THE HUMAN ELEMENT OF WILDLIFE HEALTH: MENTAL MODELS, RISK
PERCEPTIONS, AND ATTITUDES TOWARD WILDLIFE DISEASE MANAGEMENT

By

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ABSTRACT

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Wildlife disease management, like other types of wildlife management, influences, and is

influenced by, biological, ecological, and social components of the management system. Human

dimensions research provides insights for the development of management objectives and

communication messages that incorporate societal values. To increase knowledge and

understanding of human dimensions aspects of wildlife disease management, my research

objectives were to: (1) reveal expert mental models of wildlife health and disease; (2) reveal lay

person mental models of wildlife health and disease and wildlife disease management; (3)

determine key variables that influence stakeholders' wildlife disease risk perceptions; and (4)

assess factors that contribute to explaining public acceptance of wildlife disease management.

Objectives 1 and 2 were accomplished using qualitative, exploratory methods (focus groups and

the Delphi method) to promote better understanding of how experts and laypersons conceptualize

wildlife health and disease and to develop mental models representing these conceptualizations.

Objectives 3 and 4 were accomplished using a survey questionnaire mailed to a random,

nationwide sample to characterize wildlife disease risk perceptions and attitudes toward wildlife

disease management and to assess sociodemographic and social psychological factors that

influence these variables. Expert (n = 18) and layperson (n = 34) mental models of wildlife

health had several common conceptualizations, including sustainable populations, healthy

animals, habitat quality, and ecosystem health. One key difference was that experts were more

likely to view disease as being made worse by humans while laypersons were more likely to

view it as a natural phenomenon. Focus group participants viewed wildlife health as important and most did not have serious personal health concerns related to zoonotic diseases. In the survey, mean risk perception for three zoonotic diseases (rabies, plague, West Nile virus) using the constructs of severity, susceptibility, and dread was moderate (2.5 on a 1 to 4 scale). Respondents perceived zoonotic disease risk to be greater for wildlife than for humans and held higher risk perceptions for rabies and West Nile virus than plague. The four most important predictors of disease risk perceptions were gender, education, prior exposure to the disease, and concern for health. With regard to attitudes toward wildlife disease management, there was strong disagreement with allowing disease to run its course and agreement was strongest for the options of public education and non-lethal management. Across all management options, agreement was greatest when the goal of wildlife disease management was to protect "one health" and least when the goal was to protect health of pets; these differences were statistically significant but not large. The best predictor of agreement was whether respondents believed wildlife disease management was likely to result in benefits they considered important. A modified Health Belief Model consisting of six variables (perceived risk severity and susceptibility, concern for health, exposure to zoonotic disease, social trust, and belief in management being likely to result in important benefits) was found to be a good fit to the data, thus supporting it as a useful model for understanding stakeholder evaluations of wildlife disease management. Together, these findings provide insights to help managers better communicate with stakeholders about wildlife health and disease and to managers to better incorporate stakeholder perspectives into management decisions.

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CHAPTER 1

INTRODUCTION AND ORGANIZATION

"Resource problems are not really environmental problems: They are human problems that we have created at many times and in many places, under a variety of political, social, and economic systems." (Ludwig et al. 1993)

"The public has very strong opinions about their resources, how we manage them, and how they use them... Planning for the cultural, social, and political consequences of disease incidents should be viewed as an essential and primary outcome." (Michigan Department of Natural Resources Director, Rebecca Humphries, testimony to the U.S. Senate, July 8, 2009)

Wildlife diseases present a great challenge for the field of wildlife management (Decker et al. 2006, AFWA 2007). In recent years, pathogens have emerged that threaten human and animal health (e.g., avian influenza virus) while others, such as chronic wasting disease, have spread geographically, threatening the health of important wildlife populations. Other diseases, such as rabies and plague, have affected humans and animals for hundreds of years yet continue to cause concern. Maintaining healthy wildlife populations has long been recognized as an important goal in wildlife management, yet fisheries and wildlife agencies in the United States continue to face multiple threats to animal and population health (AFWA 2007). Brucellosis in bison; rabies in raccoons, skunks, and foxes; West Nile virus in migratory bird populations; white nose syndrome in bats; chytridiomycosis in amphibians—these are just a few examples of the many threats to the health of wildlife populations, and to human and domestic animal health in some cases. Stakeholder reactions to wildlife disease, their ability to support or oppose its management, and the demands they place on wildlife agencies have changed as attitudes and risk perceptions associated with wildlife diseases, new and old, have evolved. Furthermore, the presence of disease has the potential to alter how humans value wildlife which could result in

diminished public support for conservation of certain species if wildlife are viewed as vectors of disease (Decker et al. 2011).

All of these factors help make the social component of wildlife disease management highly complex (Peterson et al. 2006) and the need still exists to better integrate biological and social insights in wildlife disease management (Decker et al. 2006). Given the increase in disease risks and the uncertainty surrounding public reaction to these risks and their management, wildlife disease management decisions are not only biological or epidemiological in nature. Key elements of wildlife disease management include knowing the ecology or epidemiology of the disease, creating appropriate levels of public awareness about the disease, and implementation of sound, socially acceptable management strategies (Friend 2006, Decker et al. 2006). The latter two strategies require knowledge of stakeholder values, beliefs, and attitudes toward wildlife health and disease issues and stakeholder responses to disease risks and wildlife disease management interventions. A particular challenge facing decision makers is how to appropriately contextualize wildlife disease related risk communication in light of public understanding of those risks. Efforts to develop successful communication efforts and gain public support for management strategies will benefit from knowledge of stakeholder values, beliefs, risk perceptions, and attitudes.

Research on human dimensions aspects of wildlife health and disease management is quite limited and there are important gaps in the literature. Most publications have been published since 2004 and many are focused on hunters and chronic wasting disease (e.g., Brown et al. 2006, Needham and Vaske 2008, Needham et al. 2004, Vaske et al. 2004, Miller and Shelby 2009, Evensen 2011). There has been practically no discussion of conceptual aspects of "wildlife health" (e.g., descriptive and normative meanings of the term). Much has been written

about forest, river, stream, and ecosystem health (Steedman 1994, DellaSala et al. 1995, Scrimgeour and Wicklum 1996, Meyer 1997, Boulton 1999, Lackey 2001) but efforts to develop a common conceptual understanding of wildlife health are lacking. Since promoting wildlife health is one of the primary objectives of many wildlife disease management interventions, clarification of lay and expert mental models of wildlife health is important to identify key similarities and differences and to develop a normative model of wildlife health.

Another knowledge gap entails determining key variables that influence understanding of and concerns about wildlife disease. A key part of understanding human health concerns related to wildlife disease is to investigate factors associated with risk perception. Risk perception research is also essential to developing effective management strategies and risk communications (Vaske et al. 2009, Evensen 2011). Finally, determination of key factors that influence public acceptance of wildlife disease management is another area in need of further investigation. Factors that have been found to play an important role in influencing acceptance of wildlife management (in general) include: normative beliefs (Zinn et al. 1998); situational specifics related to incident extremity and management response (Manfredo et al. 1998, Loker et al. 1999, Reiter et al. 1999, Fulton et al. 2004, Jonker et al. 2009); risk perceptions (Needham et al. 2004, Peterson et al. 2006); social trust (Vaske et al. 2004, Needham and Vaske 2008); wildlife value orientations (Zinn et al. 1998); and beliefs and attitudes about management actions (Fulton et al. 2004, Dorn and Mertig 2005, Bruskotter et al. 2009). Several studies have shown that as risks to human health and safety increase, agreement with more drastic management strategies increases, yet little is known about the influence of risks of other types (e.g., threats to wildlife or ecosystem health) or effects of theoretical factors on wildlife disease management specifically.

