

Hunters' Knowledge, Attitudes, and Practice towards Wildlife Diseases in Ohio

Research Thesis

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By

Pallavi Oruganti

The Ohio State University

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Project Advisors: Professor Mark Moritz, Department of Anthropology
Professor Rebecca Garabed, Department of Veterinary Preventive Medicine

ABSTRACT

Ethnographic research is critical to understanding the human dimensions of wildlife diseases and management, as it allows us to understand the potential social contributors of disease transmission in specific populations. Hunters play a significant role in the ecology of wildlife disease because of their relationship with wildlife, especially in light of outbreaks of diseases such as Chronic Wasting Disease in whitetail deer. The aim of this project is to examine how hunters shape the ecology of infectious diseases.

Specifically, this project examines how Ohio hunters' knowledge, attitudes and practices affect risk exposure. Ethnographic methods including semi-structured interviews and grounded theory were used to collect and analyze data about hunters' knowledge, attitudes, and practices towards disease. Semi-structured interviews were conducted with twenty-one hunters from Southeast Ohio and surrounding areas, and an online survey was distributed to a random sample of licensed Ohio hunters. Data analyses suggest that hunters learn about wildlife disease through word-of-mouth, hunting publications and online sources, and that hunting practices are informed by these sources. However, hunters perceive low to no risk of exposure to infectious diseases. The results of this research allow us to better understand the role of hunters in the ecology of infectious wildlife diseases and allow us to identify interventions that would most effectively inform hunters about wildlife diseases and how to modify hunting practices as to minimize their risk of exposure to infectious diseases.

SUMMARY

The broader context and purpose of the study was to better understand the relationships between humans, wildlife, and livestock in the greater ecosystem context, especially in regards to infectious disease transmission and risk. The results of this study highlight the complexity of infectious disease and contribute to the fields of anthropology, veterinary medicine, environmental health, and public health.

INTRODUCTION

Hunters in the United States have a unique relationship to wildlife, and often stand at an interface of zoonotic disease transmission between three populations: humans, wildlife, and livestock. Research on the human dimensions of wildlife disease transmission however, is generally limited. Studies concerning hunters in the past in other states have focused on Chronic Wasting Disease and have revealed that hunters vary in their behavioral response to the disease (Vaske, 2010). Additionally, it has been found that perceptions of health risk do influence actual influence and stakeholder knowledge of infectious diseases does vary (Vaske, 2010). Examining the impact of human behavior in critical stakeholder populations can greatly contribute to our understanding of the ecology of infectious disease. Generally, human behavior plays an important role in the spread of infectious diseases and understanding the influence of behavior on the spread of diseases can be key to improving control efforts (Funk et al., 2010). In Ohio, hunter's perceptions and behavioral response to wildlife diseases need to be further examined, as

little is known about human beliefs, attitudes, and risk perceptions with respect to wildlife diseases or management of disease (Decker, 2006).

To do so, I examined three main questions to guide this research:

1. What are hunters' Knowledge, Attitudes, and Practices (KAP) with regard to wildlife diseases?
2. What is the relationship between hunters' Knowledge, Attitudes, and Practices?
3. How do Knowledge, Attitudes, and Practices affect risk exposure to wildlife diseases?

In order to address these main questions, I utilized the KAP framework integrated into ethnographic research methods. KAP assesses the knowledge, attitudes, and practices related to a specific health-related issue in the target population through the use of a survey divided into questions addressing knowledge, attitudes, and practices. The KAP survey is useful when the research plan is to obtain general information about public health knowledge regarding treatment and prevention practices or about sociological variables underlying these health behaviors (Launiala, 2009). As this is the goal of this research with hunters in Ohio and their perceptions, the KAP conceptual framework is appropriate and effective for this research. Furthermore, qualitative ethnographic survey methods were used to conduct semi-structured interviews. The interviews allowed for the development of a base cultural model to best develop the online survey that was more widely distributed. The methods used in this research are appropriate in addressing the main questions, as utilization of both ethnographic methods and the larger KAP survey allow a mix of both qualitative data and comparison with quantitative data from a broader sample. The methods used allow for a deeper understanding of knowledge, attitudes, and practices within the Ohio hunting populations,

but also the relationships between knowledge, attitudes, and practices and the socio-cultural motivations and factors underlying these relationships. The findings of this research add to our understanding of the relationships between animal health, human health, and ecosystem health, known as the concept of One Health (Zinsstag et al., 2011). Utilizing an interdisciplinary approach to health-related topics allows us to better develop engaging research that ultimately leads to better prevention, treatment, and education on public health issues worldwide, especially in regards to infectious disease.

Literature Review and Background

While there are many wildlife and zoonotic diseases that could be of concern to hunters, the most talked about and focused on in the realm of wildlife conservation and hunting is Chronic Wasting Disease. Chronic Wasting Disease (CWD) is a fatal, transmissible prion disease that affects captive and free-ranging deer, elk, and moose. The zoonotic potential of CWD is considered low, but many strains have been identified and much remains unknown, especially in regards to eradication and treatment (Saunders, 2012). In Ohio, there have been no major outbreaks of wildlife diseases that have caused widespread concern, but the threat of infectious disease spread throughout wildlife populations is ever present, especially when taking into consideration the increase in captive wildlife and breeding operations and the transport of wildlife across state lines. In Ohio, surveillance of Chronic Wasting Disease was focused on Holmes and Wayne counties, where several deer tested positive for CWD at a captive deer facility in 2014 (ODNR, 2015). In addition to CWD, other infectious diseases of concern for hunting populations

include Epizootic Hemorrhagic Disease (EHD), which affects ruminant species, in addition to zoonotic diseases such as Lyme Disease, Bovine Tuberculosis, Leptospirosis, and Rabies, which are associated both with contact with wildlife but also more generally with exposure during outdoor activities (AVMA, 2016).

