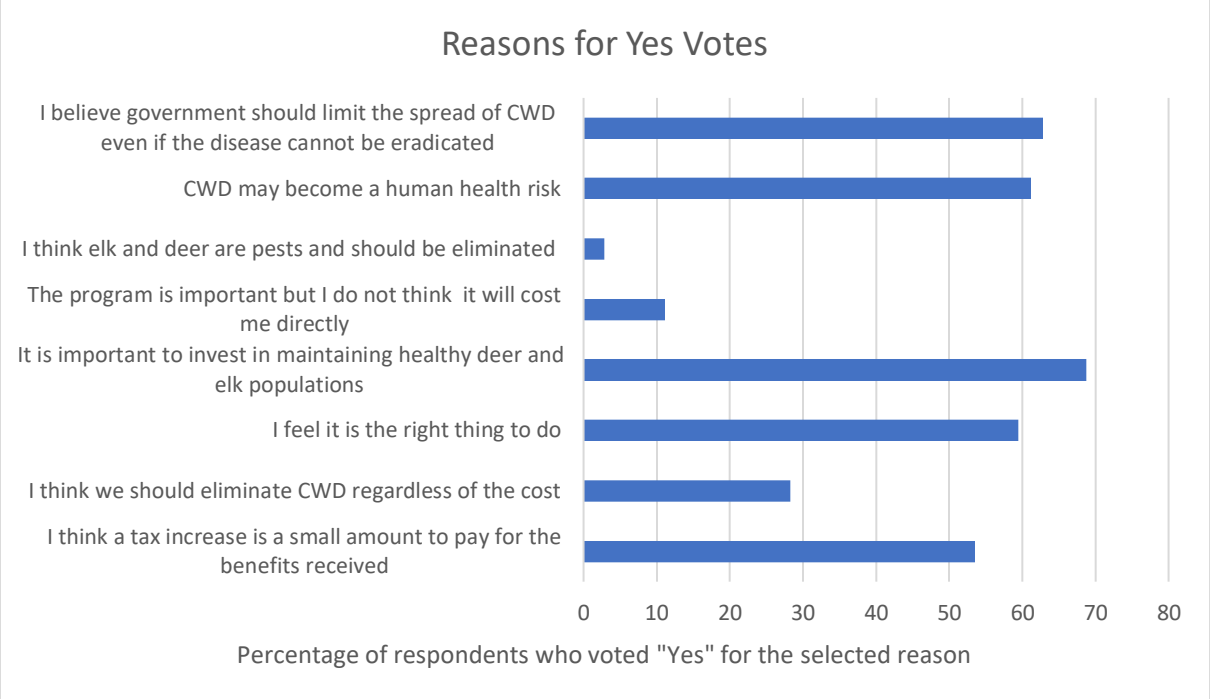


FIGURE 3.3: REASONS FOR "YES" VOTES. SOURCE: SURVEY DATA, (2018).

For respondents who voted "yes" to the referendum, 69% of them voted yes because they believe it is important to invest in maintaining healthy deer and elk populations. Only 3% of the survey respondents believe that deer and elk are pests and should be eliminated. About 62% of them agree that the government should limit the spread of CWD, even if the disease cannot be eradicated as CWD may become a human health risk.

Reasons for No votes

Respondents who voted "No" were asked to state the reason for the decision using the following question:

"If you voted No why would you vote no to a proposed surveillance program? Please check all that apply"

There responses are presented in the chart below:

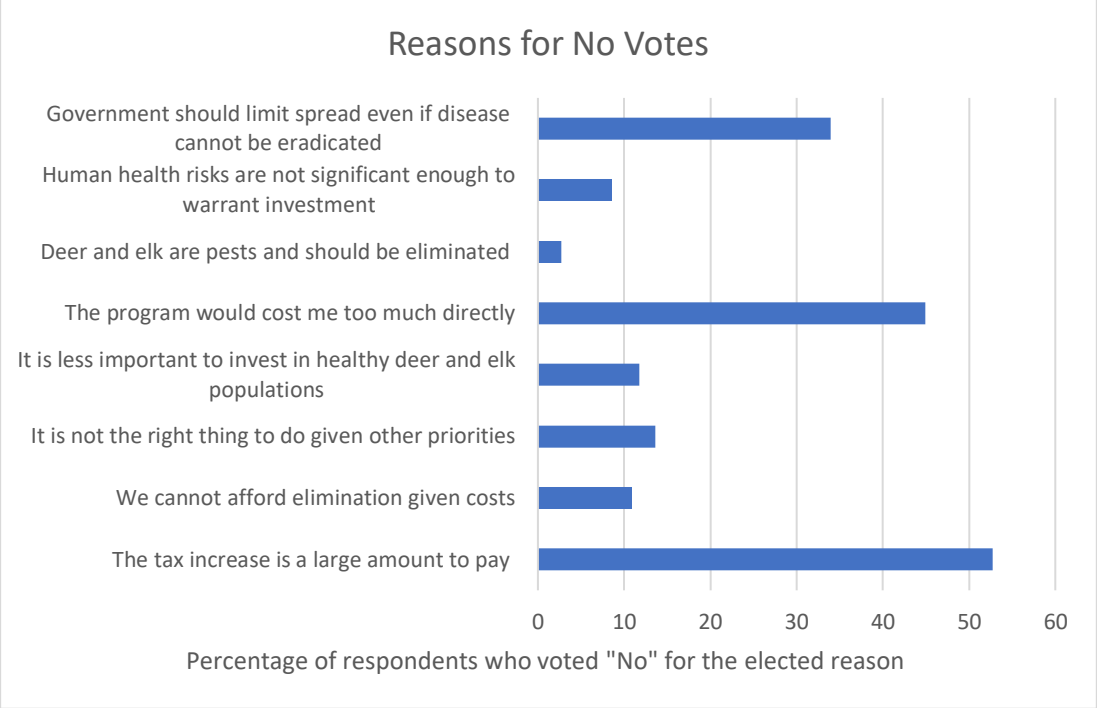


FIGURE 3.4: REASONS FOR "NO" VOTES. SOURCE: SURVEY DATA, (2018).

For the respondents who "no", the most common reasons were cost related. They thought the tax increase is a large amount to and the surveillance program would be too much of a direct cost to them. About 14% think that CWD surveillance is not the right thing to do given other priorities but 34% believe that the government should limit the spread of the disease even if it cannot be eradicated. Only 3% think that deer and elk are pests that should be eliminated.

3.8.4 CERTAINTY AND TRAP QUESTIONS

The referendum results were followed by certainty questions (Johnston et al., 2017). The question asked if respondents were: 'very certain, 'somewhat certain', somewhat uncertain', or "Very certain' that the decision they made would be the same in an actual referendum. The certainty scores were recorded on a scale of 1 to 4 with 4 being very uncertain and 1 being very certain. The mean certainty score was 1.82. This indicates that respondents were confident in their decision. However, there are some scores that indicate that the respondent's vote will not be consistent with decision making in a real-life situation.

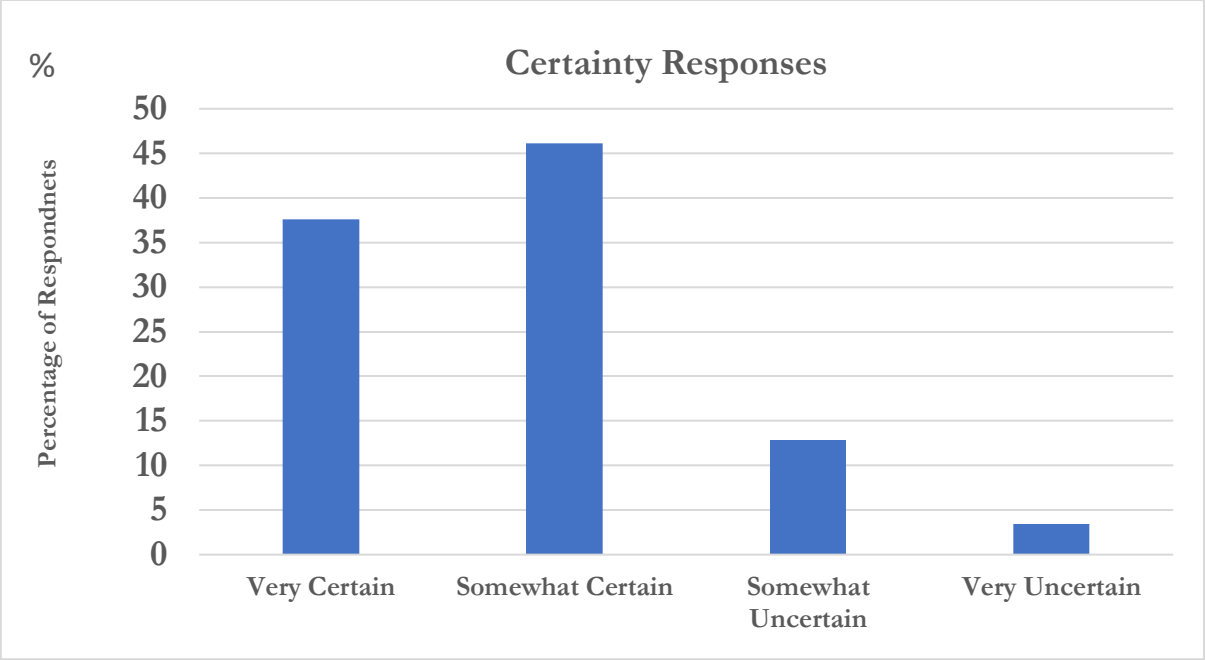


FIGURE 3.5: CERTAINTY RESPONSE FOR REFERENDUM VOTE. SOURCE: STUDY SURVEY DATA, (2018).

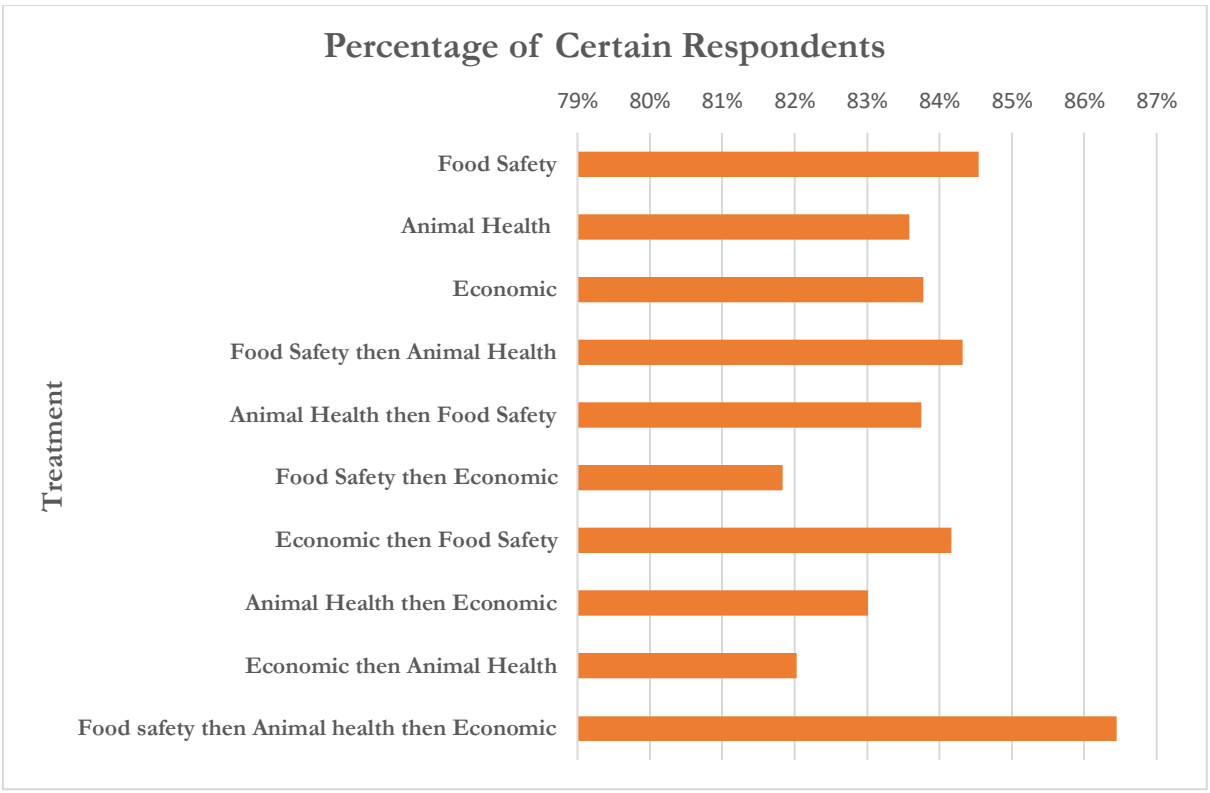


FIGURE 3.6: CERTAINTY RESPONSE FOR REFERENDUM VOTE BY TREATMENT. SOURCE: STUDY SURVEY DATA

The trap question included before our referendum instructed the respondents "Please select disagree for this question." The options provided were "agree" and "disagree". 17.04% (892) of respondents failed the trap question. This is consistent with the results found by Miller (2007) in his study of data quality across 20 different US panels. His results showed am average failure of 18%.

The referendum results reported and used for the WTP estimation in this study reflect those of the Full sample, the "Certain" sample and the "Trap" sample. The "Trap" sample are respondents who are both certain of their referendum vote and have passed the trap question.

TABLE 3.20: RESPONDENTS VOTING DECISIONS AT DIFFERENT PRICE LEVELS FOR THE DIFFERENT SAMPLE GROUPS. SOURCE: STUDY SURVEY DATA.

	Whole Sample			
Bid Price	**No**	**Yes**	**% of yes Votes**	**Total**

25	326	722	69%	1,048
50	293	754	72%	1,047
100	381	666	64%	1,047
175	439	608	58%	1,047
300	465	582	56%	1,047
Total	1904	3332	64%	5236
		Certain Sample		
25	383	665	63%	1,048
50	368	679	65%	1,047
100	450	597	57%	1,047
175	515	532	51%	1,047
300	526	521	50%	1,047
Total	2242	2994	57%	5236
		"Trap Question" Sample		
25	299	576	66%	875
50	281	591	68%	872
100	364	527	59%	891
175	403	448	53%	851
300	420	435	51%	855
Total	1767	2577	59%	4344

3.9 CHAPTER SUMMARY

This study investigates risk perceptions and what type of risks matter to the public, the Canadian public's attitude towards risk and how these may influence their willingness to support CWD surveillance. In exploring the perceptions of the different risks affecting Canadians in the wake of CWD, it is important to understand what factors affect these different risks perceptions and to what degree.

The goal is to investigate how risk. perceptions influence the public's decision to support a CWD surveillance program. First, we defined the risks of concern. The type and sources of risk were not explicitly defined but were easy to understand. Respondents are asked questions about their perception of risk to themselves, pets, wild animals, hunters, and so on. Instead of using a questionnaire, we could have directly elicited subjective probabilities of risk and consequences.

However, the sample was then grouped into 10 information treatments based on these risks. Individuals have a hard time assessing low probability events (Lusk and Coble, 2005).

The risks are grouped into three sources for further analysis: Economic risk, Human Health and food safety risk, Animal Health Risk

In addition to eliciting risk perceptions, we intend to understand what factors affect how the public perceives these risks. We aim to investigate the factors influencing the risk perceptions of respondents in each of these treatment groups. This could be useful in risk education and communication efforts. Based on literature review and the objectives of this study, we have identified several factors that may influence a respondent's risk perception concerning CWD. The factors include demographic characteristics, generalized trust, meat-eating preferences and attitude towards animals and the natural environment.