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This dissertation, "The human element of wildlife health: mental models, risk perceptions, and attitudes toward wildlife disease management," aimed to increase the capacity of natural resource agencies to address wildlife disease issues by improving knowledge and understanding of factors that influence stakeholder beliefs and attitudes toward wildlife health and disease and toward management interventions that promote healthy wildlife resources. This research supports the National Fish and Wildlife Health Initiative (NFWHI), a policy framework developed by the Association of Fish and Wildlife Agencies with the aim of helping agencies "conserve, restore, and enhance healthy fish and wildlife resources of the United States" (AFWA 2007). Funding for this research was provided by a Multistate Conservation Grant, a Michigan State University Distinguished Fellowship award, and a Safari Club International Michigan Involvement Committee scholarship.

The research objectives guiding this dissertation were to: (1) reveal expert mental models of wildlife health and disease; (2) reveal layperson mental models of wildlife health and disease and wildlife disease management; (3) determine key variables that influence stakeholders' wildlife disease risk perceptions; and (4) assess factors that contribute to explaining public acceptance of wildlife disease management. I chose to accomplish these objectives using a mixed methods approach beginning with a qualitative phase (focus groups and the Delphi method) and followed by a quantitative phase (survey questionnaire).

This dissertation is written as four separate manuscripts, plus introductory and concluding chapters. Chapters 2, 3, and 4 are written in the format of a scientific paper and have been or will be submitted for publication in professional wildlife-related journals. Chapter 2, which was published in the Wildlife Society Bulletin in September 2012, integrates the findings of an extensive literature review on wildlife health and a Delphi exercise and relates most directly to

objective 1. Chapter 3 shares results from focus groups with lay stakeholders and relates most directly to objective 2. Chapter 4, which was submitted to the Journal of Wildlife Diseases in February 2013, highlights findings from the mail survey and relates most directly to objective 3. Chapter 5 also presents findings from the mail survey and relates most directly to objective 4. Finally, in chapter 6, I make recommendations by synthesizing and drawing from the research results as a whole.

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CHAPTER 2

PROMOTING WILDLIFE HEALTH OR FIGHTING WILDLIFE DISEASE: INSIGHTS FROM HISTORY, PHILOSOPHY, AND SCIENCE

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ABSTRACT Although healthy wildlife populations are often a goal of wildlife management, ambiguity over the meaning of the term health may limit its effectiveness in guiding management objectives. Health is a complex concept with empirical and normative qualities; if it is to convey more than simply metaphorical value in wildlife conservation, clearer articulation of the meaning of wildlife health is needed. We provide a brief overview of the evolution of wildlife disease and health management, discuss important philosophical themes relevant to developing a clarified understanding of wildlife health, and share perspectives on wildlife health and disease from a Delphi exercise involving North American wildlife health professionals. The Delphi group conceptualized wildlife health as a multidisciplinary concept marked predominantly by population sustainability and resilience. Disease was considered to be a specific abnormal condition that is a part of the broader concept of health. We suggest improved integration of the descriptive and normative elements of wildlife health and greater inclusion of societal values in developing wildlife health objectives as a means to broaden the scope and effectiveness of wildlife health management. This paper has been previously published and the

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INTRODUCTION

The concept of wildlife health is increasingly considered a cornerstone of wildlife

management and, with greater attention being given to the role of wildlife in zoonotic disease

management, is viewed as a key element in protecting human and animal health (Friend 2006,

Wobeser 2006, Decker et al. 2011). The wildlife veterinary field has recently taken steps toward

an emphasis on health, led in part by the influence of conservation medicine (Daszak et al. 2004)

and the promotion of a One Health approach (King et al. 2008). The Association of Fish and

Wildlife Agencies recently developed a National Fish and Wildlife Health Initiative, designed to

enable state agencies to build capacity for management of healthy fish and wildlife resources

(AFWA 2007). Similarly, the National Park Service has initiated the Yellowstone Wildlife

Health Program, a multi-disciplinary program aimed at restoring healthy wildlife within the

Greater Yellowstone Ecosystem (National Park Service 2007).

This increasing orientation toward the notion of health, however, is potentially

problematic. The concept of health is not purely a scientific one in the biological-

epidemiological sense (Temkin 1977, Ehrenfeld 1993); because it is concerned with a desired

condition (e.g., healthy animals or populations) it has normative implications (Meyer 1997,

Richman and Budson 2000, Nelson 2009). Like many normative concepts (i.e., those having to

do with what ought to be), the term health can be ambiguous and vague (Lackey 2001) and has

been characterized as "slippery" (Ostfeld et al. 2002: 22), especially when applied to entities

beyond the individual organism (Kass 1981). In various contexts, health has also been described

as a "value-based ecological concept" (Lackey 2001: 438) and an "ill-defined normative

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concept" (Callicott et al. 1999: 23). The concept of health has strong positive connotations and, to a certain extent, people have an intuitive understanding of it (Kass 1981, Wicklum and Davies 1995). Given these qualities, some have argued that the metaphorical value of health is one of its greatest strengths. For example, Ehrenfeld (1993: 144) suggested that trying to explain health "with the rigor and specificity that will allow us to use it as a scientific tool may well strip it of the intuitive, general meaning that is its chief value." Yet health is also a scientific concept indicative of some measurable condition; to be effective in implementing policies that promote health, measurements of health need to be clearly defined (Lackey 2001, Salomon et al. 2003). We review the concept of wildlife health, suggest key themes for clarifying it, and present definitions of health from a Delphi exercise involving wildlife health professionals.

BACKGROUND

Investigation of wildlife disease is a relatively young field (Wobeser 2007) and developed almost entirely within the germ theory era. This period began in the late 1800s and was characterized by scientific advances in bacteriology which led to a greater understanding of, and emphasis on, the specific causes of diseases and away from a focus on environmental factors influencing disease (Strathern 2005, Kunitz 2007). Wildlife disease management has traditionally emphasized infectious diseases (Wobeser 2007). Some historical examples of this orientation include the publication of the first textbook on diseases of free-ranging wildlife, written by a German veterinarian, in 1914 (Lowenstine and Montali 2006) and the publication of "The Study of Epidemic Diseases Among Wild Animals" by ecologist Charles Elton in 1931. In 1933, the first American wildlife disease laboratory was established in Michigan (Thorne et al. 2005) and wildlife disease was first put into a management context in a chapter titled "Control of Disease" in Aldo Leopold's book Game Management. In 1951, the Wildlife Disease Association

was founded (Wobeser 2006) and in 1957 the Southeastern Cooperative Wildlife Disease Study was established at the University of Georgia (Friend 2006).

Beginning in the 1970s, the vocabulary of wildlife disease management shifted to greater use of the term health. In 1975, the U.S. Fish and Wildlife Service established the National Wildlife Health Center (now administered by the U.S. Geological Survey) and, in 1992, the Canadian Cooperative Wildlife Health Centre was formed (Friend 2006). Conservation medicine, referred to as a new paradigm of health and disease (Kaufman et al. 2004), was formally introduced in 1996 as a way of promoting integration of human, animal, and environmental health through a multidisciplinary perspective (Tabor 2002). Even more recently, the One Health philosophy, which is conceptually similar to conservation medicine, has emerged and gained endorsements from the American Veterinary Medical Association and the American Medical Association (Tabor 2002, King et al. 2008). Questions remain, however, whether these semantic shifts are substantive and if it matters whether wildlife management focuses on health, disease, or both. These concerns have not been well addressed in the literature, nor has a clear vision of wildlife health been articulated.