In addition to epidemiological surveys of the prevalence and transmission of wildlife diseases across the United States, much research has been done examining the specific role that hunters' behavior plays in the ecosystem. Previous studies have been look at how infectious disease spread could potentially impact hunters and their activities. The majority of these studies have been done in areas where wildlife diseases affecting whitetail deer populations have been at a higher than normal prevalence. Previous researchers have examined hunters' behavioral intentions and response to CWD (Miller, 2003). These studies that were conducted after CWD was discovered showed that less than 10% of hunters expected to change their hunting frequency or location (Miller, 2003). However, they were likely to watch for abnormal behavior, test animals, or not eat the meat (Brown et al., 2006). Additionally, a survey in 2003 in Illinois following an outbreak of CWD demonstrated that presence of CWD did not affect hunting participation (Miller, 2009). Not only is it important to look at hunting behavior, but also how perception of risk of exposure impacts hunting practices and behavior. Risk perception is defined by the degree to which an individual discerns a threat from a specific source, and perceived risks affect human decision-making and behavior (Miller, 2009; Thompson & Dean, 1996). Understanding how hunter's perceive their risk of exposure, therefore, allows us to better understand how that perceived risk may influence hunting behavior, and thus actual risk of exposure to infectious diseases. Hunters who

perceive low risk of exposure to wildlife disease like CWD may then not change their behavior (Gore, 2009). This has potential implications for evaluating the role of risk perception in infectious disease spread in stakeholder populations like hunters.

How hunters acquire hunting and wildlife information and their attitudes are also important to understanding how behavior and risk perception are shaped. When asked, the majority of respondents listed print sources, followed by word of mouth through family and friends, showing that sources of information vary but focus on media and personal sources (Miller, 2009). Ethnographies and other cultural studies on hunters in the United States are fairly limited. What literature exists describe hunting as a learned social behavior that occurs mostly in rural areas where hunters are taught at an early age by family members (Heberlein, 1987). If hunting is indeed a learned social behavior, cultural factors in addition to social networks affect the transmission of hunting knowledge, and therefore practices. Attitudes towards wildlife disease also play a large role in perception of risk and hunting behavior. Previous studies in Wisconsin in relation to CWD reveal that it is difficult to change behavior through changing attitudes (Heberlein, 2009). Overall, hunters present a unique connection between wildlife and humans, as they interact directly with wildlife and often monitor wildlife closely in the areas they hunt. It is necessary to better understand this connection, and how these interactions develop in order to understand the role that infectious disease transmission plays in this relationship, and potentially how hunter behavior influences disease transmission. Understanding how hunters fit into the ecology of these infectious diseases in Ohio where there has not been a large scale outbreak of wildlife disease like CWD will be useful in preparing to prevent a larger scale outbreak and predict hunter behavior if

there was a larger public health threat that could have a more widespread impact on animal and human populations statewide.

Conceptual frameworks

My personal motivation to study this topic with these methods comes from my academic and personal interests and goals. As a pre-veterinary student, I am passionate about issues relating to wild and domesticated animal health and welfare. As an Anthropology student, I am curious about the ways that knowledge is acquired and shared, the link between knowledge and behavior, and more specifically how human behavior can influence health. Combining my two areas of interests, I am interested in examining the ways that human behavior can impact not only human health, but also ecosystem and animal health. An interest in both the behavioral and pathological drivers of disease spread in both human and animal populations drives my interest in this research project. My personal interest in this topic is to ultimately highlight the connections between environmental, human, and animal health and the importance of this type of interdisciplinary research to public health and the One Health initiative.

More specifically with this project, ethnography is used to understand the human dimensions of wildlife disease. Ethnography is a method of qualitative research that utilizes observation and detailed interviews to develop a narrative of the experiences of groups of people. Ethnography is a guiding framework of this project, as it serves as a basis for the methodology used to collect data about people's experiences in this study. Ethnographic methodology dictates how the data is collected and ultimately how it will

be analyzed. In the specific case of this project, the goal was to describe the experiences of hunters in Ohio in relation to wildlife disease and get a better understanding of how hunters develop their knowledge and attitudes, and practices regarding wildlife disease. Semi-structured interviews were conducted (Bernard, 2002) and descriptive questions were utilized to describe how hunting practices develop and ultimately impact risk of exposure to infectious disease (Spradley, 1979). To better characterize this, a model is developed to distinguish the relationships, or lack thereof, between the knowledge, attitudes, and practices presented in the data.

The examination of knowledge, attitudes, and practices to address the social determinants of health issues is known as the KAP model. The KAP model is one often used in public health research to understand attitudes towards disease (Vandamme, 2009). The KAP framework determines much of the specific format of the surveys and interviews, and is used to look at more of the specific points that can be taken from the data. With the KAP model, knowledge, attitudes, and practices are identified separately and then relationships between these three are discerned. From the KAP model, an even larger model of the transmission of the hunter knowledge, its impact on behavior, and then ultimately the impact on infectious disease ecology can be developed. The KAP model is appropriate for this research because it allows for collection of general information about public health knowledge regarding treatment and prevention practices and socio-cultural variables contributing to health behavior (Launiala, 2009). The limitations of KAP that are discussed often occur in the context where KAP is used as the sole instrument in the data collection. With this project, KAP is integrated in a larger ethnographic framework that allows for integration of both qualitative and quantitative

data. This interdisciplinary approach to the issues of infectious disease is effective and appropriate for this topic.

This study is part of a larger study conducted in the DECML research group, which is dedicated to modeling the ecology of infectious disease using the one health approach. The One Health approach is an approach to public health research and practice that examines the connections between human, animal, and environmental health as a whole to understand the dynamics of infectious disease worldwide (Zinsstag et al., 2011). The bases of One Health is that each one of these factors is inextricably linked, and that human, animal, and environmental factors influence each other and collectively contribute to and greatly impact ecosystem health (Rabinowitz et al., 2013). This is why One Health serves as a guiding theoretical framework for this research. The project being conducted by the DECML lab specifically is taking a community approach to preventing disease in domestic and non-domestic ruminants. For this project, methods in public health, epidemiology, veterinary medicine, and anthropological research methods have all contributed to assessing the various factors that contribute to disease transmission in the area of Southeast Ohio surrounding the Wilds, a non-domestic wildlife conservation facility. Data from the project has helped to get a better understanding of some of the practices surrounding disease prevention and animal management in the area, and also the prevalence of certain infectious diseases of economic concern in the area such as *Neospora caninum*. This portion of the project seeks to understand the role of a specific stakeholder, hunters, in the ecosystem and dynamics of disease transmission in this area utilizing using anthropological research methods. Overall, this study contributes to the larger goal of the lab to look at the various ecological dynamics of infectious diseases

both in the United States and globally. The ultimate purpose is to foster interdisciplinary research to understand the various factors that contribute to disease ecology.