Understanding risk perceptions regarding CWD is important for planning risk communication and effective risk communication is vital to effective CWD management (Decker et al., 2012; Hanisch-Kirkbride, et el., 2013). For example, if people are unaware of CWD or have inaccurate perceptions of CWD risk, they might not be interested in management options like surveillance and mandatory head submission, and this may affect their behavior in general. Risk perception information can be very useful in explaining consumer behavior and might help in effective policy making and communicating information among different stakeholder groups (Decker et al., 2012; Slovic et al., 1982; Muringai and Goddard, 2017).

We also intend to investigate the how CWD risk concerns affect the public's behavior regarding disease management. We want to know how support of CWD management is changes in response to changes in food safety, animal health and economic risk concerns.

Then, socio demographic characteristics and risk perception influence economic behavior (i.e., choice of public policy), in this case, the referendum vote.

Regardless of treatments, a referendum was used in this study to reveal the public's willingness to support CWD surveillance to ensure efficient disease management. Factors expected to influence their voting decisions include food safety risk perceptions, animal health risk perceptions, economic risk perceptions, wildlife perceptions, environmental attitudes, food safety risk attitude, CWD awareness and knowledge and socio demographic characteristics.

5326 respondents completed the survey. The survey data was organized and recoded in Excel and the data was analyzed using STATA. Three Tobit models are used to estimate the effects of selected variables on food safety, animal health, and economic risks. A probit model for the referendum vote is estimated with the dataset for the whole sample, and selected respondents. Thereafter, willingness to pay values- estimates of the mean or median amount the respondents are willing to pay to support CWD surveillance - are calculated using coefficients from the regression models.

CHAPTER 4: REGRESSION RESULTS AND WILLINGNESS TO PAY TAXES TO SUPPORT A CWD SURVEILLANC PROGRAM

4.1 INTRODUCTION

In this chapter, the models, results and empirical findings of this study will be presented. These include analysis of the factors linked to different levels of food safety, animal health and economic risk perceptions, and the factors linked to preferences for higher taxes to support CWD surveillance. This chapter presents the results of the econometric analysis of the data collected in our survey. To conclude the chapter, a summary of results is presented.

4.2 RISK PERCEPTION MODELS

There are a variety of different econometric models associated with the different regression analyses undertaken in this study. The first regression models are related to identifying socio-demographic and attitudinal variables that are related to the three risk perceptions – food safety, animal health and economic risks. Each of these risks is identified in a different way as described in Chapter 3. The food safety risk is a response to a single Likert scale type question which can be modeled as an ordered probit regression (also possible to use a Tobit specification). The animal health risk variable is defined as responses to Likert scale type questions about the risks to different animals multiplied by the severity of the risks to different animals. A square root transformation is then performed on the average of these multiplications. The resulting animal health risk perception index has values in a non-ordinal range between 1 and 5 which can be modeled using a Tobit specification. The economic risk variable is defined as the sum average of responses to 7 statements (ranging from 0 to 5). The resulting risk perception index has values in a non-ordinal range between 0 and 5 and is also modeled using a Tobit specification. To be

comparable, all three risk models will be specified as Tobit regressions with the food safety risk also specified as an ordered probit regression.

4.2.1 TOBIT MODEL

The Tobit model is statistical model proposed by James Tobin. The Tobit model is a censored regression model which estimates linear relationships between variables when there is either left censoring, right censoring, or both. Left censoring occurs when the value of the value at or above a threshold takes the value of that threshold so that its true value might be equal to that threshold, but it might also be higher. In the case of right censoring, values that fall below a threshold are censored. For this study, the values of economic and animal health risks are censored at 1 and 5, the minimum and maximum values for our risk perception indices. Food safety risk perceptions were elicited using a single Likert scale question measured from with responses coded from 1 to 5. Economic risk perception variables were created by averaging the responses to seven Likert scale questions, each of the individual questions were recorded with values from 1-5 and the resulting average ranges anywhere from 1 to 5 . The animal health risk perception was derived from a two-component model. The risk variable is calculated by multiplying the perceived probability of occurrence with the perceived consequences refer to AF attitude. To keep the risk perception variable on the original 1-5 scale (there was no zero option), a square root transformation is performed.

The Tobit model can be described in terms of a latent variable Y_i and a vector of independent variables Xi. Tobit model also assumes that observed values of a risk perception by a respondent I, Y_i is determined by a latent variable Y_i^*, that can be modeled as a linear function of the independent variables Xi, a vector of coefficients, β and an error term e_i which has a normal

distribution N $(0,\sigma^2)$. Our objective is to estimate the parameters β and σ. Observed risk perception can be described as follows:

$$Yi = Y_i^* = X_i\beta + e_i$$

According to McDonald and Moffitt (1980), Tobit assumes that there is an underlying stochastic index equal to $X_i' \beta + e_i$ observed only when it is positive which qualifies as an unobserved latent variable. The expected value of y in the model is

$$E[y] = X`_i \beta\Phi + \sigma\phi$$

Where ϕ is the unit normal density, Φ is the cumulative normal distribution function, and σ is the standard error of the model. The expected value of y for observations above the limit, called y* is X` i β plus the expected value of the truncated normal error term:

$$E[y^*] = E[y \mid y > 0]$$

$$= E[y \mid e > - X`_i \beta]$$

$$= X`_i \beta + (\sigma\phi)/\Phi$$

The basic relationship between the expected value, E[y], the expected value condition on being above the limit, E[y*], and the probability of being above the limit, Φ is

$$E[y] = \Phi E[y^*]$$

Tobit uses all the observations above the limit to be estimate a regression line. McDonald and Moffitt (1980) offer a decomposition of the analysis to show that Tobit can be used to determine both changes in the probability of being above the limit and changes in the value of the

dependent variable if it is above the limit. From above the decomposition can be obtained by considering the effect of a change on the i-th variable of X on y:

$$\frac{\partial Ey}{\partial X_i} = \Phi \frac{\partial Ey^*}{\partial X_i} + Ey^* \frac{\partial \Phi}{\partial X_i}$$

The total change in y can be broken into two parts, the change in y of those observations above the limit, weighted by the probability of being above the limit, in this case 1; and the change in the probability of being above the limit, weighted by the expected value of y if above the limit.

For this study we are observing factors which affect food safety, animal health and economic risk perceptions. According to the literature review and theory, factors that are expected to affect risk perception are sociodemographic, generalized trust, CWD knowledge, meat preferences, environmental and wildlife attitude, and other risk perceptions.

The variables that were included in this model theoretically would capture the effect of the variables on the respondents' risk perception. The models for the risk perceptions are expressed as:

$FSRP_i = \beta 0 + \beta AGE + \beta 2CHILDREN + \beta 3HOUSEHOLD + \beta 4MALE + \beta 5EDUCATION+ \beta 6URBAN + \beta 7TRUST + \beta 8KNOW + \beta 9EAT + \beta 10MEAT+ \beta 11WILD + \beta 12WRA + \beta 13EPHEMERAL + \beta 14PERVERSE+ \beta 15BENIGN + \beta 16FSRP\_D + \beta 17AHRP\_D+ \beta 18ECRP + \mu_i$

$AHRP_i = \beta 0 + \beta AGE + \beta 2CHILDREN + \beta 3HOUSEHOLD + \beta 4MALE + \beta 5EDUCATION+ \beta 6URBAN + \beta 7TRUST + \beta 8KNOW + \beta 9EAT + \beta 10MEAT+ \beta 11WILD + \beta 12WRA + \beta 13EPHEMERAL + \beta 14PERVERSE+ \beta 15BENIGN + \beta 16FSRP\_D + \beta 17AHRP\_D+ \beta 18ECRP + \mu_i$

$$ECRP_i = \beta_0 + \beta AGE + \beta 2CHILDREN + \beta 3HOUSEHOLD + \beta 4MALE + \beta 5EDUCATION + \beta 6URBAN + \beta 7TRUST + \beta 8KNOW + \beta 9EAT + \beta 10MEAT + \beta 11WILD + \beta 12WRA + \beta 13EPHEMERAL + \beta 14PERVERSE + \beta 15BENIGN + \beta 16FSRP\_D + \beta 17AHRP\_D + \beta 18ECRP + \mu_i$$

Where:

FSRPi = survey respondent's food safety risk perception

AHRPi = survey respondent's animal health risk perception

ECRPi = survey respondent's economic risk perception

AGE= respondent's age in years

MALE= gender of respondent

(1= Male, 0 = Female)

EDUCATION= respondents' education in years of schooling

URBAN= if the respondent lives in a rural or urban area

(1= Urban, 0 = Rural,)

TRUST= if respondent believes people can generally be trusted

(1= Yes, 0 = otherwise)

KNOW= CWD Knowledge

EATS= if person eats venison

MEATS= if person eats meats

WILD =wildlife perception

WRA= number of wildlife related activities

EPHEMERAL=nature is ephemeral myth of nature

PERVERSE= nature is perverse myth of nature

BENIGN = nature is benign myth of nature

FSRP_D = dummy for if person also responded to food safety risk perception

(1= Yes, 0 = otherwise)

AHRP_D = dummy for if person also responded to animal health risk perception

(1= Yes, 0 = otherwise)

ECRP_D = dummy for if person also responded to economic risk perception

(1= Yes, 0 = otherwise)

4.2.2 ORDERED PROBIT

The dependent variable is ordinal but is not continuous in an ordered probit regression as in the case of qualitative dependent variable like the food safety risk perception variable in this study. Food safety risk perceptions were elicited using a single Likert scale question measured from with responses coded from 1 to 5. The idea is that there is a latent continuous metric underlying the observed ordinal responses of the survey respondents. Thresholds partition the real like into a series of regions corresponding to the various ordinal categories. The latent continuous variable, y^* is a linear combination of some predictors, X, plus a disturbance term that has a standard normal distribution:

$$Y^* = \beta_1 x_1 + \ldots + \beta_k x_k + \varepsilon$$

$$= x'\beta + \varepsilon,$$

Where ε is a normally distributed variable with the variance normalized to one. This model does not contain a constant. There are J cut-off points or threshold parameters defined as follows:

$$\alpha_1 < \alpha_2 < \ldots \alpha_J.$$

We do not observe the latent variable, but we do observe choices according to the following:

$$y = 0 \text{ if } y^* \leq \alpha_1$$

$$y = 1 \text{ if } \alpha_1 < y^* \leq \alpha_2$$

$$y = 2 \text{ if } \alpha_2 < y^* \leq \alpha_3$$

$$(\ldots)$$

$$y = J \text{ if } \alpha_J < y^*.$$

Suppose y can take three values: 0, 1 or 2. We then have

$$y = 0 \text{ if } x'\beta + \varepsilon \leq \alpha_1$$

$$y = 1 \text{ if } \alpha_1 < x'\beta + \varepsilon \leq \alpha_2$$

$$y = 2 \text{ if } \alpha_2 < x'\beta + \varepsilon$$

We can then define the probabilities of observing y = 0, 1, 2. For the smallest and largest value, the resulting expressions:

$$\Pr(y = 0 \mid x) = \Pr(x'\beta + \varepsilon \leq \alpha_1)$$

$$= \Pr(e \leq \alpha_1 - x'\beta)$$

$$= \Phi(\alpha_1 - x'\beta),$$

$$= 1 - \Phi(x'\beta - \alpha_1)$$

$$\Pr(y = 2 \mid x) = \Pr(x'\beta + \varepsilon \leq \alpha_2)$$

$$= \Pr(e \leq \alpha_2 - x'\beta)$$

$$= \Phi(\alpha_1 - x'\beta),$$

$$= 1 - \Phi(x'\beta - \alpha_1)$$

For the intermediate category,

$\Pr(y = 1 \mid x) = \Phi(\alpha_2 - x'\beta) - \Phi(\alpha_1 - x'\beta)$

for marginal effects, we obtain:

$$\frac{\partial \Pr(y = 2|x)}{\partial x_k} = \emptyset(x' - \alpha_2)\beta_k$$

for the highest category.

$$\frac{\partial \Pr(y = 1|x)}{\partial x_k} = [\emptyset(x'\beta - \alpha_1) - \emptyset(x'\beta - \alpha_2)]\beta_k$$

for the intermediate category, and

$$\frac{\partial \Pr(y = 0|x)}{\partial x_k} = -\emptyset(x'\beta - \alpha_1)\beta_k$$

for the lowest category, assuming x_k is a continuous variable.

The partial effect if x_k on the predicted probability of the highest outcome has the same sign as β_k. The partial effect of x_k on the predicted probability of the lowest outcome has the opposite sign to β_k.

4.2.3 Risk Perception Model Results

First, we estimated a risk perception basic model to understand what factors are related to food safety, animal health, and economic risk perceptions. The objective is to investigate the impact of socio demographic characteristics, environmental perceptions, and lifestyle on risk perceptions. In order to do this, we estimate censored regression (two-limit Tobit) models derived from our econometric model. The food safety risk perception variable was derived from a single

Likert scale question with ordinal responses between 1 and 5. Hence, the food safety risk perception model is estimated with a tobit and an ordered probit regression. The animal health risk perception variable is defined by the average of the square root transformation of five sets Likert scale responses, ranging continuously between 1 and 5. Respondent did not have the option to not respond. They did not have a "0" option. The animal health risk perception model is estimated with a tobit regression. The economic risk perception variable is defined as the average of seven Likert scale responses ranging continuously between 0 and 5 and the economic risk perception model is estimated using a Tobit regression.

The regression results are presented in the tables below. The marginal effects presented represented in the tables represent the marginal change in risk perception indices given a change in the explanatory variable for our sample respondents. The coefficient estimates and marginal effect estimates are provided for completeness.

The results from ordered probit regressions are consistent with the tobit model results when perception of food safety risk is minor to a great deal.

TABLE 4.1: ORDERED PROBIT MODEL RESULTS FOR FOOD SAFETY RISK PERCEPTIONS. SOURCE: STUDY SURVEY DATA, (2018).

VARIABLE	ESTIMATE	STANDARD ERROR
AGE	0.002	0.001
IF CHILDREN IN HOUSEHOLD	-0.042	0.060
HOUSEHOLD SIZE	**0.068*** **	**0.025**
MALE	0.026	0.038
EDUCATION (YEARS)	**-0.026*** **	**0.010**

LIVES IN URBAN AREA	**0.212*** **	**0.040**
LIVES IN SASKATCHEWAN	**0.199***	**0.108**
LIVES IN ALBERTA	0.096	0.066
GENERALIZED TRUST	**-0.125*** **	**0.039**
MEAT EATING PREFERENCE		
EATS VENISON	**-0.255*** **	**0.050**
CWD KNOWLEDGE	**-0.033***	**0.019**
WILDLIFE AND ENVIRONMENTAL PERCEPTION*		
WILDLIFE PERCEPTION	**-0.114*** **	**0.042**
PARTICIPATES IN WILDLIFE RELATED ACTIVITIES.	0.010	0.057
NUMBER OF WILDLIFE RELATED ACTIVITIES	0.001	0.016
NATURE EPHEMERAL	**0.143** **	**0.074**
NATURE PERVERSE	0.103	0.072
NATURE BENIGN	0.148	0.142
RISK PERCEPTION DUMMIES		
FOOD SAFETY RISK PERCEPTION DUMMY	0.000	(omitted)
ANIMAL HEALTH RISK PERCEPTION DUMMY	0.032	0.040

ECONOMIC RISK PERCEPTION DUMMY	-0.036	0.040
μ1	-1.281	0.239
μ2	-0.616	0.238
μ3	-0.031	0.238
μ4	0.614	0.239
FIT STATISTICS		
LOG -LIKELIHOOD	-4882.37	
PSEUDO R SQUARE	0.0119	
NUMBER OF OBSERVATIONS	3141	

Note: ***, **, *, significant at 1%, 5% and 10% level

TABLE 4.2: MARGINAL EFFECTS IN FOOD SAFETY RISK PERCEPTION ORDERED PROBIT MODEL. SOURCE: STUDY SURVEY DATA, (2018).