In the field of human medicine, considerable attention has been given to the philosophy of health and, consequently, the nature of the term health has been thoroughly discussed and debated (Boorse 1977, Kass 1981, Nordenfelt 1995, Brülde 2000, Schramme 2007, Tengland 2007). One key issue in the human health literature is the differentiation of health and disease (Hofmann 2005). Fundamentally, it has been argued that a health-focused perspective promotes a broader, more integrated and multidisciplinary approach than does a reductionist, disease-oriented strategy (Kass 1981). Indeed, increasing attention to wildlife health may be just another example of wildlife management and other natural resource fields focusing on more integrative

approaches (Riley et al. 2003). Yet, unlike the debates generated on related topics such as ecosystem health, forest health, and river or stream health (e.g., Steedman 1994, DellaSala et al. 1995, Scrimgeour and Wicklum 1996, Meyer 1997, Boulton 1999, Lackey 2001), there is a dearth of discussion in the literature about the meaning of wildlife health.

In the field of human health philosophy, two of the most influential lines of thought in defining and discussing health are the biostatistical and holistic theories. The biostatistical theory defines health as essentially the absence of disease, with disease defined as any impairment in normal functional ability (Boorse 1977). According to this perspective, health is a matter of statistical normality of function (i.e., the ability to perform all typical physiological functions with at least typical efficiency) at the species level. Proponents of the biostatistical view argue that defining health relative to normality is ideal since the distribution of biological characteristics is an objective measure (Boorse 1977, Richman and Budson 2000).

A different perspective arises from the holistic theory of health. Nordenfelt (1995), one of the key proponents of the holistic theory, considered it preferable to take a positive approach to defining health, rather than thinking of it as the absence of disease. The focus of this conceptualization of health is not on disease, *per se*, but on health as a contributor to quality of life. Nordenfelt (1995: 93) defined health as the ability to achieve vital goals, with a vital goal being a "state of affairs that is…a necessary condition for…minimal happiness in the long run" and, in the case of non-humans, Nordenfelt (2007) replaced the term happiness with welfare. The holistic theory opposes a purely statistical perspective of health and strives to attain well-being rather than fight disease. Health, from this perspective, is more than the absence of disease or abnormality.

Two notable definitions of wildlife health exist and help illustrate the differences between the biostatistical and holistic theories. Reflecting tenets of the holistic theory, Deem et al. (2008) characterized wildlife health as an ability to efficiently respond to disease and restore and sustain a state of balance. By this definition, wildlife health is measured in terms of particular conditions of wellness (i.e., efficient response to disease and maintenance of a state of balance). In contrast, Mazet et al. (2006: 353) described health as a condition in which an organism is "physically and biochemically complete, does not experience abnormal growth or atrophy of its component parts...and does not experience drastic changes in its physical appearance or normal functions." This definition, with its emphasis on normality, reflects tenets of the biostatistical theory. The holistic and biostatistical perspectives of health may not in fact be mutually exclusive, but further evaluation of the term wildlife health in light of these viewpoints is needed to avoid the term becoming doublespeak rather than a meaningful guideline for wildlife management objectives.

METHODS

To assess expert perspectives on wildlife health and disease, and the relationship between these two concepts, we conducted a Delphi exercise with a group of wildlife health professionals. Expertise adds authoritativeness to discussions, although lay perspectives, too, are important (Morgan et al. 2002). The Delphi exercise aided development of an expert model which pools knowledge in a systematic manner, thereby summarizing the group's collective knowledge rather than that of any one expert (Morgan et al. 2002). The Delphi method is a technique for obtaining consensus of opinion from a group of experts (Dalkey and Helmer 1963). It is an iterative, structured communication process that is anonymous (participants' identities are known to the moderator but not to one another); the process allows participants to view other participants'

judgments and revise their own responses accordingly (Linstone and Turoff 1975). The Delphi

method was originally used for technical forecasting and developing group consensus but is also

useful for exploring underlying assumptions, revealing group values, and aiding

concept/framework development (Turoff 1970, Moore 1987, Okoli and Pawlowski 2004).

Our non-random, purposive sample consisted of 18 current and retired wildlife health

professionals from the United States and Canada. Participants were solicited by means of a

request for assistance posted on the Wildlife Disease Association (WDA) website and in the

WDA newsletter and via direct email requests to known wildlife health experts. Twenty

individuals originally agreed to participate but only 18 completed the entire Delphi process. Of

the 18 participants, four individuals were affiliated with the United States government, three

were affiliated with state wildlife agencies, one was affiliated with a Canadian provincial natural

resource agency, seven were affiliated with academia, and three were affiliated with non-

governmental organizations. Participants included 14 men and four women. Nine of 18 (50%)

participants held doctor of veterinary medicine degrees. Geographical representation included

ten states and one province, though some participants' work can be characterized as being

national or international in scope.

The Delphi exercise was conducted by email from April to August 2010 and required

four rounds (or iterations). In the first round, participants were asked a series of open-ended

questions: 1) What does wildlife health mean to you (i.e., how do you define health)?; 2) In your

opinion, how are the concepts of wildlife health and wildlife disease different and how are they

the same?; and 3) Does a focus or emphasis on one or the other (health or disease) affect or

influence the achievement of healthy wildlife populations? Responses to these questions

obtained during the first round were broken down into 49 statements (e.g., "population

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sustainability" or "health is more holistic than disease"). In the second round, these 49 statements were listed along with the number of Delphi participants who responded in accordance with each statement. Participants were then asked to narrow down the list by selecting the five to eight statements they thought best responded to the original question. It was determined *a priori* that statements selected by less than 50% (i.e., fewer than nine) of the Delphi participants would be dropped. Consequently, by the third round only 20 statements remained.

Participants were then asked to rate their agreement with each of the remaining 20 statements on a scale of 1 to 5, with 1 indicating strong disagreement and 5 indicating strong agreement. The mean agreement ratings were calculated; it was determined *a priori* that items receiving a mean agreement of ≤3.75 would be eliminated. Only two of the 20 items, however, attained a mean agreement of ≤3.75 and, after rewording based on participant feedback, only one item was permanently dropped. After the final iteration, 19 items related to the original three questions remained and summary statements from these items were developed. For summary statements to be finalized, they had to receive a mean agreement of ≥4.

RESULTS

The expert model gleaned from this Delphi exercise reveals seven key conceptualizations associated with wildlife health (Figure 2-1). When asked to describe and define wildlife health, the concept was characterized chiefly by the ideas of population sustainability and resiliency. Wildlife health was also recognized as being a distinctly multidisciplinary concept and as being influenced by multiple factors other than infectious disease, including nutrition, toxins, parasites, and habitat quality. Wildlife health was considered by the Delphi participants to be applicable to individuals, populations, and ecosystems yet populations were considered the most important scale for applying health and there was greater overall disagreement about focusing health on

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either individuals or ecosystems (Table 2-1). The final summary statement (mean agreement of 4.6 on a scale of 1 to 5, with 5 representing strong agreement) was: "Wildlife health is a multidisciplinary concept and is concerned with multiple stressors that affect wildlife. Wildlife health can be applied to individuals, populations, and ecosystems but its most important defining characteristics are whether a population can respond appropriately to stresses and sustain itself." Only two of the 18 Delphi participants explicitly stated that human-oriented objectives were relevant to wildlife health. For example, one participant stated that the goal of wildlife health management is "to promote coexistence and strike a balance between the needs of people and wildlife." Another participant wrote that a healthy wildlife population is able to meet both ecological and social expectations (e.g., tourism, hunting).

Concerning disease, the Delphi experts described it as a component of wildlife health and, more specifically, as an alteration in an animal's normal state, structure, and/or function. Examples of Delphi participants' definitions of disease include: a compromised state which influences an individual animal's ability to perform ecological roles, an infection of a host with a pathogen that affects the hosts form or function, and an abnormal condition with recognizable signs, symptoms and laboratory findings. The final summary statement (mean agreement of 4.3 out of 5) was, "The concept of health is more all-encompassing and holistic than is disease. Disease is one part of the broader concept of health and, consequently, health is more than simply the absence of disease. Health is generally considered a state of being within which disease is a specific significant abnormal condition or deviation from health."