With One Health, ethnographic methods, and disease ecology as driving frameworks for the study, I believe the frameworks are appropriate and rigorous. The interdisciplinary nature of the issue at hand calls upon theory and practices from varying fields, which these frameworks encompass through integration of anthropological theoretical frameworks as well as approaches used in public health and veterinary medicine. Furthermore, the conceptual framework is rigorous because it does call upon the view of the study from a variety of perspectives, and also uses research methods that are recursive and require constant review of not only the final data, but also of the methodology being used. Thus, with these perspectives, the theoretical frameworks chosen prove to be appropriate and rigorous.

Population and Study Area

Semi-structured interview participants were sampled from the counties of Southeast Ohio, including Guernsey, Noble, Morgan, Washington, Muskingum, Perry, and Delaware counties. The study area was chosen in the larger project due to the proximity of these areas to the Wilds, which presents a unique interface of wildlife, livestock, and humans, but also with the non-domestic animals on Wilds property that could potentially be impacted by infectious diseases in the area. Hunters in these Southeast Ohio counties were interviewed to see if the proximity to the Wilds had any impact on their attitudes and practices as well. Additionally, there is a strong tradition of hunting in the Southeast

part of Ohio, with hunters relying on hunting for food or for recreational purposes. The online survey was distributed to a larger sample of all licensed Ohio hunters from across the state from the Ohio Department of Natural Resources hunter database. This was done in order to compare the results from the interview data collected on hunters in Southeast Ohio. It should be noted that in the interview data, the sample was taken using snowball sampling. Furthermore, the hunters that were sampled for the online survey were those hunters who gave an email address to the ODNR, and thus may only represent a subset of the Ohio hunting population. There may be hunters in more rural areas or of certain age groups that may not have been as equally included with this sampling strategy. From the survey, 95% of participants were hunters of whitetail deer. On average, hunters have 27 years of experience hunting, with the range being from 80 years to 1 year. 95% of the respondents to the survey were male, with 5% thus being female. Respondents were from 80 out the 88 counties of Ohio, representing 90% of Ohio all counties. Average age of survey respondents was 46, with a range from 87 to 19. With this demographic data, we can see that this survey was still able to reach a diverse group of hunters based on age and geography, which gives perspective of hunters across Ohio in comparison to just one region of the state.

METHODS

The purpose of this study was to understand hunter knowledge and behavior about infectious wildlife diseases, and therefore an ethnographic approach was used to understand these relationships. The type of logic used throughout the research process

characterizes ethnographic methods. First, ethnography can be described as abductive, meaning a theory is derived from observations to account for those observations. Furthermore, ethnographic research is iterative, meaning the methodology is applied over and over again throughout the course of a piece of work (Agar 2006). Ethnographic research is also recursive, meaning that while you are constructing an explanation for a certain observation, you may encounter a question or observation within that process itself that leads you to yet another explanation or theory (Agar, 2006). In addition, ethnographic research looks at the meaning and context of the different points of views being sought out by the researcher that led to the abductive reasoning in the first place (Agar 2006). Ethnographic research is different from other social science research methods in that it seeks out patterns as opposed to variables (Agar 2006). All these qualities distinguish ethnographic methods from other qualitative research methods, and are why ethnographic research methods are used for this research. These features of ethnographic research will provide a perspective on the issues of wildlife diseases with hunting populations that has not been extensively used with these populations.

As part of the ethnographic approach, semi-structured interviews were conducted with twenty-one hunters in Southeast Ohio during the summer of 2014. In semi-structured interviews, an interview guide is used with set questions and order, but there is the ability for the researcher to follow leads at their own discretion in addition to the written questions. Semi-structured interviews combine the freedom of unstructured interviews with the structure of an interview guide (Bernard, 2002). This is an effective method, as the interview guide allows for reliable, comparable data, while also allowing flexibility and freedom to the researcher to pursue specific topics or leads during the

course of the interview (Bernard, 2002). This interview method is appropriate for this research in particular, as the informants were only to be interviewed once, and allowed for the majority of the content of the interview to be similar while still allowing room for informants to discuss topics or thoughts not included in the interview guide. This then allows for more development and edits of the interview guide for use in future interviews—an example of the iterative nature of ethnography.

Snowball sampling was utilized to acquire the participants for the interviews, starting with previous lab contacts at The Wilds, the Ohio Department of Natural Resources, and at the OSU School of Environment and Natural Resources. The interviews were conducted in several different locations depending on the location of the participant, spanning from offices at The Wilds, participants' homes, and even the Ohio Union. Each interview lasted about one hour depending on the participant responses to the questions.

A semi-structured interview guide was constructed dividing the interview into questions regarding knowledge, attitudes, practices, and demographic information, following the KAP approach and framework. This served as the guiding questions for the interview, with room for additional questions based on participant responses and the trajectory of the interview. The first section asked to describe the participant's hunting background and when they first started hunting. The next set of questions asked them to describe their hunting practices, including field dressing and preparation of meat after hunting. The following section asked the participant to describe where they get hunting information and information about wildlife disease. Following this, the next set of questions asked more about disease knowledge and perceptions of personal risk of exposure, including asking participants to free-list diseases they know to affect wildlife

(Weller and Romney, 1988). Finally, I concluded the interviews by asking them to describe their final thoughts of perceptions about wildlife diseases and hunting, and if they had any questions or ways to improve the survey. I also collected demographic information such as age, profession, county of residence and gender at the conclusion of the survey and interview.

After each interview was recorded, it was transcribed line-by-line. Using grounded theory, each interview transcription was analyzed and codes were developed based on the responses given by the hunters. These codes were then sorted and organized to construct a better understanding of the cultural model in place within the sample population regarding how knowledge about hunting and wildlife diseases was acquired and translated to practices. Using grounded theory, patterns in the data were interpreted to distinguish knowledge, attitudes, and practices, and whether there were connections between these three categories in regards to wildlife disease and hunting knowledge and behaviors. If there were connections, these types of connections were also distinguished and differentiated. This model allowed me to understand how, if at all, knowledge, attitudes, and practices were related in relation to infectious disease knowledge, hunting behavior, and ultimately risk of exposure based on these practices and knowledge.