VARIABLE	MARGINAL EFFECTS OF EACH LEVEL OF FOOD SAFETY RISK PERCEPTION (STANDARD ERROR)				
	Insignificant 1	Very Little 2	Minor 3	Some 4	A great deal 5
AGE	-0.001 (0.000)	0.000 (0.00)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
IF CHILDREN IN HOUSEHOLD	0.013 (0.019)	0.003 (0.004)	-0.003 (0.004)	-0.006 (0.009)	-0.008 (0.011)
HOUSEHOLD SIZE	**-0.022*** (0.008)**	**-0.005*** (0.002)**	**0.004*** (0.002)**	**0.010*** (0.004)**	**0.013*** (0.005)**
MALE	-0.008 (0.012)	-0.002 (0.003)	0.002 (0.002)	0.004 (0.006)	0.005 (0.007)
EDUCATION (YEARS)	**0.008*** (0.003)**	**0.002*** (0.001)**	**-0.002*** (0.001)**	**-0.004*** (0.002)**	**-0.005*** (0.002)**
LIVES IN URBAN AREA	**-0.068*** (0.013)**	**-0.017*** (0.003)**	**0.013*** (0.003)**	**0.031*** (0.006)**	**0.040*** (0.008)**
LIVES IN SASKATCHEWAN	**-0.059** (0.030)**	**-0.020 (0.012)**	**0.009*** (0.003)**	**0.029* (0.015)**	**0.042* (0.025)**

LIVES IN ALBERTA	-0.030	-0.008	**0.005***	**0.014**	0.019
	(0.020)	(0.006)	**(0.003)**	**(0.010)**	(0.014)
GENERALIZED TRUST	**0.040*****	**0.010*****	**-0.008*****	**-0.019*****	**0.023*****
	(0.013)	**(0.003)**	**(0.002)**	**(0.006)**	**(0.007)**
MEAT EATING PREFERENCE					
EATS VENISON	**0.077*****	**0.024*****	**-0.012*****	**-0.037*****	**-0.053*****
	(0.014)	**(0.006)**	**(0.002)**	**(0.007)**	**(0.011)**
CWD KNOWLEDGE	**0.010***	**0.003***	**-0.002***	**-0.005***	**-0.006***
	(0.006)	**(0.002)**	**(0.001)**	**(0.003)**	**(0.004)**
WILDLIFE AND ENVIRONMENTAL PERCEPTION					
WILDLIFE PERCEPTION	**0.037*****	**0.009*****	**-0.007*****	**-0.017*****	**-0.022*****
	(0.013)	**(0.003)**	**(0.003)**	**(0.006)**	**(0.008)**
PARTICIPATES IN WILDLIFE RELATED ACTIVITIES.	-0.003	-0.001	0.001	0.001	0.002
	(0.018)	(0.005)	(0.003)	(0.009)	(0.011)
NUMBER OF WILDLIFE RELATED ACTIVITIES	0.000	0.000	0.000	0.000	0.000
	(0.005)	(0.001)	(0.001)	(0.002)	(0.003)
NATURE EPHEMERAL	**-0.045****	**-0.012***	**0.008****	**0.021***	**0.027****
	(0.023)	**(0.006)**	**(0.004)**	**(0.011)**	**(0.014)**
NATURE PERVERSE	-0.033	-0.008	0.006	0.015	0.019

	(0.023)	(0.006)	(0.004)	(0.011)	(0.014)
NATURE BENIGN	-0.045 (0.041)	-0.014 (0.015)	0.007 (0.005)	0.021 (0.020)	0.030 (0.032)
RISK PERCEPTION DUMMIES					
FOOD SAFETY RISK PERCEPTION DUMMY			0.000 (omitted)		
ANIMAL HEALTH RISK PERCEPTION DUMMY	-0.010 (0.013)	-0.003 (0.003)	0.002 (0.002)	0.005 (0.006)	0.006 (0.008)
ECONOMIC RISK PERCEPTION DUMMY	0.012 (0.013)	0.003 (0.003)	-0.002 (0.003)	-0.005 (0.006)	-0.007 (0.008)

Note: ***, **, *, significant at 1%, 5% and 10% level

TABLE 4.3: TOBIT MODEL (COEFFICIENTS AND MARGINAL EFFECTS) RESULTS FOR FOOD SAFETY RISK PERCEPTIONS. SOURCE: STUDY SURVEY DATA.

	Parameters		**Marginal Effects**	
Variable	Estimate	Standard Error	Estimate	Standard Error
Demographic Characteristics				
Age	0.003	0.003	0.002	0.002
If Children in Household	-0.087	0.117	-0.058	0.078
Household Size	**0.126*** **	**0.048**	**0.085*** **	**0.032**
Male	0.071	0.075	0.048	0.050
Education (Years)	**-0.031***	**0.019**	**-0.021***	**0.013**
Lives in Urban Area	**-0.395*** **	**0.157**	**-0.265*** **	**0.105**
Lives in Saskatchewan	**0.414** **	**0.210**	**0.282***	**0.145**
Lives in Alberta	**0.233***	**0.129**	**0.158***	**0.088**
Generalized Trust	0.000	(omitted)		
Generalized Trust (Don't Know)	-0.203	0.157	-0.136	0.105
Meat Eating Preference				
Eats Venison	**-0.524*** **	**0.098**	**-0.356*** **	**0.067**
CWD Knowledge	**-0.080** **	**0.036**	**-0.054** **	**0.024**
Wildlife and environmental perception **				

Wildlife Perception	**-0.228*** **	**0.082**	**-0.153*** **	**0.055**
Participates in Wildlife related activities.	0.031	0.111	0.021	0.075
Number of Wildlife Related Activities	-0.010	0.031	-0.007	0.021
Nature Ephemeral	**0.361*** **	**0.145**	**0.243*** **	**0.097**
Nature Perverse	**0.287** **	**0.140**	**0.193** **	**0.094**
Nature Benign	0.383	0.278	0.260	0.191
Nature Capricious	-	-	-	-
Risk Perception Dummies				
Food Safety Risk Perception Dummy				
Animal Health Risk Perception Dummy	0.056	0.078	0.038	0.052
Economic Risk Perception Dummy	-0.084	0.078	0.038	0.052
Constant	**3.792*** **	**0.484**		
Fit Statistics				
Log -likelihood	-4668.14			
Pseudo R Square	0.0227			
Number of Observations	3141			

Note: ***, **, *, significant at 1%, 5% and 10% level

TABLE 4.4: TOBIT MODEL RESULTS (COEFFICIENTS AND MARGINAL EFFECTS) FOR ANIMAL HEALTH RISK PERCEPTIONS. SOURCE: STUDY SURVEY DATA, (2018).

	Parameters		**Marginal Effects**	
Variable	Estimate	Standard Error	Estimate	Standard Error
Demographic Characteristics				
Age	**0.002*** **	**0.001**	**0.002*** **	**0.001**
If Children in Household	-0.024	0.044	-0.024	0.043
Household Size	0.029*	0.018	0.029*	0.018
Male	-0.017	0.028	-0.016	0.028
Education (Years)	-0.004	0.007	-0.004	0.007
Lives in Urban Area	-0.034	0.058	-0.033	0.057
Lives in Saskatchewan	0.044	0.083	0.043	0.082
Lives in Alberta	-0.024	0.049	-0.023	0.048
Generalized Trust	0.000	(omitted)		
Generalized Trust (Don't Know)	0.019	0.058	0.019	0.058
Meat Eating Preference				

Eats Venison	**-0.167*** **	**0.037**	**-0.166*** **	**0.036**
CWD Knowledge	**-0.028*** **	**0.013**	**-0.028** **	**0.013**
Wildlife and environmental perception*				
Wildlife Perception	**0.068*** **	**0.031**	**0.068*** **	**0.031**
Participates in Wildlife related activities.	**0.104*** **	**0.041**	**0.103*** **	**0.041**
Number of Wildlife Related Activities	0.005	0.011	0.005	0.011
Nature Ephemeral	**0.274*** **	**0.053**	**0.271*** **	**0.053**
Nature Perverse	**0.234*** **	**0.052**	**0.232*** **	**0.052**
Nature Benign	-0.008	0.103	-0.008	0.102
Nature Capricious	-	-	-	-
Risk Perception Dummies				
Food Safety Risk Perception Dummy	**-0.079*** **	**0.029**	**-0.078*** **	**0.029**
Animal Health Risk Perception Dummy				
Economic Risk Perception Dummy	-0.009	0.029	-0.009	0.029
Constant	2.614	0.181		
Fit Statistics				

Log -likelihood	-4668.14
Pseudo R Square	0.0227
Number of Observations	3141

Note: ***, **, *, significant at 1%, 5% and 10% level

TABLE 4.5: TOBIT MODEL RESULTS FOR (COEFFICIENTS AND MARGINAL EFFECTS) ECONOMIC RISK PERCEPTIONS. SOURCE: STUDY SURVEY DATA, (2018).

	Parameters		**Marginal Effects**	
Variable	Estimate	Standard Error	Estimate	Standard Error
Demographic Characteristics				
Age	**0.007*** **	**0.001**	**0.007*** **	**0.001**
If Children in Household	**-0.110***	**0.059**	**-0.103***	**0.055**
Household Size	0.032	0.024	0.030	0.023
Male	**-0.182*** **	**0.037**	**-0.168*** **	**0.034**
Education (Years)	**-0.031*** **	**0.010**	**-0.029*** **	**0.009**
Lives in Urban Area	0.076	0.082	0.071	0.076
Lives in Saskatchewan	0.082	0.108	0.075	0.099
Lives in Alberta	**-0.106***	**0.063**	**-0.099***	**0.059**
Generalized Trust	0.000	(omitted)		

Generalized Trust (Don't Know)	0.085	0.083	0.079	0.076
Meat Eating Preference				
Eats Venison	0.014	0.051	0.013	0.047
CWD Knowledge	0.011	0.018	0.010	0.017
Wildlife and environmental perception**				
Wildlife Perception	**0.217*****	**0.041**	**0.201*****	**0.038**
Participates in Wildlife related activities.	-0.062	0.056	-0.057	0.053
Number of Wildlife Related Activities	0.013	0.015	0.012	0.014
Nature Ephemeral	**0.298*****	**0.075**	**0.275*****	**0.068**
Nature Perverse	**0.209*****	**0.073**	**0.193*****	**0.067**
Nature Benign	0.190	0.148	0.173	0.133
Nature	-	-	-	-
Risk Perception Dummies				
Food Safety Risk Perception Dummy	**0.082****	**0.039**	**0.076*****	**0.036**
Animal Health Risk Perception Dummy	**0.226*****	**0.039**	**0.209*****	**0.036**
Economic Risk Perception Dummy				

Constant	2.504	0.245		
Fit Statistics				
Log -likelihood	-4668.14			
Pseudo R Square	0.0227			
Number of Observations	3141			

Note: ***, **, *, significant at 1%, 5% and 10% level

Older individuals are more likely to have higher economic and animal health risk perceptions than younger people. This is inconsistent with the literature on the effects of age on food safety risk perceptions including the food safety risk perceptions of CWD (Tonsor et al., 2009; Dosman et al., 2001). As expected, where gender has an effect on risk perceptions, in the case of economic and food safety risk perceptions, men have a lower risk perception than women. This is consistent with the results in the risk literature (Flynn et al., 1994; Slovic, 1997; Dosman et al., 2001). Being male usually implies lower risk perception. For food safety risk perceptions, this might be because women are responsible for the majority of household food purchases and preparations, and so they are more likely to consider food safety risk than men Dosman et al. (2001). This supports the "Safety Concerns Hypothesis" that "health concerns are more salient to women and that this heightened salience is reflected in higher levels of concern among women than among men about a given level of environmental risk" (Hitchcock, 2001).

Household size does not matter to economic risk perception but has a positive and negative impact on food safety and animal health risks respectively. The larger the household, the higher the food safety risks however, the variable on having children in the household, is associated with lower food safety risk and economic risk perceptions for CWD. Having children

in the household does not significantly influence animal health risk perceptions. Household size has no impact on economic risk perceptions.

The more educated a person is, the less risky CWD seems economically. However, years of schooling does not impact any food safety or animal health risk perceptions. Conversely, generalized trust has a negative impact on food safety and animal health risk perceptions and no impact on economic risk perceptions. Our results are consistent with the summary provided by Tonsor et al. (2009), Siegrist (2000), and Muringai and Goddard (2017) suggesting that risk perceptions are lower for those that are more trusting of experts, government and industry personals.

Regarding meat eating preferences, eating venison only impacts animal health and food safety risk perceptions. People who eat venison perceive a lower food safety and animal health risk than people who do not eat venison. This might be because they are less averse to the risks associated with consuming venison in general. Eating venison does not significantly affect economic risk perceptions but eating meat does. Meat eaters have a higher economic risk perception.

With respect to wildlife perception, the perception of wildlife importance and benefits does not affect food safety concerns but has a positive impact on how much risk respondent think the economy and animal health face due to CWD. This makes sense because CWD is a wildlife disease and the economic impacts are closely tied to wildlife related activities.

The amount of wildlife related activities people participate in has a positive impact on the economic risk perception and a negative impact on food safety risk perception. This might be because the economic impacts of CWD are tied to hunting and tourism, which are some of the wildlife related activities that respondents might engage in.

The myths of nature-believing nature outcomes are either ephemeral or perverse positively impacts all risk perceptions. Because we are interested in the effects of exposure to risk perception question treatments on other risk perceptions, we included dummy variables for whether the respondents answered questions in another risk category to help identify how that influences the risk perception of interest. The food safety risk perception seems to be independent of other risk perceptions. Exposure to animal health and economic risk perceptions would not influence risk perceptions for food safety. However, exposure to the food safety risk perception question influences animal health risk perceptions. Respondents who saw both food safety and animal health risk perception questions have higher animal health risk perceptions than they would have if they did not also respond to food safety risk perception questions. Exposure to personal food safety risk question might raise broader concerns about CWD risks.

Economic risk perception on the other hand is impacted positively by both food safety and animal health risk perception questions also responded to by respondents. Respondents with exposure to other risk types questions are more likely to report higher economic risk perceptions. This might be due to the ambiguity and lack of specificity of the potential economic impact of CWD. So, food safety and animal health risks could possibly be creating more context for the economic risk perception responses.

4.4 Models Identifying the Probability of Voting Yes for Increased Taxation to Support CWD Surveillance

The surveillance question is a binary – Yes, I would agree to higher taxes, No I would not agree to higher taxes question. Thus, a probit regression specification is appropriate. Each respondent was asked to support taxes at one of 5 levels ($25, $50, $100, $ 175, $300). Some

pretesting of the survey was conducted and the tax levels were found to be appropriate and in line with other similar questions on previous surveys (Forbes, 2011). In the probability of voting for additional surveillance our aim as to discover whether the probability of voting yes was influenced by prior exposure to one, two or three potential risks of CWD spread. To that end we introduced respondent exposure to prior risk perception questions through dummy variables reflecting the 'treatment' (number and order of risk perception questions) each respondent as exposed to. Given that there are ten treatments in total, we included nine of the treatments as dummy variables into our regressions – each of the coefficients on the nine dummy variables are reflecting the difference between responses to the constant and that particular treatment – the tenth treatment response will be the constant without any adjustment. To establish whether socio-demographic and attitudinal variables also influence the probability of voting yes for increased taxation we estimate the model in to stages – first – a base model which includes tax (or bid) level, and nine treatment dummy variables and second a full model with tax (or bid) level, nine treatment dummy variables and sociodemographic and attitudinal variables. The regressions were also analysed for three different samples. First, we have the full sample which includes all the complete respondents. Second, we have the "certain" sample which includes respondents who believe in the consequentiality of the referendum. And third, we have the "trap" sample of respondents who believe in the consequentiality of the referendum and also pass the trap question.