Further, Delphi participants agreed that although both health and disease must be emphasized, a broader focus on all determinants of wildlife health (beyond specific disease pathogens) is needed to ensure healthy, sustainable wildlife populations. Additionally, a focus on

wildlife health was considered to be more "forward thinking" and to allow managers a better

understanding of the reasons for the disease. A focus on disease alone was generally viewed as

being inadequate to provide the conditions necessary for healthy wildlife populations. As one

Delphi participant wrote, "health connotes more a sense of preventive medicine…in contrast to

the fire-engine type approach of fighting disease." Another wrote, "…achieving healthy wildlife

requires action to combat [environmental] factors, not reaction to treat sick individuals." The

applicable summary statement (mean agreement of 4 out of 5) was, "Both health and disease

must be emphasized in wildlife management. A focus on disease is sometimes necessary but

alone it is insufficient. A broader focus on all aspects of wildlife health is needed to achieve

healthy, sustainable wildlife populations. A focus on health may bring about a shift from

documentation of disease occurrences to prevention and will help managers better understand

what factors are causing the disease."

DISCUSSION

The expert model created from our Delphi exercise reveals that wildlife health

professionals believe health and disease are distinct but related concepts, both in terms of

definition and influence on management outcomes. This group of experts, diverse in

geographical location and agency of employment, held that disease is an important criterion of

health but it is not the only criterion. Moreover, health was viewed as being applicable to

individuals, populations, and ecosystems, though populations were the most acceptable scale of

reference. Indeed, populations are generally viewed as the key focus in wildlife disease

management (Wobeser 2007). Nonetheless, the individual-oriented perspective of some

veterinarians, the wildlife manager's population perspective, and the conservation medicine

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practitioner's ecological orientation are all important aspects of the broader picture of wildlife health (Ostfeld et al. 2002).

In this expert model, we observed elements of both the holistic and biostatistical notions of health—health is understood in relation to disease but it is also viewed in terms of concepts such as population resiliency and sustainability. In health philosophy, it has been argued that the biostatistical and holistic perspectives are not mutually exclusive, but are simply different in their focus or orientation (Khushf 2007, Schramme 2007). An integrative conceptualization of health incorporates elements of both the biostatistical and holistic orientations by determining healthful conditions while also continuing to focus on disease as an important criterion of health. Both orientations contribute perspectives needed in wildlife management, similar to the human health field with medical clinicians focused on diagnosis and treatment of disease in individuals and public health practitioners emphasizing health of the broader population. To prevent these differing scopes from hindering the achievement of wildlife health, greater cooperation across disciplines is needed (Ostfeld et al. 2002). Although wildlife disease management occurs at the interface between medicine and applied biology (Wobeser 2007), Leopold (1933) argued that an overly medical, "doctoring" approach is less important in promoting health than are environmental and population factors.

To promote comprehensive approaches to wildlife health, integration of human dimensions with biological-epidemiological insights is needed (Decker et al. 2006). Humans are an integral part of the wildlife health management system (Wobeser 2007) and the social sciences provide valuable input to health disciplines such as conservation medicine (Ostfeld et al. 2002). Accordingly, we view a beneficial approach to conceptualizing health as deliberately including both descriptive and normative elements. Descriptive elements correspond to the

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biostatistical emphasis and include basic information about the ecology, epidemiology, toxicology, or etiology of disease factors. This element is important to develop a baseline measurement of health for determining what is normal for each species and to understand what limits health and normality. Normative elements of wildlife health address two aspects: to decide what a population needs to attain the desired condition of wellness (e.g., to survive and sustain itself into the future), and to promote integration of societal values in the development and achievement of wildlife health objectives (Meyer 1997, Decker et al. 2006). The types of questions corresponding to these elements include: what is the health status of the species or population and what are the threats to its health?; what, from a biological perspective, are indicators of a healthy population of this species? (i.e., measures of optimal wellness in addition to measures of current conditions); and, what are the relevant societal values that influence how health is defined and how health should be managed for this species?

IMPLICATIONS

Wildlife management occurs through a mix of technical and value-laden judgments (Riley et al. 2003) and management of wildlife health is no different. The hallmarks of effective management objectives are that they are specific and measurable yet linked to values related to the decision problem (Clemen and Reilly 2001). Inclusion of societal values is critical to making values and value tradeoffs explicit rather than obscuring them and compromising the democratic ideal of openness in public decisions (Lackey 2001, Meyer et al. 2005). Defining wildlife health and setting wildlife health management objectives involve making value judgments. For example, whether concerns for human health trump concerns for wildlife health, what outcomes are most appropriate for wildlife populations, and which diseases are "bad" and should be eradicated are all questions influenced by human values. Such decisions cannot be based solely

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on biological or epidemiological expertise without the risk of ignoring important components of the decision problem. Human activities also have a direct influence on wildlife health, including the spread of disease and worsening of environmental impacts (Ostfeld et al. 2002, Friend 2006, Wobeser 2007).

In the face of continued threats to the sustainability of wildlife populations, adoption of policies that clearly articulate the meaning of wildlife health are needed. If wildlife health is to be a meaningful, measurable concept, and one supported by stakeholders and experts alike, additional deliberation is needed to better define and conceptualize it. A useful starting point is to examine expert perspectives to gain understanding of existing conceptualizations of health by those who have practical knowledge of wildlife health and disease issues. The expert model that emerged in our Delphi exercise reveals that elements of both holistic and biostatistical notions of health are present in professionals' understandings of wildlife health, though greater emphasis is placed on holistic aspects. This may indeed be a natural progression of thought as knowledge is gained about the dynamics between wildlife disease and wildlife health. Building on this model, we encourage consideration of both descriptive and normative aspects of health and disease in conceptualizations of wildlife health and the integration of societal values into the normative component. Because health is unavoidably a normative concept and management is a prescriptive endeavor, and logically we cannot derive values and prescriptions from biology alone, integration of human dimensions insights will increase the probability of achieving objectives for wildlife health.

Figure 2-1. Mental model of expert conceptualizations of wildlife health. (For interpretation of the references to color in this and all other figures, the reader is referred to the electronic version of this dissertation.)