In addition to the semi-structured interviews, an online survey was distributed to all Ohio hunters who provided email addresses to the ODNR. A random sample of 4,000 emails was sent from the full database of Ohio hunters. In total, 386 responses were collected from the email survey in addition to the 21 semi-structured interviews that were conducted. The online survey response rate was 8.9%. The online survey questions were also organized to ascertain specific information about knowledge, attitudes, and practices

and demographic information. Some questions asked participants to respond by scale, by selecting from multiple choices, by listing or filling in a response, or by indicating the extent they agree or disagree with a statement. This data was analyzed using qualitative research methods (coding) in order to identify knowledge, attitudes, and practices, and like previously if there were connections or not between these three components. Because it was an online survey, statistical analysis could be done on the responses to look at correlation between responses, which may indicate positive, negative, or no correlation between certain responses presented in the survey. This reveals patterns of behavior in the participants. Comparison can be made to the interview data, but was taken into consideration that this survey was only distributed to hunters who have an email address, and thus may only represent a subset of the total Ohio hunter population.

RESULTS

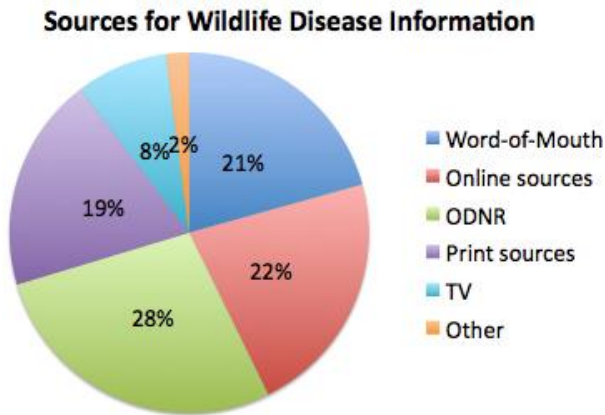
From the results of the survey, I wanted to identify the knowledge, attitudes, and practices that hunters have about hunting and wildlife diseases. Furthermore, I wanted to compare and correlate the responses in each of these sections to understand the interrelationships between knowledge, attitudes, and practices to better understand how these factors influence each other. Ultimately, the relationships between knowledge, attitudes, and practices can be used to understand hunters' potential risk of exposure to infectious wildlife diseases in their hunting practices.

What knowledge, attitudes, and practices (KAP) do hunters have about wildlife disease?

Knowledge

From the survey data, it was seen that hunters acquire hunting knowledge from a variety of sources. These include family members, friends, state wildlife agencies, word-of-mouth, Internet sources, and hunting magazines and publications. Through the data analysis, it was shown that there is a relationship between where hunters get information about general hunting information and where they get information about wildlife diseases (chi square = 84.44, df=40, p=0.00). This indicates that channels of acquiring general hunting knowledge may not be separated from channels of acquiring information about diseases. The data shows strong indication that the ODNR is the major source of information for both disease and general information. 80% of the respondents get their information about wildlife diseases from ODNR and 83% get general hunting information from the ODNR. This is followed by word of mouth (family 68%, friends 76%). When asked to rank which source of information they prefer, hunters indicated family and friends were most preferred, followed by ODNR and newspapers and magazines. Family and friends are especially important for the initial exposure to hunting practices, as one interview participant stated, “ My father and uncle, his brother, were big hunters. Just wanting to do what they did I guess is how I got into it at a really young, I just don’t remember not wanting to hunt.” Overall, data points to the ODNR and word-of-mouth as a major sources of information for hunters for both general hunting information as well as information about wildlife diseases. This indicates as well that the ODNR is a trusted source for this type of information in Ohio. Chart 1 shows the sources of information respondents indicated for wildlife disease information.

[Chart 1: Sources of wildlife information]

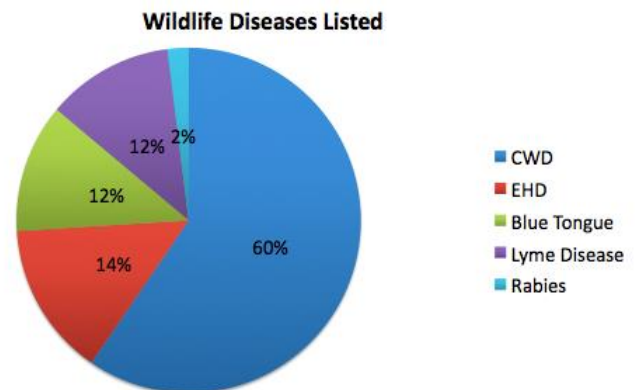


The survey data indicates no relationship between knowledge of disease prevention and perception of risk exposure (Chi square=25.48, df= 16, p=0.06). This means that those who agree that diseases can be transmitted

from animals to humans also perceive low risk of exposure to a wildlife disease through hunting. Just because a hunter may know about a wildlife disease and how to prevent exposure, that does not impact they perceive risk of exposure. Furthermore and more specifically, knowledge of zoonotic disease transmission alone was shown to not impact perception of risk exposure. (Chi-square: 57.44, DF: 16, p-value: 0.00). Public health messages related to wildlife diseases and targeted towards the hunting population in Ohio should therefore utilize the extended reach of the ODNR in order to best communicate with hunters in Ohio about public health concerns, education, and outreach.

Hunters were asked to free-list disease they knew to affect whitetail deer. The most commonly mentioned diseases were CWD, EHD, Blue Tongue, Rabies, and Lyme disease. Chart 2 shows that percentages of how often these disease were mentioned.

[Chart 2: Wildlife Diseases listed]



When asked to list other disease they knew to affect wildlife, hunters most often listed

rabies, distemper, tularemia, Lyme disease, and parasites. Hunters are able to list many wildlife diseases not associated with whitetail deer, but there was a higher response rate to the question focused on whitetail deer diseases.