4.4.1 Probit Model for Referendum Votes

For this study, a dichotomous discrete choice contingent valuation method was used. There are two outcomes of the referendum. The respondents either votes "yes" to the bid -and is

willing to support CWD surveillance -or votes no, which indicates that there are not willing to support CWD surveillance at the proposed bid level. Respondents were asked if they will be willing to accept a $ amount tax increase over 10 years to support a CWD surveillance program. The respondents had five choices: $25, $50, $100, $ 175, $300.

The dependent variable is defined as the probability of voting yes or a willingness to support increased taxes for a CWD surveillance program (P_i). Their decision-making is expected to be dependent on risk perceptions, risk attitudes, and individual characteristics. Discrete choice models are usually derived under the assumption of decision makers' utility-maximizing behavior. Models that are derived in this way are called random utility models (RUM) (Train, 2003). The utility of decision maker n chooses an alternative j is Unj, j=1… J. The decision maker chooses alternative j if and only if Unj > Uni ∀ j ≠ i (Train, 2003). In this case, the decision maker faces a choice between two alternatives. A random utility model of a binary choice can be formulated as such: let the two choices be yes and no. An individual's utility for each choice is then:

$$U_{yes} = x'_{yes}\beta + \varepsilon_{yes} \text{ and } U_{no} = x'_{no}\beta + \varepsilon_{no}$$

Using probit regression, we examined the role of various variables including risk perceptions, risk attitudes, knowledge, and sociodemographic characteristics on the decision to support CWD surveillance. The probit model is built on the assumption that decisions made by people are based on some set of underlying perceptions that are not observable. In this application, the acceptability of management options is elicited using a binary response. The objective of this study is the estimate of the probability of supporting CWD surveillance by the Canadian public as a function of sociodemographic characteristics, risk perception, risk attitude, CWD awareness and knowledge and attitudes towards wildlife and the environment.

When the dependent variable y is binary, it is typically equal to one for all observations in the data for which the event of interest has happened ("yes to vote") and zero for the remaining

observations ("no to vote"). In the probit model, the probability of "yes" is modelled in terms of y*. Y* is an unobservable, and we only know when it crosses a threshold. The latent continuous variable y* is a linear combination of some predictors, W, and an error term. For the probit, the error terms are normally distributed. We are concerned about how changes in the predictors translate into the probability of observing a particular outcome.

$$\mathbf{Y^* = \beta' X + e_i}$$

Where y* is a continuous unobserved risk perception variable and **X** is the matrix of explanatory variables, β is the vector of parameters and e is a vector of random error terms.

The observed choice variable is y:

$y = 0$ if $y^* \leq 0$,

$y = 1$ if $y^* > 0$.

where y is the observed is the observed referendum vote.

The increasing nature of the ordered classes makes it easy to interpret the model parameter β. The interpretation is as follows: a positive sign indicates a higher probability of voting yes/ more support for the increased taxation for CWD surveillance and vice versa. That is, for a risk perception dummy variable, the existence of the risk perception question exposure, the more likely it is that the respondent would vote yes for the additional CWD surveillance.

The distribution of the error term, **e** is assumed to be normal: therefore, the probability of response variables being categorized into a specific category can be derived as follows (Greene, 1993):

$$\begin{aligned} \text{Prob}(y=1 \mid x) &= \text{Prob}\,(y^* > 0 \mid \mathbf{x}) \\ &= \text{Prob}\,(x\beta + e > 0 \mid \mathbf{x}) \\ &= \text{Prob}\,(e > -\mathbf{x}\beta) \end{aligned}$$

$$= 1 - N\left(-\frac{x\beta}{\sigma}\right)$$

$$= \mathbf{\Phi}\ (\mathbf{x\beta})$$

where **Φ (xβ)** is the standardized cumulative distribution function. The parameter **β** describes the shift in the distribution as a function of independent variables. (Greene, 1993; Dosman et al., 2001).

When analyzing probit results, three issues need to be considered. First, the marginal effects of the regressors indicate the impact of changes in the regression; that is, they indicate the change in probability of being in a particular category in response to a change in the independent variable. Second, these marginal effects are not equal to, but are computed from, the estimated coefficients. Third, a change in one of the variables will shift the distribution. The direction of the shift for choices Prob (y =0) and Prob (y =1), can be determined from the parameter sign. that is, if the parameter sign is positive the Prob (y= 1) will increase.

4.5 REFERENDUM RESULTS

Firstly, a basic model that included only the risk perception treatments was estimated to explain respondent's probability of voting yes to increased taxation to support CWD management is estimated without accounting for socio-demographic factors, environmental perceptions and attitudes concerning CWD and venison. The table below presents the regression results for the basic model for the original survey sample, the certain sample and the sample which passed the trap questions.

TABLE 4.6: ESTIMATES OF THE (BASE) PROBIT MODEL WITH JUST THE INFORMATION TREATMENTS. SOURCE: STUDY SURVEY DATA, (2018).

	Original Sample		Certainty Adjusted Sample		"Trap Question" Sample	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-Value
Price	**-0.002**	**0.000**	**-0.001**	**0.000**	**-0.002**	**0.000**
Food safety risk	**-0.263**	**0.001**	**-0.299**	**0.000**	**-0.338**	**0.000**
Animal health risk	0.051	0.525	-0.008	0.920	-0.013	0.885
Economic risk	-0.083	0.302	-0.104	0.187	**-0.156**	**0.075**
Food-safety-animal health	0.014	0.860	-0.078	0.323	-0.094	0.281
Animal health-Food safety	**-0.176**	**0.026**	**-0.239**	**0.002**	**-0.290**	**0.001**
Food safety-Economic	-0.054	0.503	**-0.150**	**0.057**	**-0.147**	**0.093**
Economic-Food Safety	**-0.175**	**0.028**	**-0.204**	**0.010**	**-0.240**	**0.006**
Animal Health-Economic Risk	-0.059	0.464	**-0.155**	**0.048**	**-0.181**	**0.038**
Economic – Animal Health Risk	-0.117	0.144	**-0.181**	**0.021**	**-0.182**	**0.037**
Constant	**0.638**	**0.000**	**0.514**	**0.000**	**0.613**	**0.000**

Fit Statistics			
Log likelihood	-3381.6336	-3527.2252	-2886.1941
Pseudo R Square	0.0147	0.0134	0.0167
Sample Size	5236	5236	4344

Compared to treatment 10 (information provision for all three risk perceptions, the constant), respondents in other treatments are less likely to vote yes in the referendum, all else being equal. It appears that considering all risk perceptions increases the chances of supporting the referendum.

As expected, the price of the referendum has a negative impact on the probability of respondents voting yes to the referendum. Priming in the form of exposure to food safety risk questions seems to have the most significant effect on public decision making. Being exposed to food safety risk questions reduces the chances of individuals voting in favor of the referendum relative to the base year. However, having either animal health or economic risk in addition to food safety risk, increases the possibility of a yes vote.

In specifying the full model (based on also including important demographic and attitudinal models as in the risk perception models) a full model is estimated to explain the probability of voting yes for increased taxation to support CWD surveillance. In this model the following variables are added to the regression – age, gender, household size, if children are in household, education, if they live in urban area, generalized trust, venison consumption, CWD knowledge, wildlife perception, number of wildlife related activities, and myths of nature.

TABLE 4.7: ESTIMATES OF PROBIT MODEL FOR MODEL 1 (ORIGINAL SAMPLE). SOURCE: STUDY SURVEY DATA, (2018).

ORIGINAL SAMPLE				
	PARAMETERS		MARGINAL EFFECTS	
	ESTIMATE	STANDARD ERROR	ESTIMATE	STANDARD ERROR
DEMOGRAPHIC CHARACTERISTICS				
TAX INCREASE	**-0.002*** **	**0.000**	**-0.001*** **	**0.000**
AGE	**0.009*** **	**0.001**	**0.003*** **	**0.001**
GENDER	-0.016	0.037	-0.006	0.014
HOUSEHOLD SIZE	0.007	0.024	0.002	0.009
IF CHILDREN IN HOUSEHOLD	0.024	0.059	0.009	0.022
EDUCATION	**0.039*** **	**0.010**	**0.015*** **	**0.004**
LIVES IN URBAN AREA	**0.096** **	**0.039**	**0.037** **	**0.015**
GENERALIZED TRUST	**0.196*** **	**0.038**	**0.073*** **	**0.014**
MEAT EATING PREFERENCE				

EATS VENISON	**0.143*** **	**0.047**	**0.055*** **	**0.018**
CWD KNOWLEDGE	**0.044** **	**0.018**	**0.017** **	**0.007**
RISK PERCEPTION TREATMENTS				
FOOD SAFETY RISK	**-0.310*** **	**0.082**	**-0.119*** **	**0.032**
ANIMAL HEALTH RISK	0.048	0.084	0.018	0.031
ECONOMIC RISK	-0.081	0.083	-0.030	0.031
FOOD-SAFETY-ANIMAL HEALTH	-0.029	0.083	-0.011	0.031
ANIMAL HEALTH- FOOD SAFETY	**-0.164** **	**0.082**	**-0.062** **	**0.032**
FOOD SAFETY-ECONOMIC	-0.035	0.083	-0.012	0.031
ECONOMIC-FOOD SAFETY	**-0.155***	**0.082**	**-0.059***	**0.032**
ANIMAL HEALTH-ECONOMIC RISK	-0.047	0.083	-0.017	0.031

ECONOMIC – ANIMAL HEALTH RISK	-0.116	0.082	-0.043	0.032
WILDLIFE AND ENVIRONMENTAL ATTITUDES				
WILDLIFE PERCEPTION	**0.295*** **	**0.040**	**0.111*** **	**0.015**
NUMBER OF WILDLIFE RELATED ACTIVITIES	**0.059*** **	**0.014**	**0.022*** **	**0.006**
NATURE EPHEMERAL	**0.727*** **	**0.069**	**0.257*** **	**0.023**
NATURE PERVERSE	**0.629*** **	**0.067**	**0.229*** **	**0.024**
NATURE BENIGN	**-0.251***	**0.143**	**-0.095***	**0.057**
CONSTANT	**-2.454*** **	**0.233**		
FIT STATISTICS				
SAMPLE SIZE	5236			
LOG LIKELIHOOD	-3126.89			
PSEUDO R2	.114935			

TABLE 4.8: ESTIMATES OF PROBIT MODEL FOR MODEL 2 (CERTAIN SAMPLE). SOURCE: STUDY SURVEY DATA, (2018).

CERTAINTY ADJUSTED SAMPLE				
	PAREMETERS		MARGINAL EFFECTS	
	ESTIMATE	STANDARD ERROR	ESTIMATE	STANDARD ERROR
DEMOGRAPHIC CHARACTERISTICS				
TAX INCREASE	**-0.002*** **	**0.000**	**-0.001**	**0.000**
AGE	**0.011*** **	**0.001**	**0.004**	**0.001**
GENDER	0.019	0.037	0.007	0.014
HOUSEHOLD SIZE	0.023	0.024	0.008	0.009
IF CHILDREN IN HOUSEHOLD	0.025	0.058	0.009	0.023
EDUCATION	**0.033*** **	**0.010**	**0.012**	**0.004**
LIVES IN URBAN AREA	0.059	0.039	0.021	0.015
GENERALIZED TRUST	**0.229*** **	**0.037**	**0.081**	**0.015**
MEAT EATING PREFERENCE				
EATS VENISON	**0.101** **	**0.047**	**0.036**	**0.019**
CWD KNOWLEDGE	**0.051*** **	**0.017**	**0.018**	**0.007**
RISK PERCEPTION TREATMENTS				
FOOD SAFETY RISK	**-0.354*** **	**0.081**	**-0.125**	**0.032**
ANIMAL HEALTH RISK	-0.021	0.082	-0.008	0.032

ECONOMIC RISK	-0.106	0.082	-0.037	0.032
FOOD-SAFETY-ANIMAL HEALTH	-0.128	0.082	-0.045	0.032
ANIMAL HEALTH- FOOD SAFETY	**-0.234*** **	**0.081**	**-0.083**	**0.032**
FOOD SAFETY-ECONOMIC	**-0.150***	**0.082**	**-0.053**	**0.032**
ECONOMIC- FOOD SAFETY	**-0.180****	**0.081**	**-0.064**	**0.032**
ANIMAL HEALTH-ECONOMIC RISK	**-0.150***	**0.082**	**-0.053**	**0.032**
ECONOMIC – ANIMAL HEALTH RISK	**-0.190****	**0.082**	**-0.067**	**0.032**
WILDLIFE PERCEPTION AND ENVIRONMENTAL ATTITUDES				
WILDLIFE PERCEPTION	**0.349*** **	**0.040**	**0.123**	**0.016**
NUMBER OF WILDLIFE RELATED ACTIVITIES	**0.066*** **	**0.013**	**0.023**	**0.006**
NATURE EPHEMERAL	**0.732*** **	**0.071**	**0.258**	**0.025**
NATURE PERVERSE	**0.653*** **	**0.069**	**0.230**	**0.026**
NATURE BENIGN	-0.228	0.151	-0.080	0.060
CONSTANT	-2.869	0.234		
FIT STATISTICS				
SAMPLE SIZE	5236		5236	

LOG LIKELIHOOD	-3236.47	-3231.45
PSEUDO R2	.12707	0.0961

TABLE 4.8: ESTIMATES OF PROBIT MODEL FOR MODEL 3 (CERTAINTY ADJUSTED AND PASSED TRAP QUESTIONS). SOURCE: STUDY SURVEY DATA.

CERTAINTY ADJUSTED AND PASSED TRAP QUESTIONS				
	PARAMETERS		MARGINAL EFFECTS	
	ESTIMATE	STANDARD ERROR	ESTIMATE	STANDARD ERROR
DEMOGRAPHIC CHARACTERISTICS				
TAX INCREASE	**-0.002*** **	**0.000**	**-0.001**	**0.000**
AGE	**0.011*** **	**0.002**	**0.004**	**0.001**
GENDER	0.010	0.040	0.004	0.016
HOUSEHOLD SIZE	0.036	0.026	0.013	0.010
IF CHILDREN IN HOUSEHOLD	0.012	0.064	0.004	0.025
EDUCATION	0.037	0.010	0.013	0.004
LIVES IN URBAN AREA	**0.222***	**0.041**	**0.025**	**0.017**
GENERALIZED TRUST	**0.222*** **	**0.041**	**0.079**	**0.016**
MEAT EATING PREFERENCE				
EATS VENISON	**0.108** **	**0.052**	**0.038**	**0.021**
CWD KNOWLEDGE	**0.050*** **	**0.019**	**0.018**	**0.008**
RISK PERCEPTION TREATMENTS				
FOOD SAFETY RISK	**-0.318*** **	**0.089**	**-0.113**	**0.035**
ANIMAL HEALTH RISK	-0.018	0.090	-0.006	0.035
ECONOMIC RISK	-0.050	0.090	-0.018	0.035
FOOD-SAFETY-ANIMAL HEALTH	-0.082	0.089	-0.029	0.035
ANIMAL HEALTH- FOOD SAFETY	**-0.184** **	**0.089**	**-0.065**	**0.035**
FOOD SAFETY-ECONOMIC	**-0.158***	**0.089**	**-0.056**	**0.035**
ECONOMIC- FOOD SAFETY	**-0.190***	**0.089**	**-0.070**	**0.035**

ANIMAL HEALTH-ECONOMIC RISK	-0.080	0.089	-0.028	0.035
ECONOMIC – ANIMAL HEALTH RISK	**-0.193****	**0.089**	**-0.069**	**0.035**
WILDLIFE PERCEPTION AND ENVIRONMENTAL ATTITUDES				
WILDLIFE PERCEPTION	**0.333*****	**0.044**	**0.118**	**0.017**
NUMBER OF WILDLIFE RELATED ACTIVITIES	**0.686*****	**0.076**	**0.244**	**0.007**
NATURE EPHEMERAL	**0.611*****	**0.074**	**0.217**	**0.028**
NATURE PERVERSE	**-0.249*****	**0.166**	**-0.089**	**0.028**
NATURE BENIGN	0.333	0.044	0.118	0.066
CONSTANT	**-2.841*****	**0.255**		
FIT STATISTICS				
SAMPLE SIZE	4344			
LOG LIKELIHOOD	-2703.24			
PSEUDO R2	.11913			

TABLE 4.9: LIKELIHOOD RATIO TEST STATISTIC FOR MODEL SPECIFICATION OBTAINED FROM PROBIT MODEL. SOURCE: STUDY SURVEY DATA.