EXPERT CONCEPTUALIZATIONS OF WILDLIFE HEALTH

Characterized by population sustainability

Characterized by population resiliency

Influenced by habitat quality

Influenced by multiple types of stressors

Wildlife Health

Applies to **populations**, individuals, and ecosystems

More than the absence of disease

Multidisciplinary in nature
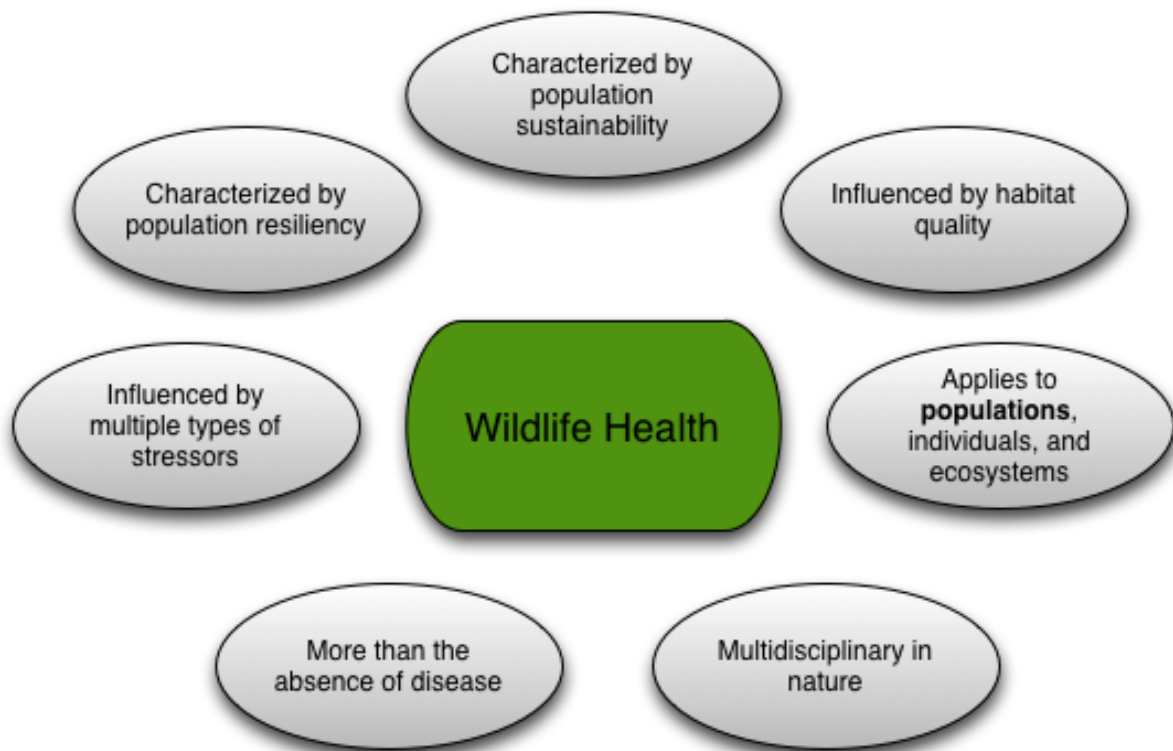
Table 2-1. Delphi expert responses to "What does wildlife health mean to you?"

Mean agreement (1 to 5 scale with 5 indicating strong agreement)	Response statements
4.39	Population sustainability (e.g., healthy populations are able to sustain themselves over the long term)
4.33	Population resiliency (e.g., wildlife populations can respond appropriately to stresses)
4.89	Multiple types of stressors are relevant to wildlife health (e.g., nutrition, infectious disease, parasites, toxins)
4.78	Wildlife health is multidisciplinary in nature
4.44	Quality of the environment/habitat is part of the wildlife health picture
4.50	Wildlife health applies to both populations and individuals
4.11	Wildlife health applies to ecosystems

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CHAPTER 3

WHAT ARE THEY THINKING? EXPLORING LAYPERSON MENTAL MODELS OF WILDLIFE HEALTH AND DISEASE

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ABSTRACT Communication is an important part of wildlife disease management. Communication efforts aim to inform the public about health and disease issues and to promote public support for management interventions. To be most effective, communication strategies should be based in knowledge of stakeholder understandings of key issues. We conducted focus group interviews with diverse groups of participants in five states across the United States to evaluate how laypersons conceptualize wildlife health and wildlife disease management. Based on insights from the focus groups, we developed a simple mental model representing predominant conceptualizations of wildlife health. Wildlife health was associated with absence of disease; balanced, sustainable populations; healthy animals; habitat quality; and ecosystem health. Wildlife disease was commonly viewed as a natural phenomenon. Factors influencing support for wildlife disease management included the specific methods used, cost, predicted consequences of management, level of uncertainty, and severity of the disease threat. Knowledge attained from these focus groups provides empirical evidence of beliefs and

perceptions that influence public understanding and agreement with wildlife disease management.

INTRODUCTION

Wildlife disease management presents a significant challenge to wildlife professionals (Decker et al. 2006). For example, health and disease issues can have a range of negative consequences including direct health impacts to humans, domestic animals, and/or wildlife; alteration of human attitudes toward and tolerance of wildlife; reduced participation in wildlife-related recreation; and lowered perceptions of the value of wildlife (Conover 2002, Friend 2006, Decker et al. 2011). Wobeser (2002) emphasized the importance of public education in wildlife disease management, specifically to attain public support for management actions and to influence human activities that contribute to disease occurrence. Increasingly, it is being recognized that science and local knowledge (i.e., knowledge not coming from traditional scientific expertise) are both important (Failing et al. 2007) and that communication should emphasize a two-way information sharing process over a one-way educational approach (Gray and Ropeik 2002). Effective communication, whether the goal is to raise public awareness about wildlife health and disease issues, to gain public approval of wildlife disease management, or to encourage health promoting behaviors, will benefit from both expert-based information and knowledge of stakeholder values, beliefs, and attitudes, including basic conceptualizations of wildlife health and disease and relevant risks.

Investigations of human dimensions aspects of wildlife health and disease are limited and few studies provide in depth, qualitative insights (e.g., Evensen 2011, Bosch et al. 2010). Although a few commentaries have discussed and defined wildlife health (Mazet et al. 2006, Deem et al. 2008), and at least one has provided insights into expert conceptualizations of

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wildlife health (Hanisch et al. 2012), we are not aware of any empirical research that has examined layperson conceptualizations of wildlife health. Such conceptualizations, or mental models, are fundamental to decision framing which, in turn, influences problem understanding, decisions about how to address a problem, and attitudes toward the problem (Kahneman and Tversky 1984, Hammond et al. 1999).

Mental models, which can provide insights relevant to wildlife management (Decker et al. 2006, Enck et al. 2006), are psychological representations that help people describe and explain a phenomenon (Mathieu et al. 2000, Kellermanns et al. 2008). Mental models reveal stakeholder perceptions, assumptions, knowledge, and beliefs about a phenomenon and, consequently, analysis of these models can inform decision-making and understanding of problems (Kolkman et al. 2005). Expert mental model frameworks have been developed to guide risk communication and to reveal how practitioners conceptualize the WDM system (Atman et al. 1994, Decker et al. 2006, Hanisch et al. 2012), yet it is also important to understand layperson mental models to reveal variability in assumptions about the management system (Enck et al. 2006).

In this paper, we analyzed data from exploratory focus group interviews to create preliminary mental models of conceptualizations of wildlife health and wildlife disease and to inform the development of a survey questionnaire for testing theory-based hypotheses related to acceptance of wildlife disease management. Our objectives were to characterize layperson conceptualizations and understandings of wildlife health and disease and to assess factors influencing acceptance of wildlife disease management.

METHODS

We used qualitative, open-ended, exploratory questions to achieve study objectives. Qualitative data are "representations of human acts and utterances," the analysis of which seeks to interpret the understandings of the research subjects (Sivesind 1999: 361, Creswell and Plano Clark 2007). Specifically, we conducted focus groups which are structured group interviews used to collect detailed opinions and knowledge about a particular topic (Bader and Rossi 2002). We conducted five focus groups from April to June 2010, one at each of the following locations: East Lansing, Michigan; Albany, New York; Covington, Georgia; Flagstaff, Arizona; and Portland, Oregon. We selected locations in different regions of the United States since regional variations in public attitudes and opinions are common (Alm et al. 2001, Winter et al. 2002). All sessions were moderated by a professional facilitator affiliated with Michigan State University and lasted from 1.25 to 2 hours. All focus groups were audio recorded using a handheld digital recorder.

Focus group participants (n = 34) were individuals interested in wildlife but who were not employed as wildlife professionals. Participants were self-selected and were recruited by contacting local environmental, conservation, and sportsmen's groups (e.g., Michigan United Conservation Clubs, Oregon Wild, Coconino Sportsmen, and Georgia Wildlife Federation) and by posting notices online at relevant websites (e.g., Portland Hiking Club and Northern Arizona Audubon Society). As an incentive, we provided participants with a pizza dinner and a $10 gas or grocery gift card. Research methods were approved for use by the Michigan State University Social Science Institutional Review Board (IRB# 09-874).