Attitudes

From the interview data, we see that hunters in Southeast Ohio are generally not concerned about wildlife disease in the areas they hunt, and report they perceive little to no risk of personal exposure. Hunters perceive that most hunters in Ohio are not concerned or knowledgeable about wildlife diseases. Concern for disease prevention and related behaviors seem higher in more experienced or older hunters. Furthermore, hunters are more concerned about impacts on wildlife populations rather than impacts on their own health. From the online survey data, we see that ranking of whether Ohio hunters are knowledgeable about wildlife diseases is correlated with ranking of whether hunters are concerned about wildlife diseases. (chi-square: 159.25, DF: 16, p-value: 0.00). The data shows that 50 % of respondents indicated that Ohio hunters are concerned about wildlife diseases, while only 30% agreed or strongly agreed that hunters are knowledgeable about wildlife diseases. This generally agrees with the interview data, which indicated Ohio hunters are not knowledgeable about wildlife diseases and need to be more concerned. Overall, in terms of attitudes, this data shows that Ohio hunters are split about their perceived knowledge of diseases and concern over disease. Half believe Ohio hunters are concerned about disease, and less than a third believe that Ohio hunters are knowledgeable about wildlife disease. There is a statistical correlation between perceived personal risk of infection and agreement that wildlife diseases are more dangerous to

wildlife populations than to personal health. (Chi-square: 147.05, DF: 16, p-value: 0.00) 60% perceive no or low risk of being exposed to an infectious wildlife disease, while 50% strongly agree or agree that wildlife diseases are more dangerous to wildlife populations than their own health. This is reflected in the interview data, as one hunter noted, “But [diseases] haven’t been a problem in Ohio yet so its not a big deal for most Ohio hunters.” This data could indicate that hunters perceive low risk of being infected with a wildlife disease and also believe that wildlife diseases impact the wildlife population more than human populations.

The lack of statistically significant correlation in the cross-tabulation of the specific individual hunter health concerns versus general attitudes towards general hunter population health concerns about wildlife diseases indicates that there is no direct relationship between personal concerns of health and general population concerns of health. This contrasts with what was seen in the interview data, where multiple informants indicated that they were concerned about wildlife diseases, but expressed that the general hunting population was not. Looking at the data, half of respondents to the online survey agree that Ohio hunters are concerned and that wildlife diseases are a concern they personally have (50% indicated that were concerned or very concerned). This ultimately reveals information about the attitudes people have towards wildlife disease. About half of Ohio hunters are concerned about it, but their own personal concern does not have a relationship with their attitudes about what Ohio hunters may generally be concerned about in terms of health and safety. In the current environment of low wildlife disease prevalence in white-tailed deer populations, hunters are split about their level of concern over their perception of risk of exposure.

Practices

From the interview data it was seen that practices were informed by outside sources and information as well as the hunter's personal experience over time. Hunting practices were found to be motivated by maintaining safety and awareness with usage of weapons, the desire to harvest an animal, and keeping meat fresh in the file until it can be processed. Many practices discussed, though no intentionally done to prevent disease, help to prevent exposure to infectious disease such as wearing gloves to keep clean or the wear bug spray and bug nets to keep bugs away. The hunting process is best summarized in these steps based on the information from the interviews:

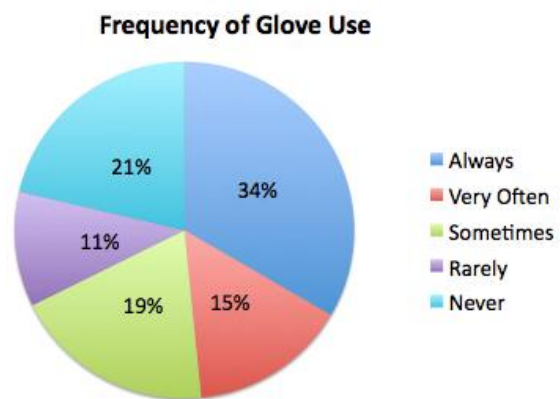
1. Preparation/scouting
2. Waiting/searching for target animal in a tree stand or blind
3. Taking the shot
4. Tracking shot animals if needed
5. Field dressing
6. Meat processing and distribution

Understanding the hunting process is important to understand what behavior may lead to risk of exposure to disease and also what motivation hunters have while in the field hunting.

When looking at the relationship between teaching hunting to others and hunting alone or with others, there is a statistically significant correlation (chi-square: 17.59, DF: 2, p-value: 0.00). Those who teach hunting also hunt both by themselves and with others. This indicates that practices related to knowledge sharing are related to hunting with others. This further highlights the hands-on nature of teaching of hunting practices that

was often described in the interview data, especially to family members and children. As one hunter interview noted, “ I try to teach people who don’t have any knowledge about hunting whether they want to hunt or not about why I hunt and why hunting is beneficial.” 76% of respondents indicated they taught hunting to a family member, and 64% indicated they taught hunting to a child/young adult.

When comparing what game people hunt versus whether they wear gloves when field dressing, there is not statistically significant correlation. This indicates that the type of hunter (by game) does not impact this type of risk-reducing behavior



[Chart 3: Frequency of Glove Use]

(wearing gloves) (Chi-square: 50.97, DF: 52, p-value: 0.51). Chart 3 shows the frequency of glove used as described by respondent. Once again, the data is split on this question with about 50% indicating using gloves “always “ or “very often”.

What is the relationship between hunters’ knowledge, attitudes, and practices?

Knowledge-Attitudes Relationship

The ranked responses for “There is enough information about wildlife diseases available to hunters” was cross tabulated with the responses for “ I would like to learn more about diseases in wildlife.” Examining the relationships between these two variables will show the relationship between knowledge and attitudes relating to wildlife diseases. Based on the cross-tabulation data, there is a statistically significant relationship between the two

questions (Chi-square 83.57, DF: 16, p-value: 0.00). Examining the data, we notice that agreement with the statement: "I would like to learn more about wildlife diseases" correlates with the disagreement with the statement that there is enough information about wildlife. This could indicate that hunters want to learn more about wildlife diseases, but believe there is not enough information about wildlife disease available to hunters. Cross-tabulation of ranking data for "I know what I can do to prevent spread of infectious wildlife diseases" and "How much risk do you believe there is of being exposed to or infected by a wildlife disease through hunting reveals no statistical significance between the two statements. This shows that there is no correlation between knowledge of disease prevention and perception of risk exposure (Chi square=25.48, df= 16, p=0.06). There is a correlation between agreement/disagreement that diseases can be transmitted from animals to humans (Chi-square: 57.44, DF: 16, p-value: 0.00). The data indicates that those who agree that diseases can be transmitted from animals to humans also perceive low risk of exposure to a wildlife disease through hunting. This indicates that it is not knowledge of zoonotic disease transmission alone that impacts risk exposure perception. This data indicates that knowledge does not necessarily impact attitudes in a certain way, and thus, looking at knowledge and attitudes in isolation does not allow us to understand how hunting behavior is impacted by base knowledge and general attitudes regarding wildlife disease and perceived risk of exposure.