Log likelihood	K (# of parameters)	Chi-statistics	Df	P-value	Conclusion
Base					
-3381.634	12				
Base + demographic variables + meat eating habits +environmental attitudes					
-3125.77	28	511.73	26	0.0000	Reject the null

4.6: Willingness to Pay Distribution for Each Treatment

An individual willingness to pay (WTP) is calculated by using actual values of the variables, and the coefficients obtained from the base probit model. For the base model, the formulas for WTP are defined below:

For treatments 1-9,

$WTP_i = -\frac{\alpha+\beta_i}{\beta_p}$

For treatment 10,

$WTP_{10} = -\frac{\alpha}{\beta_p}$

where, i = treatment name from 1-9

α= coefficient on the constant

β_x = coefficient of treatment parameters.

β_p = coefficient on the bid price.

For the full model, willingness to pay is calculated with the following formula:

$$WTP = -\frac{\alpha + \sum \beta_x X_a}{\beta_p}$$

Where β_x = coefficient of dependent variable

X_a = value of X independent variable

α= coefficient on the constant

β_p = coefficient on the bid price.

WTP is calculated for each individual in the sample and then sorted by treatment to see if willingness to pay differs by treatment. So, the WTP is reported by group who had a particular treatment dummy equal to one.

To illustrate,

$$WTP_1 = \frac{-\alpha+\beta_{price}Price+\beta_{urban}Urban+\beta_{trust}Trust+\beta_{eat}Eat+\beta_{know}Know+\beta_{treatment1}Treatment1+ \beta_{wild}Wild+\beta_{activities}Activities+\beta_{ephemeral}Ephemeral+\beta_{perverse}Perverse}{\beta_{price}}$$

$$WTP_2 = \frac{-\alpha+\beta_{price}Price+\beta_{urban}Urban+\beta_{trust}Trust+\beta_{eat}Eat+\beta_{know}Know+\beta_{treatment2}Treatment2+ \beta_{wild}Wild+\beta_{activities}Activities+\beta_{ephemeral}Ephemeral+\beta_{perverse}Perverse}{\beta_{price}}$$

The table below shows the willingness to pay for the base model and full model with the demographic characteristics, meat eating habits, CWD knowledge, animal perceptions, wildlife activity and environmental attitude variables.

For the base models and full model, WTP for CWD surveillance were positive and statistically different from zero for all 10 treatment groups. For the base model, the willingness to pay associated with exposure to only food safety risk questions (treatment 1) was $150, it was $324 for the respondents exposed to only animal health risk questions (treatment 2), and $298 for the respondents exposed to only economic risk questions (treatment 3). The treatment group with the highest willingness to pay was the group exposed to all risk perceptions, the constant. The

willingness to pay for CWD was $335 dollars for respondents primed to all three risk perception questions (treatment 10). I

For the full model, the WTP for the respondents primed to only food safety risk questions (treatment 1) is $310. The WTP for respondents primed to only animal health risk questions (treatment 2) is $328. The willingness to par for respondents primed to only economic risk questions (treatment 3) is $326. The WTP for the respondents primed to all three risks (treatment 10) is highest with a value of $329.

These WTP values are for the sample group who are certain and also pass trap questions. The rest of the willingness to pay is included in the table below.

Results from the WTP estimations show that the willingness to pay varies by the information treatment and sample. Being primed of the information on all three risks of CWD increases the chances of supporting the CWD surveillance referendum with the highest willingness to pay. Just being primed of the food safety concerns, results in the lowest willingness to pay. This might be because of the respondents may consider the risk to their health of low concern especially considering that there are individuals who do not eat venison. However, when respondents are primed about food safety risks as well as either economic and animal health risks associated with CWD, their willingness to pay is higher. The order of the risk priming may also matter. For example, in treatments 4 and 5 where respondents were primed to both food safety and animal health risks, the WTP in treatment 5- respondents were primed to food safety risk last- is lower than the willingness to pay for treatment 4. This also the case for treatments 6 and treatment 7. Priming respondents to food safety risks appears to reduce the chances of voting yes to the referendum. Having respondents primed by food safety risk perception questions and having food safety risk information? may reduce their chances of voting yes to the referendum.

Respondents seem to consider the CWD surveillance program to be most impactful to animal health and the economy.

TABLE 4.10: WILLINGNESS TO PAY FOR BASE MODEL AND FULL MODEL. SOURCE: STUDY SURVEY DATA.

	Food Safety	Animal Health	Economic	Food Safety and Animal Health	Animal Health and Food Safety	Food Safety and Economic	Economic and Food Safety	Animal Health and Economic	Economic and Animal Health	Food Safety, Animal Health and Economic
Treatments	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
					Base Model					
Vote	246.35	452.37	364.34	427.94	302.85	383.41	303.65	380.05	342.12	418.60
(S.E)	6.36	8.43	7.81	8.52	7.39	8.06	7.25	8.05	7.84	8.47
Vote-certain	148.27	348.40	282.22	300.19	189.30	250.85	213.60	246.90	229.25	353.92
(S.E)	3.91	7.38	6.56	6.99	4.94	6.13	5.42	6.07	5.80	7.61
Vote-certain pass trap	150.56	324.03	298.83	314.38	208.53	230.76	188.60	271.20	212.50	335.27
(S.E)	3.69	6.68	6.37	6.70	5.04	5.47	4.55	6.09	5.13	6.94
					Full Model					
Vote	394.38	416.21	408.37	411.56	403.32	411.16	403.84	410.44	406.25	413.30
(S.E)	5.86	6.08	6.01	6.05	5.97	6.04	5.96	6.03	6.00	6.07
Vote-certain	329.02	350.53	345.08	343.67	336.78	342.20	340.26	342.24	339.62	351.92
(S.E)	4.79	5.03	4.97	4.97	4.89	4.95	4.92	4.95	4.92	5.06
Vote-certain pass trap	310.27	328.70	326.69	324.74	318.37	319.76	317.59	324.81	317.68	329.82
(S.E)	4.43	4.64	4.61	4.60	4.53	4.55	4.51	4.60	4.52	4.65

4.7: CHAPTER SUMMARY

In Chapter 4, we ran regressions of the factors affecting risk perceptions and willingness to support the CWD referendum for the proposed CWD surveillance program. The results showed that risk perception levels were heterogenous across survey respondents, with socio demographic variable, venison consumption, generalized trust and myths of nature having varying effects on the level of food safety, animal health and economic risks that a respondent perceives. Older respondents have higher food safety risk perceptions while living in an urban area lowers food safety perception levels. People who live in larger households have higher food safety risks perceptions while more educated people have a lower food safety and economic risk perceptions.

Eating venison and having more knowledge about CWD lower food safety and animal health risk perceptions and have no effect on animal health risk perceptions. Having a more positive view of wildlife means a higher perception of economic and animal health risks but a lower food safety risk perception.

Priming individuals to economic risks had no effect on the levels of food safety or animal health risk perception but priming an individual to animal health risks increased the level of economic risk perceptions. Priming an individual to food safety risk perceptions increased their economic risk perception and decreased their animal health risk perception.

Exposure to different risk perception questions does appear to influence an individual's probability of voting yes to pay additional taxes for CWD surveillance. In the base model, the willingness to pay for the referendum was highest for treatment 10 (food safety- animal health-economic) and lowest for treatment 1(just food safety). A full model where variables such as demographic characteristics, venison consumption, wildlife and environmental attitudes contributed to explaining the probability of voting yes to the referendum was also estimated. The

likelihood ratio test suggested that the additional variables were important. In that model after sorting the individual WTPs for each respondent into treatment groups the average WTP treatment 10 (food safety- animal health- economic) was the highest and willingness to pay for treatment 1 (just food safety) was the lowest. This is consistent with the WTP values for the base model as well. Over the entire sample, the average WTP was positive and statistically significant at a 5% significance level.

Hence, the Canadian public's behavior regarding CWD management varies by the type of priming they receive through survey questions. Other factors affecting referendum votes include, myths of nature, venison consumption, wildlife perception, wildlife related activities, environmental attitudes, CWD knowledge, venison consumption, generalized trust, and socio demographic characteristics like age and living in an urban area.

CHAPTER 5: SUMMARY

5.1 INTRODUCTION

Chronic Wasting Disease is a prion disease that is currently known to affect animals of the cervid family. Since it was discovered in Canada, CWD has continued to expand its geographic range and increase in prevalence. Since CWD is an animal disease, there are concerns about the animal health, food safety and economic risks that exist because of its occurrence and level of prevalence. There is also the need for management options to help mitigate and control disease spread. However, success of these management options is tied to public support. In turn, public support depends on their perception of risks posed by CWD.

5.2 OVERALL DISCUSSION

This thesis examined how risk perceptions of Chronic Wasting Disease influence Canadian Public's willingness to support a surveillance program proposed as a management option for CWD-a prion disease that currently known to infect members of the cervid family. As an animal disease, CWD is expected to pose food safety, animal health and economic risks. This study was interested in understanding what factors influenced the public's perception of CWD risk. In addition, the study also explores how different risks/ risk information affected their decision making regarding CWD management. To do this, data were collected from an online national survey in 2018. A referendum was included in the survey to elicit willingness to support CWD surveillance described to help mitigate CWD risk by monitoring disease prevalence and spread.

The survey sample (5236 individuals) has 51% females and 49% males. The sample consisted of respondents ranging from 18 years to 65 years, with an average age of 41, same as the Canadian

2016 census. Compared to the Canadian 2016 census data, the proportion of Alberta residents in the survey were less than the census. There was a higher proportion of respondents from Prince Edward Island in the survey than in the Canadian census. The respondents in the survey generally had a higher education level than the census population, 35% of respondents compared to 11%.

The research objectives and results of this study are presented below.

The first objective was to access how sociodemographic and behavioral factors affect the public's perception of animal health, food safety, animal health and economic risks.

A censored tobit model and an ordered probit model was estimated the effects of socio-demographics and other variables on the perception of the CWD risks examined in this study. The regression results implied that some of the differences in a given risk perception of CWD can be explained by socio-demographic characteristics, meat eating preferences, and wildlife and environmental perception and other risk.

Results from the food safety perception regression showed that people with large household sizes are more likely to have a higher perception of risks associated with venison consumption while respondents who are more educated and living in urban areas are less likely to have a higher perception of CWD food safety risks. The sociodemographic factors that affect animal health risk perceptions include age of respondents and household size, both having a positive impact on food safety risk perceptions. For economic risks, being older has a positive impact, but having a larger household size has a negative impact. Individuals who have eaten venison and have more knowledge about CWD are less likely to be concerned about the food safety and animal health risk associated with CWD. However, venison consumption and CWD knowledge have no impact on the economic risk perceptions of CWD.

Regarding wildlife and environmental concerns, results show that more positive perception of wildlife implies animal health and economic safety risk concern but has a negative

impact on food safety risk perceptions. Whether an individual participates in wildlife activities only positively impacts the level of animal health risk perceived. However, an individual participating in more wildlife related activities influences their animal health risk perception positively but has no effect on their food safety and economic risk perceptions.

The four myths of nature considered in this study include nature capricious, nature ephemeral, nature perverse, and nature benign. Individuals who think nature is benign are more likely to be concerned about CWD risk, regardless of risk. Individuals who believe that nature is perverse are less likely to care about the risks. They are also more likely to be concerned about economic risk than all the other risks considered. The effects of the myths of nature on the referendum votes may be overestimated due to potential endogeneity.

TABLE 5.1: RISK CONCERNS BY MYTHS OF NATURE. SOURCE: STUDY SURVEY DATA.

	FOOD SAFETY	ANIMAL HEALTH	ECONOMIC
NATURE EPHEMERAL	0.068	0.053	0.097
NATURE PERVERSE	0.067	0.052	0.094
NATURE BENIGN	0.133	0.102	0.191

The results of this study also imply that perceptions of food safety risks are independent of knowledge of other risk types. However, knowledge of food safety risk has a negative impact on the perception of animal health risk and a positive impact on the perception of economic risk.

The second objective of this study was to investigate what factors influenced the Canadian public's decision to support surveillance programs to help manage the spread of CWD. A probit model was estimated with the referendum vote as the dependent variable. As expected, the higher

the cost of surveillance to the respondent, the less likely they are to support a surveillance program. Individuals who agreed that the environmental problems can only be controlled by radical changes in human behavior as a whole (nature ephemeral), individuals who believe that environmental problems are not entirely out of control but the government should dictate clear rules about what is and what is not allowed (nature perverse) and individuals who believe nature is benign are more likely to vote yes to the referendum than individuals who do not know whether environmental problems will magnify or not (Nature capricious).

The next objective was to examine how information provision and priming regarding the different risk type influence the public's willingness to pay for the surveillance program.

The individual willingness to pay were grouped (and averaged) by the treatment group they belonged to. Each treatment group saw a different number and sequence of risks questions which primed respondents to the existence of each risk category while providing information on the scope of each risk.

The mean willingness to pay were all positive regardless of treatment group. The group with the lowest willingness to pay is treatment one with only food safety risk information. And the one with the highest WTP is the treatment with all risk information provided to the respondent. The results from the study indicate that priming respondents to more risk information using the risk perception elicitation questions increased their likelihood of saying yes to the referendum, and resulted in higher willingness to pay values. This might be because respondents are not likely to be informed or aware of all the potential risk that CWD poses. Therefore, if they are primed to more risk concerns, or economic risks, they may be willing to pay more to mitigate these risks.

The results also imply that the order in which the risk perception questions are asked may also influence their willingness to pay. Priming respondents to food safety risk questions before

they answer the referendum question is likely to reduce their willingness to pay compared to economic and animal health risk questions.

A final related objective of this study is to understand how sociodemographic and behavioral factors influence willingness to pay additional taxes to support CWD surveillance. Older individuals, individuals who live in urban areas, individuals who are more trusting, have a positive perception of wildlife and participate in more nature related activities are more likely to support the CWD surveillance program by paying additional taxes. Eating venison and having more knowledge about CWD also increases a respondent's chances of voting yes to the referendum.

5.3 LIMITATIONS FOR OF THIS STUDY

As the surveillance program is a hypothetical program at the time of survey and this study. Hence possibility of hypothetical bias and strategic behavior cannot be ignored. While this study uses some cheap talk, information provision, follow-up questions and an ex-post certainty question to try to account for the existence of hypothetical bias, we cannot say for certain that the results are completely free of bias given the length and scope of this survey. In addition, no analysis was conducted on the ex-post consequentiality question included in the survey.