The focus group interview guide consisted of ten open-ended questions developed to explore how people think about wildlife health and disease and wildlife disease management interventions. The questions were pre-tested using students in an upper-level fisheries and

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wildlife undergraduate course during spring semester 2010. In addition to the interview

questions, we administered brief exit surveys to all participants and 33 exit surveys were

collected from the 34 participants. The exit surveys collected basic demographic information,

participation in wildlife related recreation, and quantitative rankings of level of concern related

to disease risks to human health, domestic animal health, and wildlife health.

The lead author prepared verbatim written transcripts from the audio recordings for all

focus groups. (Filler words such as "um" or "like" were omitted from transcripts.) The data for

analysis came from the text of these transcripts and coding was used for analysis. Codes are

"tags or labels for assigning units of meaning to the descriptive or inferential information" that

has been collected (Miles and Huberman 1994: 56). We used theme coding to analyze data,

whereby the coder selects pieces of text relevant to a specific theme and then attaches a code to

them (Sivesind 1999). Thus, we grouped responses to each question thematically; for example,

responses to the question "What comes to mind when you hear the term wildlife health?" were

grouped into themes such as sustainable populations, balanced populations, and habitat quality

(Table 3-1). We also analyzed topics contained within the text by doing word searches for

references to specific diseases, species of animal, organizations, science, and theoretical

variables such as naturalness, situational specifics related to acceptance of wildlife disease

management, and statements related to trust in management entities. Quantitative rankings of

concern for health risks were analyzed using the non-parametrical Mann-Whitney U test (Vaske

2008).

RESULTS

About two-thirds of focus group participants were men (68% were male and 32% were

female). Distribution of those living in rural, suburban, and urban areas was roughly equivalent

(35%, 27%, and 38%, respectively). Nearly 80% of focus group participants regularly participated in wildlife watching and 67% and 61% of participants fished and hunted, respectively. A third of focus group participants were between the ages of 18-35, 24% were between the ages of 36-55, and 42% were 56 or older. In the anonymous exit survey, we found concern for wildlife health ($\bar{x} = 4.09$) to be greater (P≤.005) than for human ($\bar{x} = 2.79$) or domestic animal ($\bar{x} = 2.97$) health, a finding which is consistent with verbal comments expressed in the focus groups.

Focus group participants associated wildlife health with disease or, more specifically, the absence of disease; sustainable populations; balanced populations; and physically healthy animals. Ecosystem/environmental health and habitat quality were also considered by many stakeholders to be conceptually related to wildlife health. Deer (i.e., white-tailed or mule deer) were the most frequently referenced species, although wildlife health was generally viewed as including all wildlife species in multiple categories including birds, mammals, reptiles, amphibians, and even fish. Socioeconomic factors such as harvest rates, wildlife damage levels, and economic impacts were also discussed in relation to wildlife health. We constructed a layperson mental model of wildlife health using the predominant themes (Figure 3-1).

Disease. In this theme related to wildlife health, participants viewed health specifically in terms of disease, or the absence of disease.

"I think of very specific things like rabies." (Oregon)

"Wildlife health means…the animals or reptiles can live a natural life, a full natural life, and reproduce without problems and disease." (Georgia)

"The first thing I thought of was the medical health of the animals with regard to whether they have diseases or not and what their longevity is." (Oregon)

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Population sustainability. This theme reflects the dominant emphasis on wildlife populations and the perspective that healthy populations are sustainable populations. More specific indicators or measurements of wildlife health expressed by participants included population size and trends; condition and size of animals; condition of habitat; reproduction; birth and death rates; age and sex ratios; harvest rates; the geographic distribution of the population; and comparison of the population to a historical baseline.

> "It's basically a sustainable, healthy population of any species be it deer, turkey, fish, salamanders, lizards, frogs, whatever." (Georgia)

> "I think of being able to maintain a population that is neither in decline nor becoming excessively overpopulated." (Arizona)

> "The population in terms of total habitat being able to sustain a rise in numbers over time." (Michigan)

Balance. In this theme, participants expressed wildlife health as a matter of populations being below carrying capacity or in balance with their environment so as to not destroy habitat or cause other problems associated with overabundance.

> "The word that comes to my mind is the word balance. Whenever you are using health it's all about balance. Balancing the correct population, balancing the correct harvest…" (Michigan)

> "I think an overpopulated, I mean, a population that is too large is unhealthy." (Arizona)

> "I'm thinking of buck to doe ratios and how does the habitat look and what's the browse impact and things like that…more along the lines of biological carrying capacity." (New York)

"There are people who think that it's a healthy herd because they're seeing more deer. And I'm thinking it's a really unhealthy herd when you have that excess of animals." (New York)

Healthy animals. In this theme, participants emphasized the health of individual animals in terms of concepts such as reproduction, appearance, and physiology.

"I usually think of it in terms of the reproductive capacity or the reproductive rates of a particular deer or turkey." (Georgia)

"Is it a nice healthy deer or is it kinda scrawny from the swamp up in the U.P.? Is it a nice size Chinook or is it one out of Lake Huron where there is no food left?" (Michigan)

"When I think of wildlife health, I think of physiology of the individual animal. I would think of going and taking samples...blood samples and hair samples and things like that to test for disease and test for normal growth rates." (Oregon)

Habitat quality and availability. In this theme, participants emphasized the importance of habitat to wildlife health.

"The first thing I would think about is that they would have viable habitat because without that there isn't any wildlife at all." (Arizona)

"Land quality...like [are] there habitat corridors or private property and trails or roads disrupting what would be a natural path for plants and animals to go through." (Oregon)

Ecosystem health. This theme reflected conceptualizations of health that included the whole ecosystem rather than, or in addition to, a single species or animal.

"When I hear wildlife health I think of functional, sustainable ecosystems." (Michigan)

"When I think of wildlife health I think of a holistic health and the ecosystem health." (Oregon)

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"I think of healthy animals, healthy ecosystems, and healthy environment." (Michigan)

"The relationship between different animal species with each other. So if you're trying to measure one's health it would be hard to do that without knowing if other species that it's dependent on or that are dependent on it are also affected." (Oregon)

Measuring wildlife health. Participants also noted that determinations of health are not necessarily absolute but are related to context, as revealed by the following quotes.

"Sometimes when I think of health in regards to wildlife, there's an underlying question. Health according to who...by whose definition?" (Michigan)

"When I think of wildlife health I recognize that you can have different targets for what a healthy population is. And so a healthy deer herd in Schenectady County is very different from my concept of a healthy deer herd in Columbia County." (New York)

"Health is…how does it compare to whatever I assume is a good healthy baseline which is not necessarily based on anything real but…how [humans think] it should've been or was." (Oregon)

When asked what comes to mind when they hear the term wildlife disease, focus group participants most frequently provided examples of specific diseases. The top four diseases identified, comprising 72% of all references to specific diseases, were rabies, chronic wasting disease, bovine tuberculosis, and Lyme disease. Some participants also conceptualized disease as including phenomena such as invasive species and environmental contaminants. Chief concerns about wildlife disease expressed by participants were, in descending order of frequency: threats to wildlife health, overreaction and fear responses from the public leading to negative attitudes toward wildlife, threats to human health (though most people indicated they did not have personal concerns about health risks from wildlife disease), and impacts on domestic animals

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including pets and agricultural livestock. In addition, many participants viewed wildlife as being more vulnerable to disease than are humans and domestic animals. Participants considered humans to have important, chiefly negative, influences on the occurrence of wildlife disease through, for example, environmental contamination, habitat encroachment, or introduction of invasive species.

Examples of disease. When thinking about disease, participants tended to name a specific malady such as rabies, but also included more general concepts such as invasive species.