Knowledge-Practices Relationship

When comparing the ranking responses for frequency of glove use and the knowledge of infectious transmission prevention practices, the lack of statistical significance in the data

indicates no relationship between knowledge and practices in regards to wearing gloves as a form of infectious disease transmission prevention. (Chi-square: 15.56, DF: 16, p-value: 0.48). Slightly less than 50% of respondents indicated that they always wear or often wear gloves, while 42% of respondents agree or strongly agree that they know what to do to prevent the spread of infectious disease. The lack of statistical relationship indicates that there could be no correlation between what hunters know and practice in regards to infectious disease prevention. This is very significant, as it shows that knowledge in itself does not impact not only attitudes, but also practices. This is of big consequence to public health education programming, and it indicates that knowledge in itself and “spreading the word” about certain public health messages may no be effective in causing behavioral change in hunting populations. Furthermore, there is no statistically significant correlation between contacting a wildlife officer after seeing a sick animal when hunting and the source of information used most often (Chi-square: 10.53, DF: 20, p-value: 0.96). This may indicate that this type of behavior is not learned from any one source in particular, and that this type of behavior could be learned either from ODNR suggestion or from personal sources. The critical link between knowledge and practices are attitudes, but that does not necessarily mean that knowledge in itself would impact attitudes, which would then impact practices.

Attitudes-Practices Relationship

Reasons for hunting (recreation, food source, etc.) were not correlated with the number of hours out actively hunting. These reasons for hunting alone are not predictors of time spent hunting, and ultimately risk exposure from time spent hunting. (Chi-square: 12.60,

DF: 15, p-value: 0.63). There was no correlation seen between having direct contact through wildlife and perceived risk of exposure (Chi-square: 5.00, DF: 4, p-value: 0.29). Being exposed to wildlife outside of hunting doesn't impact perception of exposure to wildlife diseases.. Generally, attitudes about wildlife disease were characterized by low perception of risk. Because of this, hunting practices were unaffected by the state of attitudes towards wildlife disease.

What are the hunters' potential risks of exposure to wildlife disease?

KAP and Risk Exposure

Hunters have varied sources of knowledge that shape their practices and attitudes towards wildlife diseases, which do in turn affect risk exposure and disease prevention. Perception of risk come from portrayal or risk from these knowledge sources, whether that be state departments, articles, or word—of-mouth. Current low perceived risk of exposure leads to decreased use of risk-reducing behaviors in the hunting practice. Also, however, there is a difference between applied knowledge and general knowledge. Hunters are aware of these diseases and their potential impact, but may not be actively preventing when they do not see an immediate risk to their health from their knowledge sources or from their own current experience in the field.

Based on hunter's description of hunting practices in both the interviews and survey, several potential risks of exposure could be identified. These include field dressing of deer and other game, insect bites, having regular contact with domestic animals or wildlife outside of hunting, feeding portions of game meta to domestic animal,

leaving viscera in the field after dressing, butchering and meat processing, cooking and ingesting meat improperly, and exposure to pathogens just from being outside in the woods for hunting activities (bacterial infections especially). There are many diseases that the ODNR and AVMA have listed to be potentially able to spread to hunters through the hunting practices. The level of risk of exposure depends on what game is being hunted, geographic area, and of course the prevalence of infectious, transmissible disease in the hunting area. Some of the disease that could have direct health effects for hunters include anaplasmosis, babesiosis, brucellosis, campylobacteriosis, cryptosporidiosis, tapeworms, ehrlichiosis, E. coli infections, giardiasis, hantavirus, leptospirosis, Lyme disease, Q fever, rabies, roundworm, toxoplasmosis, trichinosis, tuberculosis, tularemia, and in some areas West Nile virus (AVMA, 2016).

DISCUSSION

In summary, the results of this research show that hunters in Ohio have varied sources of knowledge, but indicate the ODNR and social networks as major resources. Hunters perceive low risk of exposure to wildlife and zoonotic disease but express interest in learning more about them. Hunters do not change their practices based on knowledge of wildlife diseases. Attitudes relating to level of perception of risk of exposure to wildlife disease play a large role in whether hunting practices are changed in response to wildlife disease. The distinction between general and applied knowledge regarding infectious disease explains why hunters are aware of these diseases but may not be actively preventing transmission in their hunting practices. Comparing these results to previous

studies of the hunter's behavioral response to wildlife disease, we see a similarity in the description of hunter's lack of perception of risk of exposure to wildlife diseases like CWD. Furthermore, this data reinforces previous findings that attitudes determine changes in practices, but attitudes are difficult to change with more knowledge alone. Interestingly, the results from this Ohio study show hunter's reliance on the ODNR as a main source of information for hunting and wildlife information, which contrasts with studies in Illinois, where the Department of Natural Resources was not as trusted as a main source of information regarding wildlife diseases. The results of this study highlight the complex relationships between knowledge, attitudes, and practices and the importance of the examining the role of human dimensions in looking at wildlife populations and infectious disease ecology in the state of Ohio and beyond.

Theoretical Contributions

Theoretically, this study emphasizes the importance of One Health type research and initiatives and the contribution that interdisciplinary research can make to the study of emerging infectious diseases in the US. This project shows the very complex relationships between human behavior, environmental health, and animal health. Interdisciplinary type approaches like this are key to addressing the varying factors contributing the ecosystem health, and issues within ecosystem health such as infectious disease spread and wildlife conservation (Buttke, 2015). Specifically in the examining the role of wildlife health in this "One Health" approach, there are several implications for not only wildlife conservation in the sense of infectious disease transmission and

prevention, but also in how specific stakeholders may react to wildlife disease. For example, wildlife disease may influence the number of hunters, which in turn can impact wildlife population numbers either positively or negatively (Buttke, 2015). Thus, continuing to apply a One Health approach in specific populations like hunters can help us understand the greater context of infectious disease and the various factors that play into these risk environments.

Practically, It is necessary to examine the relationships among KAP to understand how it impacts behavior and overall disease risk. To effectively address any gaps in knowledge about disease risk, it is important to understand how individuals perceive wildlife-associated disease so that risk messages are relayed in ways that effectively inform people (Decker et al., 2012). Understanding KAP allows us to best tailor public health education and information for communities based on the way they gain knowledge and in a way that would best reduce high-risk practices within current practices. Overall this study sheds light on the need to increase research on the human dimensions of wildlife diseases and to better understand how human relationships with wildlife can impact infectious disease spread, and ultimately public health.