Another limitation of this study was the instrument used to elicit economic risk perceptions in a way that was familiar an understandable to the respondents. The food safety, animal health and economic risks of CWD vary in scope and it is hard to know if the instrument we used capture all of the dimensions of risk. We are especially not sure if the respondents understood the economic risk presented in the model. Future studies could test the robustness of tis economic risk elicitation instrument as well as use other risk elicitation methods and questions.

There was a lot of information provided to the respondents that could have created respondent fatigue. There could be a better way to model information provision and methods of risk elicitation, so it is less overwhelming to the respondents. An example of this is a visual risk elicitation tool like a risk ladder. Using a visual method of risk perception could have been more helpful because it is hard to quantify each of the risks posed by CWD.

5.4 IMPLICATIONS FOR POLICY

This study contributes to the literature on the economic impact of CWD. As a contribution to the already existing literature, we studied multiple (more than two) risk types in one study. The public's perception of economic risk regarding CWD is a component that has not been elicited in literature. We investigate how information provision on multiple risk types influence risk perceptions and decision making. It is also explored a unique management option (CWD surveillance).

Understanding how the public makes decision regarding an animal disease like CWD is important for managing the disease now and similar diseases in the future. It makes it possible for government and management institutions to make better decisions on whether to pursue a management program like surveillance. Also, it gives insight to what kind of management programs would be supported by the public and what to focus on when proposing management options.

For example, based on our study, consumers who are older more educated and living in urban areas are more likely to vote support CWD surveillance programs. Hence, CWD surveillance programs could be targeted at specific groups of people instead of the whole public. Because people who have some knowledge about CWD are more likely to support surveillance,

CWD education programs can be an effective way of increasing the chances of public support for CWD mitigation.

Priming respondents to animal health and economic risk perceptions made them more likely to vote yes to the referendum. Hence, CWD information provision and awareness programs may be more successful id they focus on the animal health and economic impact of the disease.

Effective management strategy is important to ensure the control of CWD spread. This study could help the government and management agencies to design management programs that take into consideration what concerns and risks are most important to the Canadian public. For example, personal food safety risk appears to be really important to decision making. The public will be more likely to stand behind programs that reduce their chances of being affected by venison consumption.

It is also important to note how important the public's behavior towards the environment is. For example, individuals who think nature is capricious and there is nothing we can do to affect nature are less likely to support a surveillance problem because they probably view it as pointless.

There is a positive willingness to pay for CWD surveillance which implies that the public is interested in supporting the surveillance program.

5.5 RECOMMENDATIONS FOR FUTURE RESEARCH

This study focuses on the effect of risk perceptions on the likelihood of individuals voting yes to a referendum. Risk perceptions are subjective measure of the possibility and severity of a risk and were found in this study to impact respondent's behavior regarding disease management. Results from this study also found that social values impact both risk perceptions and risk management behavior. Future research could consider exploring in details how non-

environmental values like political and religious values influence risk perception and risk management behaviour.

The risk perception variables used in this study were developed in multiple dimensions. For example, the economic risk perception variable was made up of 7 parts and related to four stakeholder groups. Future research can explore the risk perceptions to the different stakeholder groups and scenarios in details without grouping them into a single variable.

In addition, the results of this study show that priming affects respondent decision making. Future research can test the consistency of how these set of priming questions influence decision making regarding CWD. There should also be more investigating how priming respondent using survey questions may influence choices in other referendum scenarios.

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APPENDICES

APPENDIX 1: FULL SURVEY

NATIONAL CHRONIC WASTING DISEASE SURVEY
MARCH 2018

1. In which of the following age groups do you fall?

1. ❒ 18 -20
2. ❒ 21-24
3. ❒ 25 -29
4. ❒ 30 -36
5. ❒ 37 -45
6. ❒ 46 -55
7. ❒ 56 -65
8. ❒ 65+

2. Please indicate your gender.

1. ❒ Male
2. ❒ Female
3. ❒ Other – please identify_____

3. How many people live in your household?

1. ❒ 1
2. ❒ 2
3. ❒ 3
4 ❒ 4 or more

4. How many children younger than 18 live in your house?

1. ❒ No home living children < 18 years
2. ❒ 1
3. ❒ 2
4. ❒ 3
5. ❒ 4
6. ❒ More than 4

5. What is the highest level of education you've achieved? **ONLY ONE ANSWER POSSIBLE**

1. ❒ Elementary school
2. ❒ Secondary (high) school

3. ❒ Technical/ business school/Community college
4. ❒ University
5. ❒ Post graduate studies (Masters or PhD)

6. What is the approximate range of your total household income? **ONLY ONE ANSWER POSSIBLE**

1. ❒ $ 24,999 or under
2. ❒ Between $ 25,000 and $ 34,999
3 ❒ Between $ 35,000 and $44,999
4. ❒ Between $ 45,000 and $ 64,999
5. ❒ Between $ 65,000 and $ 79,999
6. ❒ Between $ 80,000 and $ 99,999
7. ❒ Between $ 100,000 and $ 119,999
8. ❒ $ 120,000 or more

7. Which region do you live in? **ONLY ONE ANSWER POSSIBLE**

1. ❒ Newfoundland
2. ❒ Prince Edward Island
3. ❒ Nova Scotia
4. ❒ New Brunswick
5. ❒ Quebec
6. ❒ Ontario
7. ❒ Manitoba
8. ❒ Saskatchewan
9. ❒ Alberta
10. ❒ British Columbia
11. ❒ Yukon
12. ❒ Northwest Territories
13. ❒ Nunavut

8. Do you live in a city, in a town or in the countryside? **ONLY ONE ANSWER POSSIBLE**

1. ❒ In a city (>100,000 inhabitants)
2. ❒ In a town (> 10,000 inhabitants)
3. ❒ In the countryside/rural district

9. Do you own any rural land? (cottage, farm etc.)

1	❒	Yes
2	❒	No

10. Which of the following best describes your food preferences?

❒	I eat meat and fish
❒	I eat fish but don't eat meat
❒	I do eat meat but I don't eat fish
❒	I am a vegetarian (I don't eat either meat or fish)
❒	I am a vegan (I eat no animal products including dairy products, eggs, seafood, fish, white meat and red meat)

11. Please select disagree for this question.

1.	❒	Agree
2	❒	Disagree

12. Have you, or has any member of your household, ever eaten venison (meat from deer, elk or moose)?

1.	❒	Yes
2	❒	No

13. Generally speaking, would you say that most people can be trusted?

People can be trusted	**Can't be too careful in dealing with people**	**Don't know**
1	**2**	**3**
❒	❒	❒

14.

In the last twelve months did you take any overnight trips within Canada for any of the following reasons?		
	Yes	No
	1	2

Sightseeing in natural areas	1.	❒	❒
Watch, feed, photograph or study wildlife	2	❒	❒
Hunt wildlife	3	❒	❒

15.

In the last twelve months did you take any day trips within Canada for any of the following reasons?

		Yes	No
		1	2
Sightseeing in natural areas	1.	❒	❒
Watch, feed, photograph or study wildlife	2.	❒	❒
Hunt wildlife	3.	❒	❒

16. Which of the following activities do you participate in?

		Yes	**No**
		1	**2**
Feeding wildlife at my house with table scraps or special food (including bird seed) for wildlife	**1.**	❒	❒
Photographing, studying or recording wildlife	**2**	❒	❒
Observing, collecting or creating wildlife related art or literature	**3**	❒	❒
Being a member of any wildlife related organization	**4**	❒	❒
Contributing to an organization that protects endangered wildlife	**5**	❒	❒
Contributing to an organization that promotes wildlife conservation	**6**	❒	❒
Other general outdoor recreation (e.g. camping, hiking, backpacking, biking, cross country skiing, canoeing, rafting)	**7**	❒	❒
Motorized outdoor recreation (e.g. all terrain vehicle driving (ATVing), snowmobiling, boating	**8**	❒	❒

17. Indicate how strongly you agree or disagree with all of these sentences.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
	1	2	3	4	5
1. Wildlife is an important part of the natural environment	❒	❒	❒	❒	❒
2. Wildlife is an important part of the Alberta and/or Canadian economy	❒	❒	❒	❒	❒
3. Wildlife is more of a nuisance than a benefit to my life	❒	❒	❒	❒	❒
4. Diseases seriously endanger wildlife	❒	❒	❒	❒	❒
5. Wildlife diseases can seriously affect people's health	❒	❒	❒	❒	❒

18. Please identify whether you agree or disagree with the following statements:

Statement	Strongly Disagree	Mildly Disagree	Neutral	Mildly Agree	Strongly Agree
	1	2	3	4	5
1. I worry about changes to the countryside, such as the loss of native plants and animals	❒	❒	❒	❒	❒
2. There is nothing I can personally do to help stop the losses in the world's biodiversity	❒	❒	❒	❒	❒
3. We can afford to lose some of the world's biodiversity	❒	❒	❒	❒	❒
4. Biodiversity losses in animals domesticated for food production are	❒	❒	❒	❒	❒

less serious than similar losses in wildlife					

(UK survey with some attitudes towards biodiversity)

19. To what extent do you feel knowledgeable about environmental problems? 1 means that "you have little knowledge", and 10 means that "you know a lot."

1	2	3	4	5	6	7	8	9	10

20. Please identify whether you agree or disagree with the following statements:

	Strongly Disagree	Mildly Disagree	Neither agree nor disagree	Mildly Agree	Strongly Agree
	1	2	3	4	5
1. Human beings can progress only by conserving nature's resources					
2. Human beings can enjoy nature only if they make wise use of its resources.					
3. Human progress can be achieved only by maintaining ecological balance.					
4. Preserving nature at the present time means ensuring the future of human beings					
5. We must reduce our consumption levels to ensure well-being of the present and future generations					

21. Please indicate which one of the following statements corresponds most with your view on nature: **<u>only one answer is possible</u>**

1. _____ Environmental problems can only be controlled by enforcing radical changes in human behavior in society as a whole.
2. _____ Environmental problems are not entirely out of control, but the government should dictate clear rules about what is and what is not allowed.
3. _____ We do not need to worry about environmental problems because in the end, these problems will always be resolved by technological solutions.
4. _____ We do not know whether environmental problems will magnify or not.

(the above two are from scales in papers by Corral-Verdago et al and by Steg and Sievers)

22. Please answer the following questions. Give your answer on a scale from 1 ("insignificant") to 5 ("a great deal").

	Insignificant	Very little	Minor	Some	A great deal
	1	2	3	4	5
How much risk do you think there is to **you personally** of experiencing negative consequences from eating unsafe foods?	❒	❒	❒	❒	❒
How much risk do you think there is to **the average Canadian person** of experiencing negative consequences from eating unsafe foods?	❒	❒	❒	❒	❒
How much control do you think **you personally** have over the safety of food?	❒	❒	❒	❒	❒
How much control do you think **the average Canadian person** has over the safety of food?	❒	❒	❒	❒	❒
How much knowledge do you think **you personally** have about the safety of food?	❒	❒	❒	❒	❒
How much knowledge do you think **the average Canadian person** has about the safety of food?	❒	❒	❒	❒	❒

23. **Do you ever eat meat from animals you or someone else has hunted?**

never	tried it once	occasionally	frequently	regularly
1	**2**	**3**	**4**	**5**
❒	❒	❒	❒	❒

24. **Have you ever ordered venison (deer, elk or moose meat) in a restaurant?**

never	tried it once	occasionally	frequently	regularly
1	**2**	**3**	**4**	**5**
❒	❒	❒	❒	❒

25. Do you ever purchase/obtain venison (deer, elk or moose meat) from a store or other source?

never	tried it once	occasionally	frequently	regularly
1	2	3	4	5
❒	❒	❒	❒	❒

26. When you obtain/buy deer, elk or moose meat, is it **usually from** …….. (If yes to question 26 One ONLY)		
a supermarket,	❒	**1**
a butcher's shop	❒	**2**
your own hunting experience	❒	**3**
a farmer's market	❒	**4**
or another way (directly from a farm or through acquaintances)	❒	**5**

27.
What do you think about eating venison? (answer about your perceptions even if you have never eaten venison)

	1	**2**	**3**	**4**	**5**	
1. When eating venison, my household is exposed to …						
very little risk	❒	❒	❒	❒	❒	a great deal of risk
2. Members of my household accept the risks of eating venison						
strongly disagree	❒	❒	❒	❒	❒	strongly agree
3. Members of my household think eating venison is risky						
strongly disagree	❒	❒	❒	❒	❒	strongly agree
4. For members of my household, eating venison is …						
not risky	❒	❒	❒	❒	❒	risky
5. For members of my household, eating venison is worth the risk						
strongly disagree	❒	❒	❒	❒	❒	strongly agree
6. My household is … the risk of eating venison						
not willing to accept	❒	❒	❒	❒	❒	willing to accept

Chronic Wasting Disease

- Chronic wasting disease (CWD) is a progressive, fatal, degenerative disease belonging to a group of diseases called Transmissible Spongiform Encephalopathies (TSEs).

- Other examples of TSEs are Scrapie, BSE (mad cow disease) and Creutzfeldt–Jakob disease (CJD, the most common TSE found in humans). All TSEs are ultimately fatal.
- CWD affects some but not all members of the cervid family (elk, moose, mule deer and white-tailed deer to date), has no current treatment or vaccine and is the only TSE to occur in free-ranging species. There is ongoing research to develop treatment or vaccines for CWD as well as live animal tests for the presence of the disease.
- Although extensive surveillance has not provided any scientific evidence that CWD has been transmitted to humans, Health Canada suggests the most prudent approach is to consider that CWD has the potential to infect humans. Health Canada continues to recommend avoiding consumption of foods from known CWD infected or any diseased animals, and taking precautions when handling cervid carcasses. In addition, in areas where CWD is known to occur in wild cervids, continued consistent Federal and Provincial/Territorial communications, warning and precautions should be provided to groups who may be expected to have higher exposures to cervids through hunting and diet (e.g., rural and Indigenous populations).There is currently no evidence that CWD can be contracted by livestock such as cattle, sheep, goats, horses or bison although research is ongoing.

28. Before responding to this survey, had you heard of chronic wasting disease (CWD)?

1. Yes	☐	2. No	☐

29. If you had heard of CWD before this survey, did you know that CWD can infect deer, before responding to this survey?

1. Yes	☐	2. No	☐

30. If you had heard of CWD before this survey, did you know that CWD can infect elk, before responding to this survey?

1. Yes	☐	2. No	☐

Please review the following before answering the following questions.

CWD in wild population of deer and elk

- Chronic wasting disease is thought to have been introduced into Saskatchewan farmed elk in the late 1980s via affected elk imported from the United States, but it was not recognized in farmed elk until 1996. Wildlife agencies in the prairie provinces began surveillance programs to determine the presence of the disease amongst free-ranging deer and elk in the 1990s.
- No cases of chronic wasting disease have been found in Manitoba, Ontario, Quebec, British Columbia or the Maritimes.
- Saskatchewan has found 360 mule deer, 94 white tailed deer and 10 elk with chronic wasting disease out of 45,563 wild animals tested to the end of 2016.
- The first confirmed case of CWD in a wild Alberta deer occurred in September, 2005, almost 3 years after CWD was found in farmed elk and deer.
- In Alberta more than 46,000 wild cervids (deer, elk and moose) have been tested for CWD since 2005.

- A total of 590 cases of CWD have been found in wild Alberta deer to the end of 2016, up from 94 cases of CWD to the end of 2010.
- To date, 1 case of CWD has been found in a wild elk in Alberta and 1 case has been found in a moose.
- Rates of CWD infection in the province of Alberta in 2017, for example, remain low (5.4% of tested mule deer, 1.5% of tested white tailed deer and fewer than 1% of elk).