> "The first thing I think of is [chronic wasting disease]…and then the obvious things, rabies, [epizootic hemorrhagic disease]...and then to go down on the list it would be the white nose syndrome with the bats and colony collapse disorder with honeybees." (New York)

> "[I think] of invasive species or how we're domesticating elk and buffalo and then it's spreading disease to the wild elk and buffalo." (Oregon)

> "To me a wildlife disease is something that seems to be extremely detrimental to a specific animal like [chronic wasting disease] or the bighorn sheep here [that] get a disease from a fly." (Arizona)

Threats associated with disease. Participants expressed concerns mainly related to health risks from disease, including human, domestic animal, and wildlife health. Concerns about economic impacts were also raised.

> "I think of two things: the interplay of wildlife and domestic animals. One giving disease to the other and back and forth. And then, secondly, the possibility of bringing in a disease that nobody's ever seen before." (Michigan)

"If I had to list ten things I'm worried about with health regards, [zoonotic disease] would not fall in the top ten for my personal health. No way. Personally, no concerns." (Oregon)

"I would be concerned about the devaluation, if that's the correct word, of wildlife in general because of diseases. Where people don't want deer around. Where people don't want raccoons around. You know, eliminate these populations because of potential for disease." (Michigan)

"Maybe I care more about wildlife than I do my friends or my neighbors or my animals. To me it's more important because if you look at it economically, hunters, naturalists, people who get outside and work, a lot of our livelihood in this country depends on wildlife." (Georgia)

Vulnerability of wildlife. When asked whether they were most concerned about the impacts of zoonotic disease on human, domestic animal, or wildlife health, participants often stated that they believed wildlife to be more vulnerable to disease.

"I think wildlife are more, I guess, vulnerable because they don't have vets or doctors they go to if they're sick whereas humans of course we got doctors. And domesticated animals if there's a problem there you can call your vet." (Georgia)

"All too often wildlife becomes infected with one thing or another and people aren't aware of it. Even the Game and Fish isn't always aware of it right away and so it can have a greater impact. Where with people it usually gets noticed very quickly so then you can do something about it." (Arizona)

"We're smart enough, we have enough technology that we're able to deal with the effects on humans of some disease. And even with our pets and domesticated animals [we have]

veterinarians and all that…but it's very hard to control or manage the effect it has on the wildlife." (New York)

Naturalness of disease. Another theme that emerged from the focus groups was naturalness or, specifically, ways in which participants talked about wildlife disease issues as being natural or unnatural. Beliefs in the naturalness of wildlife disease ranged from the perspective that it is part of the "cycle of life" or "balance of nature" to the view that humans have made disease problems worse.

> "The diseases and illnesses within all types of wildlife, that's part of creation. X amount of skunks are gonna have rabies. Not to have rabies in skunks would be an unnatural situation. If a certain amount of deer didn't die from natural causes, the coyotes wouldn't have anything to eat." (Michigan)
>
> "I think that most diseases occur naturally in the wild. It's all part of the cycle. You have outbreaks just like you do with human diseases. I don't think we have a great many man-caused diseases at this point in time." (Arizona)
>
> "I guess we could argue that [wildlife disease is] natural but we've affected everything on the planet so nothing is natural anymore except maybe very few remote areas." (Oregon)

Misunderstandings of wildlife disease. Although we found the focus group participants on the whole to be quite thoughtful and informed with respect to the issues discussed, we heard some comments indicating oversimplifications or misperceptions of wildlife disease problems.

> "Rabies is a disease that will in the long run manage itself." (New York)
>
> "If we quit trying to manage then maybe it would all kinda fix itself given enough time." (Oregon)

"[White nose syndrome] will improve the overall health of our bat population."

(Michigan)

Focus group participants were asked when they thought wildlife disease managers should, and should not, intervene. The key factors discussed as influencing agreement with wildlife disease management were the specific management methods being used, cost in dollars of management, the predicted outcome or consequences of management, effectiveness of methods, level of uncertainty, severity of the disease threat (e.g., human health threat, decimation of wildlife populations), risk of the disease spreading or becoming an epidemic, and the particular species involved.

"Depends on the severity of whatever it is. If it's severe and threatening the entire area or perhaps even the entire species within a certain region, then you really should intervene definitely because it's going to affect everything." (Arizona)

"If it's considered a nuisance animal, you've got too many of them and it's a nuisance animal and the disease doesn't affect other animal species, [then you don't intervene]." (Georgia)

 "When it impacts human beings, they have to [manage]. It's a human health issue." (Michigan)

"Depends on the intervention method. What does intervening consist of? Does intervening consist of using some kind of chemical toxin? Really depends on the method. Extermination of the species?" (Oregon)

Another important factor influencing agreement with wildlife disease management was the desire for uncertainty to be minimized and to know that managers understand the outcomes of management activities.

"If there's not a plan...that anticipates consequences...and intervention is going to involve spraying something or killing wolves [it] seems like it shouldn't happen." (Oregon)

"If the wildlife managers said we're gonna go exterminate the javelina herd in Tucson because there's a disease there, I think you'd have to know what the possible outcomes are of exterminating or not... It just can't be thrown out there, we're gonna do this because we want to." (Arizona)

"[I would want to know about] the situation, the management action they would propose, and the effect it would have if they didn't do it." (Michigan)

"Don't we do things to control one thing and it causes another problem?" (Georgia)

DISCUSSION

Knowledge of layperson mental models related to wildlife health and disease is a frequently overlooked yet useful component of communication strategies related to wildlife health issues. We found support for wildlife health to be high among this diverse group of stakeholders and, overall, their conceptualizations of wildlife health were holistic. For example, health was generally viewed as more than the absence of disease and as applicable to a wide variety of species and multiple organizational levels. Several findings point toward a high degree of concern for the health of wildlife among the focus group participants. In the exit survey, participants rated concern for effects of disease on wildlife health as greater than concern for human or domestic animal health. Similarly, many focus group participants expressed the perspective that wildlife is particularly vulnerable to disease, more so than are humans or domestic animals.

Our findings challenge the notion that wildlife disease management must be framed in terms of protecting human health or benefitting economic interests to gain public support, at least

for some groups of stakeholders. Protection of human health is typically given highest priority when justifying wildlife disease management (Wobeser 2007). We do not claim that anthropocentric factors are unimportant but it appears that communication messages emphasizing health effects on valued wildlife species could garner greater agreement with wildlife disease management among some stakeholder groups. In particular, the idea of wildlife being more vulnerable to disease may prove persuasive in creating awareness about the seriousness of disease risks. Perceived severity and susceptibility associated with a health risk influence assessment of the risk which, in turn, influences judgments about risk management (Sharma and Romas 2008). If people do not perceive themselves as susceptible to health effects from wildlife disease, as we found in our focus groups, another way to influence perceptions of disease could be to emphasize the severity of disease to valued wildlife species.

Our findings suggest that many stakeholders view wildlife health at least partly in terms of balance, making it a particular communication challenge if wildlife professionals seek to dispel the concept of the balance of nature in relation to disease. Focus group participants viewed health as applicable to different organizational levels (i.e., individual, population, ecosystem), but the emphasis was on populations, and population balance was discussed particularly in reference to being below carrying capacity or not so abundant as to damage habitat or vegetation. The idea of a "balance of nature" has been described as a myth that oversimplifies the dynamic workings of the natural world (Kricher 2009). It was argued by ecologist Charles Elton to be fictitious, yet the idea of balanced nature was central to Aldo Leopold's view of the natural world (Christensen 1999) and it has proven to be a persistent heuristic in wildlife management. With regard to wildlife disease, the communication need lies in discouraging complacency about

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the effects of disease because it is viewed as something that maintains balanced wildlife populations.