Furthermore, the complex relationships between knowledge, attitudes, and practices highlight the importance of the use of ethnographic for these types of study. Ethnographic methods allowed for thorough responses on these types of questions directly characterized in the own words of the informant. Qualitative data like what was collected in this study contributes greatly to looking at infectious disease and public health, especially in an ecological context. Infectious diseases cannot be understood through biology alone but rather must be considered within the context of the cultural and

social worlds they inhabit (Singer, 2014). With ethnographic interviews and the KAP survey, the interrelationships between cultural and biological drivers of infectious disease can be determined and the relationships between them can be characterized and modeled. This can then assist in conducting future research or in development of public health programming.

Strengths and Limitations of Study

Due to the ethnographic approach used, the main strength of this study is the description of knowledge, attitudes, and practices of hunters in regard to wildlife disease that comes directly from the source (Bernard, 2002). The in-depth interviews gave much insight into knowledge, attitudes, and practices of hunters in the study area, and hunters were able to describe their experiences in context and in their own words. Open-ended questions encouraged original responses, and this descriptive data allowed for examination of relationships between knowledge, attitudes, and practices instead of solely identifying these three as separate entities. With this, we could not only see what hunters do, but also why they do it. It is this understanding of motivations and overlapping relationships between knowledge, attitudes, and practices that allowed for the development of a cultural model reflecting the relationship between hunters and wildlife disease in their behavioral practices. From this data, the online survey could be developed in an appropriate way that modeled the pattern of responses seen in the interview data. The inclusion of a larger, online survey distributed across Ohio expanded

the relevance of the study outside of Southeast Ohio. The data following the survey, thus, is more representative of hunters across Ohio of various backgrounds.

In addition to the several strengths of the study design, there are of course limitations as well. First, while much information was gained from the semi-structured interviews, the sample size (21 interviews) was small. Furthermore, the sampling strategy for the interviews many represent a different population than the general Ohio hunting population, as I interviewed many individuals who worked in wildlife and conservation and so may have more expertise on this subject. Also, because of the snowball sampling, the subjects interviewed were often related or in the same social circles. This could have accounted for some trends in the interview data that was collected. While the online survey helps to diversify the data with a random sampling technique, this survey was once again only distributed to hunters who have an email address, which may be considered only a subset of the population of Ohio hunters. Furthermore, only one female participant was interviewed out of 21 interviews, and only 5% of online survey respondents were female. It would be interesting to expand the amount of women in the study to see if gender has an impact on hunting experiences and practices. Additionally, it could be beneficial to expand interviews with hunters to areas outside of Southeast Ohio, since the proximity to the Wilds did not seem to play a factor in hunter behavior and knowledge. Interviews could be conducted in Holmes and Wayne County where CWD surveillance was in place in the 2015-2016 hunting season following positive detection of the disease in 2014. It would be interesting to see if this surveillance and other news regarding CWD in the area affect hunting practices and behavior in an area that has been impacted by an infectious disease of high concern. While the KAP

framework was determined to be rigorous and appropriate for this study, it is also important to understand its limitations. The KAP model is one often used in public health research, but even so there are both strengths and limitations to using the KAP framework itself. This is because utilizing KAP may assume that the behavior of your study population can be characterized within these three subheadings and that indeed there is some relationship between the three. There is no standard measure of viability for KAP surveys (Vandamme, 2009), but the incorporation of the KAP framework in to qualitative interview methods provides context for responses, therefore supplying reliability and viability of the KAP framework.

Future Directions

Further investigation on this topic would involve participant observation of hunters in Ohio to assess if the practices and behaviors detailed in the interview data are reflected in actual hunting practices. Furthermore, an expanded survey in other states can assess the impact of geography and varying wildlife populations and disease prevalence on hunting behavior. An increased focus on hunting practices and the specific links to disease spread can also be studied by coupling this type of qualitative research with actual understanding of the prevalence of wildlife and zoonotic disease among Ohio hunters and hunting areas. This can also be expanded beyond hunting, but also to increased focus on meat preparation and distribution. Continued interdisciplinary research in the field of infectious disease and wildlife conservation can only add to the expanding understanding of the ecology of emerging infectious diseases. This type of

research can be extended beyond just hunters to other stakeholders such as farmers, wildlife workers, and others who have relationships and connections to animal populations and the greater environment.

Practical Implications

The findings of this research add to the knowledge of base for several fields, and can act as a starting point for future research and public health outreach. Within anthropology, this study adds to the description of the relationships between humans and the environment, especially in context of infectious disease transmission. In veterinary medicine and wildlife conservation, this type of research helps to better characterize the cycle of infectious diseases in a greater, ecosystem context in which humans may play a larger role. It reminds us that infectious disease transmission does not occur simply due to pathological and biological drivers. The integration of cultural perspectives when looking at veterinary and wildlife issues gives the bigger picture of infectious diseases in the natural environment. For the field of public health, this type of research highlights the need to understand the various drivers of disease that should be considered when designing public health education, prevention and treatment programs that are effective in stakeholder populations.

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APPENDIX

Online Survey Instrument

Hunters and Wildlife Diseases

Q5 1. Hunting Procedures and Practices

First, this section will ask you specifics about how you hunt

Q6 What game do you typically hunt? (Select all that apply)

- White-tail deer (1)
- Turkey (2)
- Squirrel (3)
- Raccoon (4)
- Coyote (5)
- Rabbit (6)
- Duck (7)
- Dove (8)
- Pheasant (9)
- Quail (10)
- Wild Boar (11)
- Woodcock (12)
- Grouse (13)
- Other (14)

Q7 Approximately how many days out of the year do you hunt in total?

- 1-5 (1)
- 6-10 (2)
- 11-15 (3)
- 16-20 (4)
- 21-25 (5)
- 26-30 (6)
- 31-40 (7)
- 41 or more (8)

Q8 Do you wear or use any forms of personal protection or safety gear when you hunt?

- Yes (1)
- No (2)
- Sometimes (3)

Q9 If you answered yes to the previous question, what types of personal protection/safety gear do you wear or use?

Q10 How many hours are you out actively hunting on each trip, on average?

- 1-3 hours (1)
- 4-10 hours (2)
- 11-15 hours (3)
- 16 or more hours (4)

Q11 Do you hunt by yourself or with others?