CWD on prairie elk and deer farms

- Alberta (and other prairie provinces) began conducting voluntary testing for CWD in farmed and wild elk and deer in the fall of 1996.
- In August, 2002 Alberta initiated a mandatory surveillance program for all farmed elk and deer.
- 89 farmed herds of deer or elk in Saskatchewan and Alberta have been found to have CWD since 1996 – when farms are found to have CWD the farm's herds of animals are depopulated (destroyed)
- 7 animals (2 white tailed deer and 5 elk) have been found in farmed deer and elk in Alberta since 2002, with the most recent found in 2015 and 2016, out of 72,733 animals tested.
- Alberta, Saskatchewan, Manitoba and the Yukon test all farmed deer and elk for CWD prior to meat from those animals being sold – other parts of Canada have voluntary testing protocols for farmed deer and elk and no animals have been found.

31. Before responding to this survey, did you know that CWD has recently been found in both farmed and wild deer and elk in Alberta ?

1. Yes	☐	2. No	☐

32. Before responding to this survey did you know that CWD has been found in in both farmed and wild deer and elk in Saskatchewan?

1. Yes	☐	2. No	☐

33. Please answer the following questions. Give your answer on a scale from 1 ("insignificant") to 5 ("a great deal").

	Insignificant	**Very little**	**Minor**	**Some**	**A great deal**
	1	**2**	**3**	**4**	**5**
How much risk do you think there is to **you personally** of experiencing negative consequences from eating unsafe meat from deer, elk or moose?	❒	❒	❒	❒	❒
How much risk do you think there is to **the average Canadian person** of experiencing negative consequences from eating unsafe meat from deer, elk or moose?	❒	❒	❒	❒	❒

How much risk do you think there is to **the average Canadian hunter** of experiencing negative consequences from eating unsafe meat from deer, elk or moose?	❒	❒	❒	❒	❒
How much risk do you think there is to **the average Canadian Indigenous person** of experiencing negative consequences from eating unsafe meat from deer, elk or moose?	❒	❒	❒	❒	❒

34. Please indicate your level of agreement with the following statements on a scale from strongly disagree to strongly agree.

	Strongly Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly Agree	Don't know
	1	2	3	4	5	6
The threat of CWD has been exaggerated.	☐	☐	☐	☐	☐	☐
Efforts should be taken to eliminate CWD from the country.	☐	☐	☐	☐	☐	☐
CWD should be contained to its current geographical area.	☐	☐	☐	☐	☐	☐
I think there is a potential for CWD to be transferred to humans	☐	☐	☐	☐	☐	☐
I, or my family, have concerns about eating elk and deer meat because of CWD.	☐	☐	☐	☐	☐	☐
I believe that eating elk and deer meat will cause CWD related infections in humans.	☐	☐	☐	☐	☐	☐

35. Please answer the following questions to the best of your ability, based on your current knowledge.

Probability of Occurrence	**Very unlikely**	**unlikely**	**Neither likely or**	**likely**	**Very likely**

			unlikely		
	1	**2**	**3**	**4**	**5**
What is the likelihood of CWD transmission to pets?					
What is the likelihood of CWD transmission to domestic livestock, for example cattle or bison?					
What is the likelihood of CWD Transmission to a large enough group of deer, elk and moose that these wild animal populations decline in Canada					
What is the likelihood of CWD transmission to other cervid populations (eg caribou) ?					
What is the likelihood of CWD transmission to other wildlife species (eg. coyotes, snakes, bears)?					
Magnitude of Consequences	**Not very severe**	**Somewhat severe**	**Fairly Severe**	**Severe**	**Very severe**
	1	**2**	**3**	**4**	**5**
If your pet were to contract a version of CWD, how serious do you think the consequences would be?					
If domestic livestock (cattle, bison) were to contract a version of CWD, how serious do you think the consequences would be?					
If enough deer, elk and moose were to contract CWD that the populations of these wild animals were depleted, how serious do you think the consequences would be?					
If other cervids, such as caribou, were to contract CWD, how serious do you think the consequences would be?					
If other wild animals (such as coyotes, snakes, and bears) were to contract CWD, how serious do you think the consequences would be?					

36. Deer, elk and moose are animals strongly associated with Canadian wilderness, tourists and hunters may visit Canada partly or mostly because of the existence of these animals. In addition, deer and elk farms are other economic activities associated with the animals. If CWD were to continue to spread throughout the country please identify how severe you think the following economic impacts might be for Canada

	Not Severe Economic impact	Slightly severe Economic impact	Fairly Severe Economic impact	Severe economic impact	Very severe economic impact	Do Not Know
	1	2	3	4	5	6
Economic trade barriers against the exports of venison or any products from deer and elk farms						
Economic costs for deer and elk farms when the disease is spread to the farmed animals from wild animals						
Economic costs for outfitting firms who generate income from hosting and advising hunters from other parts of North America and the world						
Lost tourism revenue from hunters who might not wish to hunt in Canada if the						

animal disease spreads						
Lost tourism revenue to national parks and towns from declining population of cervids						
Economic costs for cattle or bison farmers if the disease spreads to livestock from wild animals						
Increased costs of food for Indigenous communities who might otherwise have used deer, elk or moose as a source of protein in their diets						

41. One of the best things that can be done to manage the spread of CWD is to increase surveillance or monitoring. "Disease surveillance is the ongoing observation of disease within a wild population designed to assist disease management" (Artois et al 2009). From surveillance it will be possible to identify how far CWD has spread (how many regions have animals with CWD and how many do not), measure disease intensity (how many of the animals, of the total population, are infected in areas where the disease is known to occur) and over time identify trends in prevalence/intensity or geographic spread to evaluate control programs and to inform needs for research. The types of surveillance for wild cervid populations utilize four main and two rare sources of cervid samples for CWD testing:

Hunter harvested animals
Clinically suspected cases (reported by the public or found by agency staff)
Road kill
Herd reductions (in areas where disease has been found or is expected)
Predator – killed cervids (rare)
Poached or confiscated cervid remains (rare) (Norbert and Pybus, 2014)

Without more surveillance, it will be possible for disease to spread into unexpected areas and become more prevalent potentially affecting other animals. The surveillance provides critical information for wildlife managers and government in general as to the significant effects of the disease on populations and whether more interventions are necessary to slow the spread. More surveillance will require funding for diagnostic testing (including more laboratories), for staff time, for incentives to encourage public participation (reporting of sick animals, for example), and for communication.

On the next page we provide you with some maps highlighting the CWD distribution in 2008 and 2018 to illustrate the spatial spread of the disease. We will then ask you whether or not you would vote for a surveillance program that will help in monitoring spread and infection rates of CWD but results in a certain increase in your annual taxes to pay for the costs of the program.

HOW WOULD YOU VOTE?
There are defined surveillance programs that the provincial and federal government agencies could adopt to deal with CWD in the different regions of the country. Whether the additional surveillance will result in sufficient information to allow government agencies to develop control programs that reduce prevalence and spatial spread is unknown.

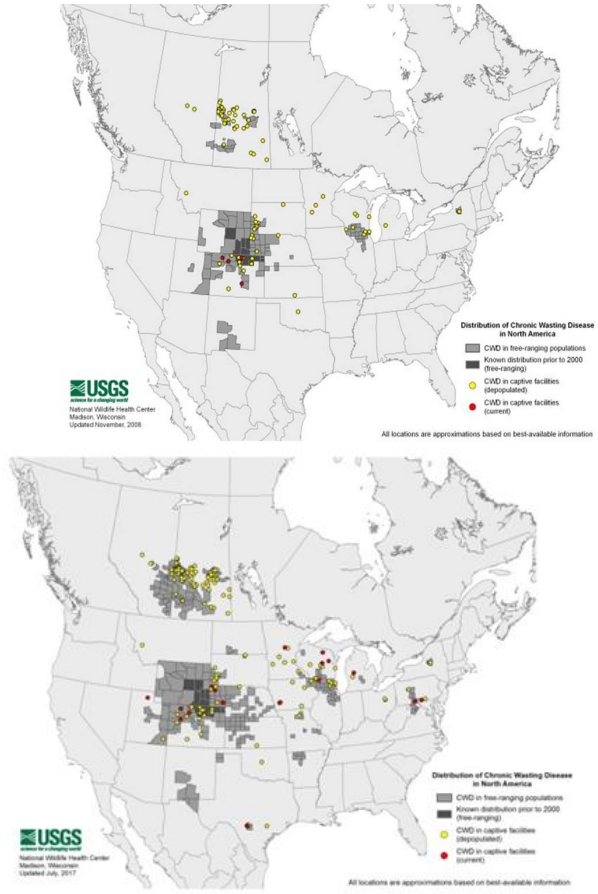
In the following screens, we provide you with two maps of North America
- The map on the left side of the screen is the geographic distribution of CWD in 2008
- The map on the right is the current distribution of CWD in 2018

It is very important that you vote as if this were **a real referendum** being posed collectively by all of the provincial governments in the country.

Please place your vote for the following proposed CWD surveillance program:

How would you vote in a referendum on the proposed CWD surveillance program that would allow government agencies to monitor spread and prevalence and to make informed decisions on more interventions to reduce spread but resulted in a *$5 (25, 50, 100, 175, 300))* increase in annual provincial taxes for the next 10 years?

MAP A **Map B**



1. ☐ I vote YES for the proposed CWD surveillance program with a $25 (varying as above) tax increase
2. ☐ I vote NO for the proposed CWD surveillance program

42. How certain are you that this is the choice you would make if it were an actual referendum?

1	☐	Very certain
2	☐	Somewhat certain
3	☐	Somewhat uncertain
4	☐	Very uncertain

43. How certain are you that this survey might actually influence government surveillance policy for CWD?

1	☐	Very certain

2	☐	Somewhat certain
3	☐	Somewhat uncertain
4	☐	Very uncertain

44. How certain are you that the increase in tax dollars you have considered might be the actual tax increase the government imposes to increase surveillance for CWD?

1	☐	Very certain
2	☐	Somewhat certain
3	☐	Somewhat uncertain
4	☐	Very uncertain

43. When placing your votes, how important was each of the following to you:

		Not important at all	Slightly important	Very important	Extremely important
		1	2	3	4
CWD prevalence rate in infected areas	1	☐	☐	☐	☐
Degree to which CWD has spread across the country	2	☐	☐	☐	☐
Change in annual taxes because of CWD surveillance program	3	☐	☐	☐	☐
Uncertainty about what is being done about CWD in other regions in Canada and in the United States	4	☐	☐	☐	☐

The type of surveillance programs which might be implemented to deal with CWD (Eg. Encouraging culling of animals in particular areas to increases number of tested animals versus encouraging more mandatory submission of heads from hunter harvest)	5	☐	☐	☐	☐

44. If you voted yes why would you vote yes to a proposed program? Please check all that apply

1. ☐ I think the tax increase is a small amount to pay for the benefits received.
2. ☐ I believe that we should eliminate CWD regardless of the cost.
3. ☐ I feel it (undertaking disease surveillance) is the "right" thing to do.
4. ☐ It is important to invest in maintaining healthy, CWD-free elk and deer herds.
5. ☐ The program is important but I don't think that the program will cost me directly.
6. ☐ I think that elk and/or deer are pests and should be eliminated with or without of CWD infection.
7. ☐ CWD may become a human health risk.
8. ☐ I believe that the government should limit the spread of CWD even if the disease cannot be eradicated.

45. If you voted No why would you vote no to a proposed surveillance program? Please check all that apply

1. ☐ I think the tax increase is a large amount to pay for the benefits received.
2. ☐ I believe that we cannot afford to eliminate CWD given the cost.
3. ☐ I feel it (undertaking disease surveillance) is not the "right" thing to do given other public priorities.
4. ☐ It is less important to invest in maintaining healthy, CWD-free elk and deer herds than to invest in other environmental problems.
5. ☐ The program is important but I think that the program will cost me directly too much money.
6. ☐ I think that elk and/or deer are pests and should be eliminated with or without CWD considerations.
7. ☐ Even if CWD may become a human health risk, it is not significant enough to warrant investment.
8. ☐ I believe that the government should limit the spread of CWD even if the disease cannot be eradicated.

45. For quality assurance purposes, select strongly agree.

	Strongly disagree	Disagree	Neither Disagree or Agree	Agree	Strongly Agree

	☐	☐	☐	☐	☐

46. To date provincial governments in CWD affected areas have conducted a variety of programs to address CWD in the wild. Please rate how acceptable the following provincial management programs would be to you on a scale from highly unacceptable to highly acceptable. (complete even if CWD has not been found in your province/region to date). (items will be randomized in survey delivery)

* The only effective method of testing for CWD currently is examination of brain or lymph tissue, requiring the submission of heads from killed animals to a government agency, Alberta Fish & Wildlife Division in Alberta for example, for testing. Similar tests are conducted in Yukon, Saskatchewan and Manitoba and occasionally in other provinces where there are concerns about the possibility of CWD.
** Hunters are required to obtain an appropriate tag to hunt an animal of a certain species within certain Wildlife Management Units (or regions of a particular province). In this example, a hunter would be issued a new tag if they submit the head for testing and therefore could hunt an additional animal.
***CWD can be transmitted through animal to animal contact with bodily fluids (saliva, urine, feces) and by animals carrying the disease shedding prions in the environment. The prions that are shed can be retained in the soil, grasses and other plants that grow in affected areas and through feed that has been contaminated by infected animals.

	Highly Unacceptable	Somewhat Unacceptable	Neither acceptable or unacceptable	Somewhat Acceptable	Highly Acceptable	Don't know
	1	2	3	4	5	6
Targeted Culling (reducing local population densities) of elk herds in the areas where CWD is most concentrated.	☐	☐	☐	☐	☐	☐
Targeted Culling (reducing local population densities) of deer herds in the areas where CWD is most concentrated.	☐	☐	☐	☐	☐	☐
Mandatory submission of heads* for testing in certain Wildlife Management Units (regions of a province)	☐	☐	☐	☐	☐	☐
Voluntary submission of heads* for the entire province.	☐	☐	☐	☐	☐	☐
Educational Materials placed on the webpage of the Fish and Wildlife section	☐	☐	☐	☐	☐	☐

of Alberta Environment and Parks or other similar provincial government agencies.						
Open public meetings to discuss CWD issues.	☐	☐	☐	☐	☐	☐
Mailouts and advertisements (educational materials) in local newspapers.	☐	☐	☐	☐	☐	☐
Freezer locations for deer head submission*.	☐	☐	☐	☐	☐	☐
Providing additional hunting tags** to hunters who submit the heads of their killed animals in certain Wildlife Management Units (eg. Alberta) or provincial regions	☐	☐	☐	☐	☐	☐
Take no action towards controlling CWD and simply allow it to run its natural course	☐	☐	☐	☐	☐	☐
Restrict baiting (using deer or elk urine to attract animals to areas to be hunted) of animals for hunting purposes	☐	☐	☐	☐	☐	☐
When vaccines are developed, implement vaccination program for wild deer, elk and moose	☐	☐	☐	☐	☐	☐
When technology allows the testing of material from live animals, subsidize data collection of different samples (fecal samples etc.) which could be used to monitor CWD spread	☐	☐	☐	☐	☐	☐

Thank You

APPENDIX 2: RISK LADDER

Risk Assessment

From IUCN guidelines for wildlife and domestic disease risk analysis

- Likelihood of susceptibility.
- Likelihood of exposure
- Severity for the population.

Question for risk assessment: What is the likelihood and what are the consequences of an identified hazard occurring within an identified pathway or event?'

Animal Risk Assessment for wildlife and Domestic animal Diseases

Disease	Infected Animals	Likelihood of exposure (Animals)	Severity for the population (Animals)	Code
Anthrax	Bison and Cervids, HORSES, GOATS	The organism can be spread within an area by pigs, dogs, wild birds, via water courses, and through faecal contamination of transports and articles by infected animals	Fatal for infected animals	6
Avian Flu	Birds	A virus through direct contact with infected waterfowl or other infected poultry, or through contact with surfaces that have been contaminated with the viruses.	Fatal for infected animals	6
Chronic Wasting Disease	Cervids	It is not known exactly how CWD is **transmitted**. The infectious agent may be passed in feces, urine or saliva. **Transmission** is thought to be lateral (from animal to animal).	Fatal for infected animals	6

Foot and mouth Disease	cattle; sheep; pigs; goats; deer;	The primary method of transmission within herds and flocks is by direct contact or via respiratory particles and droplets. Pigs are potent secretors of airborne viruses. Spread of	There is vaccination and treatment for infected animals	4
Mad Cow Disease	cattle, sheep and goats	A cow gets BSE by eating feed contaminated with parts that came from another cow that was sick with BSE.	Animals experience increased apprehension and nervousness, increased sensitivity to touch and sound, muscle tremors.	5
Moose Measles	Canine, Bear, Cougar, Cervids, Sheep	Transmitted through consumption of feces from infected animals	Not harmful beyond aesthetics	2
Orf (Contagious Echthyma)	Sheep and Goat	direct contact with scabs on infected animals.	Severely infected animals may be in poor condition	3
Papillomas (warts)	Cervids and any mammal	This condition is spread between animals by direct contact	Affected animals are usually in good body condition.	3
Plague	Fleam Rodents, Mink marten, bobcat lynx			
Rabies	Bat, any mammal	Vaccination for rabies exists. You can get rabies if you are bitten or licked by an	Rabid animals may also appear weak or paralyzed.	4

		infected animal or if saliva from an infected animal comes into contact with your skin, eyes, nose, lips, cuts or scratches.		
Ringworm	Any mammal	Ringworm occurs in skin lesions, contaminated skin flakes, hairs of infected mammals and birds, or as fungal spores in the environment.	Ringworm causes animals to have areas of thickened skin with hair loss over the head or legs.	2
Sarcoptic Mange	Canine	**transferred** between hosts through direct contact	. Badly affected animals are in poor body condition. Animals may appear weak and are fearless of people.	4
Tetanus	Any animal	The bacteria enter animals either through deep traumatic wounds, during parturition, or as a consequence of management procedures	Affected **animals** typically show stiffness and muscle spasms that progress in most cases until the **animal** collapses, dead.	5
Tuberculosis	Bison, Cervids, birds	Is spread by direct contact with material coughed up by infected animals and birds.	tuberculosis usually affects the lungs, causing difficulty breathing, coughing and discharges from the mouth or nose.	6

Tularemia	Tick, Hare rabbit,Beaver,Muskrat	Bite from a tick, through handling infected animals, eating or drinking contaminated food or water and breathing in the bacteria F. tularensis.	Animals may become lethargic or depressed and have high body temperatures. Tiny, pale spots on the liver, spleen or lung are typical lesions of tularemia.	3

Disease	**Infected Animals**	**Likelihood of susceptibility**	**Likelihood of exposure (Humans)**	**Severity for the population (Humans)**	
Anthrax	Bison and Cervids, HORSES, GOATS	YES!!!	Through cuts, open sores and scratches - Inhaling spores from contaminated materials, such as dust and grass - Eating undercooked meat	8 Bison Cervids Inhaled anthrax is fatal; avoid dead animals	6

Avian Flu	Birds	YES!	Spread from birds to people as a result of direct contact with infected birds, such as during home slaughter and plucking of infected poultry.	Can be fatal if not treated immediately	5
Chronic Wasting Disease	Cervids	No evidence at the present time that people can get it	unknown	Unknown	1
Foot and mouth Disease	cattle; sheep; pigs; goats; deer; camelids; buffalo; elephant	yes	Consumption of unpasteurised milk, dairy or unprocessed meat products from infected animals or as a result of direct contact with infected animal	Symptoms are mostly mild and self-limiting, including tingling blisters on the hands, feet and the mouth, sore throat, and fever.	4

Giant Liver Fluke	Cervids	NO	Liver flukes do NOT affect the meat	No risk to people	1
Hydatid Disease	Canine and cervids	YES!	The worms release eggs in the dog & wild canine feces, and eggs stick to their fur • The shed eggs can infect people	Gets worse with time and depends on organ affected	5
Mad Cow Disease	Cattle, sheep and goats	Yes (human variation) but very rare	Eating nerve tissue (the brain and spinal cord) of cattle infected with mad cow disease	Human infections are rare but can be fatal	6
Moose Measles	Canine, Bear,Cougar,Cervids,Sheep	No	Adult worms live & grow in the intestines of infected carnivores	No risk to people	1
Orf	Sheep and Goat	Yes	Yes, by contacting affected skin	May require medical attention & treatment	2

Papillomas (warts)	Cervids and any mammal	NO		NO risk to people	1
Plague	Fleam Rodents,Mink marten,bobcat lynx	YES!!	Being bitten by an infected rodent flea - Contact with abscesses on infected animals - Through bites and scratches - Inhaling infectious airborne droplets (rare)	Human infections are rare but can be severe	5
Rabies	Bat, any mammal	YES!!	From the bite or scratch of an infected animal - From saliva of infected animals that touches your eyes, nose, mouth, or skin wounds	Rabies is serious. Seek treatment as soon as possible if bitten by a wild animal	6
Ringworm	Any mammal	yes	Yes, by touching the skin & hair of infected	Beware: May require medical attention	2

			animals - Note: some types		
Sarcocystis	Duck, Birds	no		No known risk to people	1
Sarcoptic Mange (Scabie)	Canine	Yes	Low risk of infection though	Itchy, but rare and short lived;	2
Seroma (hydrocyst)	Any mammal	NO!!	They are not infectious	NO risk to people	1
Tetanus	Any animal	Yes!	a cut or wound. Even a tiny pinprick or a scratch can be an entry point for the bacteria, but deep puncture wounds or cuts are more likely to become infected.	. At least 10% of people who develop tetanus in Australia will die as a result of the disease.	5
Trichinellosis	Bear, Cougar	YES!	By eating undercooked bear or	No or mild symptoms most	5

			cougar meat infected with the Trichinella worm • You cannot get it from an infected person	common; can be fatal	
Tuberculosis	Bison,Cervids, birds	YES!	Inhaling bacteria from: open wounds, fluids from the mouth and nose, or feces of an infected animal - Directly through breaks in the skin (rare)	Gets worse with time; fatal if untreated	5

Tularemia	Tick, Hare rabbit,Beaver,Muskrat	YES!	Bites or scratches from infected wildlife - Contact with meat, water, feces, urine or body parts of infected animals - Breathing in dust from pelts and paws	Fever-like symptoms; early treatment reduces severity	**5**

Levels of confidence of risk of zoonotic transmission of animal diseases

Level 0: Not zoonotic—Evidence of lack of zoonotic potential. Good grounds for not taking further action

- Seroma
- Giant Liver Fluke
- Moose Measles.
- Warts

Level 1: Potential zoonosis—Possibility of human pathogenicity not excluded. Work needed on biomarkers of infection and pathways of exposure.

- Chronic Wasting Disease.

Level 2: Potential zoonosis—Serological evidence of infection, or human exposure has occurred but surveillance not sufficiently reliable. Enhanced surveillance needed

- CWD

Level 3: Confirmed zoonosis—Human cases have been reported, but evidence against person to person spread. Enhanced surveillance needed. Control exposure of humans to animals and environmental sources.

- Anthrax
- Avian flu
- Hydatid Disease (Tape Worm)
- Rabies
- Tetanus
- BSE

- Orf

Level 4: Confirmed zoonosis—Human cases have occurred, with subsequent person to person spread not excluded. Control of direct or indirect person to person spread needed

- Tuberculosis
- Plague
- Ringworm
- Sarcoptic mange (Scabies)

Human Health Risk Ladder

Disease	Risk Level
Tuberculosis	**High Risk**
Plague	
Anthrax	
Rabies	
Hydatid Disease	
Tetanus	
BSE	
Bird Flu	

Orf	**Medium Risk**
Scabies	
Ringworm	
Warts	**Low Risk**
Giant Liver Fluke	
Seroma	

Animal Health Risk Ladder

Disease	**Risk Level**
Bird Flu	**High Risk**
Tuberculosis	
CWD	
Anthrax	
BSE	**High**
Hydatid Disease	**Medium Risk**
Tetanus	

Foot and Mouth Disease	**Low Medium**
Rabies	
Scabies	
Tularemia	
Ringworm	**Low Risk**
Moose Measles	

APPENDIX 3: CORRELATION BETWEEN MYTHS OF NATURE AND VOTING YES TO THE REFERENDUM

	EGALITARIAN	***HIERACHIST***	***INDIVIDUALIST***	***FATALIST***	***YES VOTE***
EGALITARIAN	1				
HIERACHIST	-0.7980835	1			
INDIVIDUALIST	-0.1204477	-0.1421883	1		
FATALIST	-0.2594095	-0.3062326	-0.046217	1	
YES VOTE	0.08602351	0.045257	-0.1019999	-0.1749214	1

APPENDIX 4: DEMOGRAPHIC CHARACTERISTICS BY TREATMENT GROUP.

DEMOGRAPHIC CHARACTERISTICS BY TREATMENT GROUPS							
	AGE	IF CHILDREN IN HOUSE HOLD	HOUSE HOLD SIZE	GENDER (FEMALE)	YEARS OF EDUCATION	INCOME	LIVES IN CITY
Treatment 1							
Mean	47.18	0.23	2.32	0.47	14.94	65577.24	0.55
Standard Deviation	14.26	0.42	1.02	0.50	1.99	42415.05	0.50
Minimum	19.00	0.00	1.00	0.00	8.00	0.00	0.00
Maximum	65.00	1.00	4.00	1.00	18.00	120000.00	1.00
Treatment 2							
Mean	48.45	0.21	2.35	0.49	14.95	64685.06	0.51
Standard Deviation	13.82	0.40	1.01	0.50	2.08	42226.52	0.50
Minimum	19.00	0.00	1.00	0.00	8.00	0.00	0.00
Maximum	65.00	1.00	4.00	1.00	18.00	120000.00	1.00
Treatment 3							
Mean	48.25	0.21	2.29	0.47	14.93	61765.20	0.52
Standard Deviation	13.88	0.41	0.97	0.50	1.98	42503.39	0.50
Minimum	19.00	0.00	1.00	0.00	8.00	0.00	0.00
Maximum	65.00	1.00	4.00	1.00	18.00	120000.00	1.00
Treatment 4							
Mean	47.26	0.20	2.35	0.50	15.09	66558.26	0.56
Standard Deviation	14.61	0.40	0.99	0.50	2.05	42021.36	0.50

Minimum	19.00	0.00	1.00	0.00	8.00	0.00	0.00
Maximum	65.00	1.00	4.00	1.00	18.00	120000.00	1.00
Treatment 5							
Mean	47.89	0.19	2.27	0.47	14.96	67299.20	0.51
Standard Deviation	13.91	0.39	1.01	0.50	1.99	42964.96	0.50
Minimum	19.00	0.00	1.00	0.00	8.00	0.00	0.00
Maximum	65.00	1.00	4.00	1.00	18.00	120000.00	1.00
Treatment 6							
Mean	48.19	0.22	2.34	0.50	14.78	67031.51	0.50
Standard Deviation	13.96	0.42	0.98	0.50	2.05	41467.91	0.50
Minimum	19.00	0.00	1.00	0.00	8.00	0.00	0.00
Maximum	65.00	1.00	4.00	1.00	18.00	120000.00	1.00
Treatment 7							
Mean	47.38	0.19	2.25	0.50	14.78	67366.12	0.57
Standard Deviation	14.33	0.39	0.94	0.50	1.92	41649.82	0.50
Minimum	19.00	0.00	1.00	0.00	8.00	0.00	0.00
Maximum	65.00	1.00	4.00	1.00	18.00	120000.00	1.00
Treatment 8							
Mean	47.39	0.20	2.26	0.46	15.02	68384.27	0.53
Standard Deviation	14.27	0.40	1.00	0.50	2.05	43136.14	0.50
Minimum	19.00	0.00	1.00	0.00	8.00	0.00	0.00
Maximum	65.00	1.00	4.00	1.00	18.00	120000.00	1.00
Treatment 9							
Mean	47.11	0.22	2.31	0.52	14.96	66032.45	0.54
Standard Deviation	14.07	0.41	1.02	0.50	2.05	42200.48	0.50

Minimum	19.00	0.00	1.00	0.00	8.00	0.00	0.00
Maximum	65.00	1.00	4.00	1.00	18.00	120000.00	1.00
Treatment 10							
Mean	47.61	0.20	2.32	0.47	14.91	63974.19	0.54
Standard Deviation	14.23	0.40	1.00	0.50	1.97	44350.14	0.50
Minimum	19.00	0.00	1.00	0.00	8.00	0.00	0.00
Maximum	65.00	1.00	4.00	1.00	18.00	120000.00	1.00

APPENDIX 5: PERCENTAGE OF YES VOTES BY TREATMENT FOR THE ORIGINAL SAMPLE, CERTAINTY ADJUSTED SAMPLE, AND CERTAINTY ADJUSTED SAMPLE WHO PASSED TRAP QUESTION

Food Safety Risk Treatment 1				**Animal Health Risk** **Treatment 2**			
Price	**Original Sample**	**Certainty Adjusted Sample**	**Certainty and passed trap question**	**Price**	**Original Sample**	**Certainty Adjusted Sample**	**Certainty and passed trap question**
25	0.70	0.70	0.66	**25**	0.68	0.68	0.64
50	0.61	0.61	0.58	**50**	0.80	0.80	0.69
100	0.57	0.57	0.52	**100**	0.74	0.74	0.68
175	0.50	0.50	0.40	**175**	0.57	0.57	0.49
300	0.47	0.47	0.42	**300**	0.59	0.59	0.54
Economic Risk Treatment 3				**Food Safety then Animal Health Risk** **Treatment 4**			
25	0.64	0.64	0.62	**25**	0.72	0.72	0.68
50	0.74	0.74	0.66	**50**	0.79	0.79	0.69
100	0.66	0.66	0.63	**100**	0.68	0.68	0.51

175	0.60	0.81	0.55	**175**	0.59	0.59	0.55
300	0.55	0.80	0.53	**300**	0.57	0.57	0.57
Animal Health then Food Safety Risk Treatment 5				**Food Safety then Economic Risk** **Treatment 6**			
25	0.68	0.68	0.65	**25**	0.71	0.71	0.68
50	0.65	0.65	0.59	**50**	0.62	0.62	0.53
100	0.52	0.52	0.47	**100**	0.62	0.65	0.54
175	0.60	0.60	0.51	**175**	0.68	0.68	0.54
300	0.55	0.55	0.51	**300**	0.62	0.62	0.50
Economic then Food Safety Risk Treatment 7				**Animal Health then Economic Risk** **Treatment 8**			
25	0.64	0.64	0.59	**25**	0.68	0.55	0.56
50	0.72	0.72	0.69	**50**	0.75	0.72	0.73
100	0.67	0.67	0.54	**100**	0.63	0.55	0.63
175	0.51	0.51	0.43	**175**	0.62	0.53	0.52
300	0.46	0.46	0.41	**300**	0.54	0.46	0.48
Animal Health then Economic Risk Treatment 9				**Animal Health then Economic Risk** **Treatment 10**			
25	0.71	0.64	0.59	**25**	0.73	0.71	0.68
50	0.68	0.63	0.66	**50**	0.79	0.70	0.72
100	0.57	0.54	0.56	**100**	0.69	0.62	0.64
175	0.54	0.46	0.46	**175**	0.60	0.57	0.55
300	0.61	0.52	0.49	**300**	0.56	0.50	0.52