- By myself only (1)
- With others only (2)
- Both (3)

Q12 If you hunt with others, who do you typically hunt with? (Select all that apply)

- Family (1)
- Friends (2)
- Hunting Club/Organization (3)
- I don't hunt with others (4)
- Other (5)

Q13 Do you teach hunting, or have you taught others how to hunt?

- Yes (1)
- No (2)

Q14 If you answered yes to the previous question, who have you taught hunting to?

- Family member (1)
- Friend (2)
- Child/Young adult (3)
- Someone older than you (4)
- I taught as a formal hunter education instructor (5)
- Other (6)

Q15 1. Hunting Procedures and Practices (cont.)

Q16 Indicate how often you do the action that is indicated in each statement below

	Never (1)	Rarely (2)	Sometimes (3)	Very Often (4)	Always (5)
I field dress the hunted game myself (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I leave the organs/guts of a field dressed animal in the field (e.g. in the woods) (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I wear gloves when field dressing (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I process the meat of hunted game myself (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I take hunted game to a meat processor (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q17 Indicate the degree to which you agree or disagree with the following statements below

	Strongly Disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)
If an animal does not look healthy, I will not shoot it (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If I saw an animal that appears sick, I would contact my local wildlife office or officer (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q18 I have direct contact with wildlife other than through hunting

- Yes (1)
- No (2)

Q19 If yes, what is the nature of that contact, and how often do you have contact with wildlife outside of hunting?

Q20 Do you own any dogs? If so how many?

- Yes, 1 dog (1)
- Yes, 2 dogs (2)
- Yes, 3 or more dogs (3)
- No, I don't own any dogs (4)

Q21 If you have dogs, do you feed any meat, organs, or scraps of hunted game to your dogs?

- Yes (1)
- No (2)
- Sometimes (3)
- I do not own any dogs (4)

Q22 What is the main function of the dog or dogs you own? Please indicate for up to 5 dogs you own. Skip this question if you do not own any dogs

	Pet (1)	Hunting Dog (2)	Livestock Guard (3)	Herding (4)	Other (5)
Dog 1 (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dog 2 (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dog 3 (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dog 4 (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dog 5 (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q23 2. Hunting Information Next, we would like to ask you about how you gain information and knowledge about hunting and what hunting resources you use.

Q24 From whom did you first learn to hunt? (Select all that apply)

- Family (1)
- Friend (2)
- Self-taught (3)
- Other (4)

Q25 Have you ever taken a Hunter Education course?

- Yes (1)
- No (2)

Q26 If you have taken a hunter education course, in what year did you complete it?

Q27 What sources do you use for hunting information, news, and tips? (Select all that apply)

- Family (1)
- Friends/Colleagues (2)
- Magazines/Newspapers (3)
- ODNR, Division of Wildlife (4)
- Online Sources of websites (5)
- Social Media (Facebook, Twitter, Instagram, etc) (6)
- Hunting Organizations/Clubs (7)
- Shops/Stores/Businesses (8)
- Other (9)

Q28 Rank the following 8 sources of hunting information in order of which source you prefer to use most often, with 1 being the source you prefer most. Drag each item with your cursor into your desired ranking.

- ____ Family (1)
- ____ Friends/Colleagues (2)
- ____ Magazines/Newspapers (3)
- ____ ODNR, Division of Wildlife (4)
- ____ Online sources or websites (5)
- ____ Social Media (Facebook, Twitter, etc) (6)
- ____ Hunting Organizations/Clubs (7)
- ____ Shops/Stores/Businesses (8)

Q29 Why do you hunt? (Select all that apply)

- Recreation/Sporting Activity (1)
- Food source (2)
- Social activity (3)
- Crop control (4)
- Wildlife population/predation control (5)
- Other (6)

Q30 3. Wildlife Diseases Next, we would like to ask about your attitudes and perceptions of wildlife diseases and hunting.

Q31 Do you have any health and safety concerns as a hunter?

- Yes (1)
- No (2)
- Somewhat (3)

Q32 If so, what health and safety concerns do you have? (Select all that apply)

- Wildlife disease/infectious disease (1)
- Injury or other illness (2)
- Firearm/weapons safety (3)
- Other (4)

Q33 List all the diseases you know to affect white-tail deer(Separate each with a comma)

Q34 List any other wildlife diseases you are aware of (separate each with a comma)

Q35 3. Wildlife Diseases (cont.)

Q36 Rank how much you agree or disagree with each statement below:

	Strongly Disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)
"Diseases can be transmitted from animals to humans" (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
"Ohio hunters are knowledgeable and aware of diseases that affect wildlife populations" (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
"I find that Ohio hunters are concerned about wildlife diseases" (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
"I know what I can do to prevent spread of infectious wildlife diseases" (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
"Wildlife diseases are more dangerous to wildlife populations than my own health" (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
"There is enough information about wildlife diseases available to hunters" (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
"I would like to learn more about diseases in wildlife" (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q37 Rank your response to the question below from No risk to Very high risk.

	No Risk (1)	Low Risk (2)	Neutral (3)	High Risk (4)	Very High Risk (5)
How much risk do you believe there is of being exposed to or infected by a wildlife disease through hunting? (1)	○	○	○	○	○

Q38 Where do you get information about diseases in wildlife? (Select all that apply)

- Word of mouth (family, friends, etc) (1)
- online articles/websites/social media (2)
- ODNR/Division of Wildlife (3)
- Magazines/Newspapers (4)
- TV (5)
- Other (6)

Q39 4. Demographic Information Finally, we would like to ask some questions about your personal background. Any personal information will not be shared outside the study without your consent

Q40 What is your age?

Q41 How long have you been hunting? (in years)

Q42 What is your gender?

- Male (1)
- Female (2)
- Other (3)

Q43 What is your occupation?

Q44 What is your city/town of residence?

Q45 What is your county of residence?

Q46 Please list all the Ohio counties where you currently hunt (Separate each with a comma)

Q47 Have you ever hunted outside of Ohio?

Yes (1)

No (2)

Q48 Please lists the states outside of Ohio where you have hunted, or leave this section blank if you only hunt in Ohio (separate each with a comma)

Q49 If you have hunted outside of the United States, please list the other countries where you have hunted (separate each with a comma, leave this blank if you have only hunted in the US)