Some focus group participants expressed beliefs that wildlife disease is natural, which supports Wobeser's (2007: 27) assertion that disease in wild animals is still commonly viewed as "a natural phenomenon and that nature will take care of itself." For any given risk, the belief that the risk is natural as opposed to anthropogenic can lead to lower risk perceptions (Sjöberg 2000) which can lead to less support for human intervention in mitigating the risk. If wildlife disease is construed as simply being part of nature, stakeholders may become complacent about the need for, and less likely to support, wildlife disease management. Consequently, an important area of communication pertinent to wildlife disease management may be to emphasize human influences on disease prevalence. For example, movement of animals and disease agents is a particularly deleterious cause of anthropogenic disease problems (Wobeser 2007).

With respect to factors expressed by participants as influencing their support for, or opposition to, potential wildlife disease management interventions, we discovered concerns that haven't previously been highlighted in human dimensions of wildlife disease management research. Uncertainty related to management interventions and a desire for assurance that managers understand the potential outcomes of wildlife disease management were expressed as concerns. Similarly, a focus group study that examined acceptability of forest fuel management strategies found an important consideration among stakeholders to be agency competence which was related to the belief that wildfire professionals knew what they were doing (Winter et al. 2002). Individuals make judgments about the appropriateness of actions based on their understanding of the costs and benefits and it is important in communication campaigns to emphasize both benefits gained and costs avoided. In wildlife disease management, a

particularly relevant cost stems from management uncertainty and the need to ensure the public, as much as is practical, that actions aren't being taken that could result in significant unintended consequences. Just as there is concern for vulnerability of wildlife to disease, there also appears to be concern for vulnerability of wildlife, or the ecosystem more broadly, to management actions.

These focus group participants provided a good representation of the diversity of people who are likely to be key stakeholders with respect to wildlife issues (e.g., hunters, outdoor enthusiasts, environmentalists) and included representation from several states across the United States. The individuals who participated in these focus groups were not selected randomly and results cannot be generalized to the public at large. Focus group results, however, can provide insights beyond the specific group of participants so long as extrapolations are kept more general and tentative than would be the case with a random survey sample (Minnis et al. 1997).

IMPLICATIONS

Insights from these focus groups contribute to the knowledge base of wildlife disease management and encourage consideration of how laypersons, as opposed to experts, think about the complex notion of wildlife health. Because communication is a two-way process requiring mutual understanding, non-expert views are a critical piece of information in the development of risk communication related to wildlife disease management. While not representative of all stakeholders, the support and concern for wildlife health expressed by these participants indicated that a broad suite of concerns, much broader than human health impacts alone, are relevant to communicating about wildlife health and disease issues. Beliefs in the vulnerability of wildlife and the naturalness of disease have potential to influence attitudes toward wildlife

disease management and offer opportunities to improve communication with the public about

wildlife health and disease issues.

Table 3-1. Themes that emerged in response to focus group questions.

QUESTION TOPIC	RESPONSE THEMES
Characteristics of wildlife health	- Healthy, sustainable populations - Balanced populations (e.g., populations that are within carrying capacity) - Absence of disease - Physical and physiological condition (e.g., normal lifespan, normal reproduction) - Habitat quality - Functional ecosystems - Includes a broad array of species, including fish, although some species considered more important than others
Indicators or measurements of wildlife health	- Abundant harvest - Condition of habitat - Population size and trends - Condition, size, weight of animal - Reproduction, recruitment, birth rates - Age and sex ratios (e.g., buck to doe ratios) - Mortality - Normal geographic distribution - Comparison of population to historical numbers or some baseline
Hindrances to wildlife health	- Human encroachment (development, urban sprawl, etc.) - Invasive species - Environmental contaminants - Overpopulation (of the species) - Climatic factors (e.g., drought or hard winters and climate change) - Captive wildlife facilities (including fish farms)
Characteristics of wildlife disease	- Exists in all species and is "natural" to a certain extent - Lack of personal or public awareness - Emphasis on infectious diseases but includes more than that - Refers to a specific health problem

Table 3-1 (cont'd)

Concerns about wildlife disease	- Impacts on wildlife (most frequently expressed concern) - Impacts on humans (health, food supply, recreation) - Cost and economic impact - Impacts on pets or livestock - Fear responses from people leading to devaluation of wildlife - Upsetting of ecological balance
Factors influencing agreement with wildlife disease management	- Specific methods (e.g., how invasive?) - Cost in dollars - Predicted outcome or consequences - Effectiveness - Level of uncertainty - Severity of disease threat (e.g., human health threat, decimation of wildlife populations) - Risk of disease spreading or becoming an epidemic - Species involved (e.g., is it a nuisance or overabundant species?)

Figure 3-1. Layperson mental model of wildlife health.
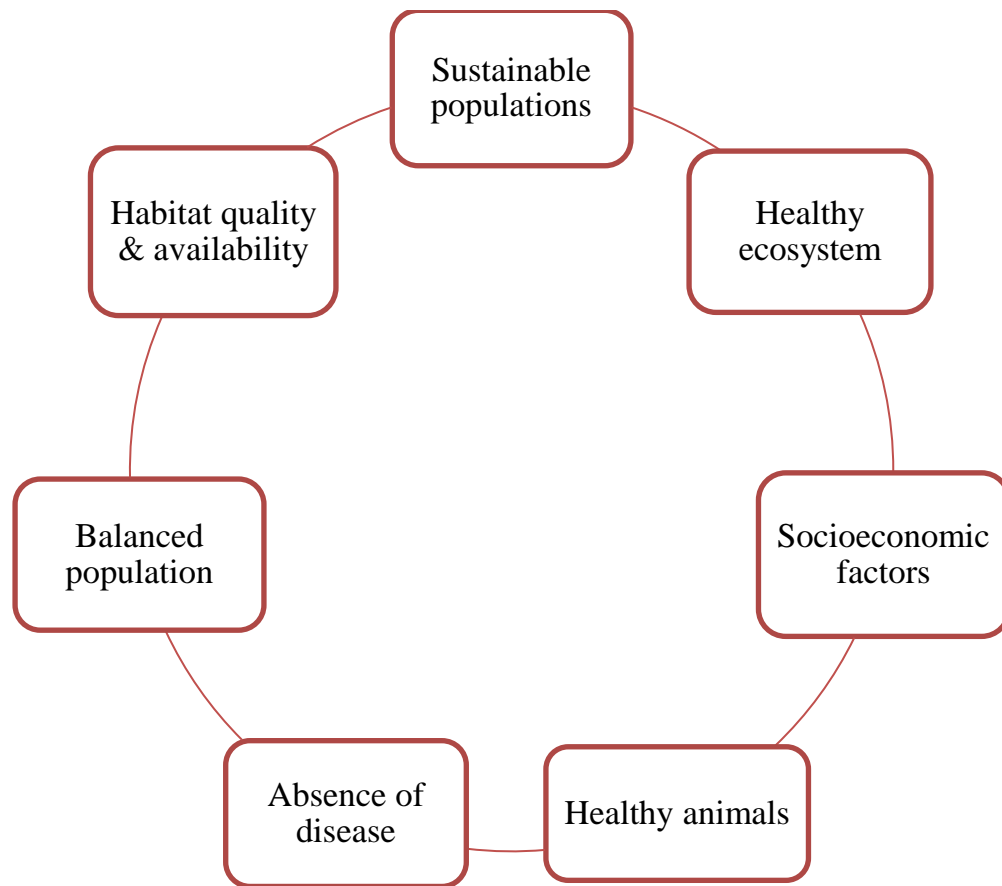
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CHAPTER 4

EVALUATION OF WILDLIFE DISEASE RISK PERCEPTIONS

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ABSTRACT Risk perception has an important influence on wildlife management and is particularly relevant to issues that present health risks, such as those associated with wildlife disease management. Knowledge of risk perceptions is useful to wildlife health professionals in developing communication messages that enhance public understanding of wildlife disease risks and that aim to increase public support for disease management. To promote knowledge of public understanding of disease risks in the context of wildlife disease management, we used a self-administered questionnaire mailed to a stratified random sample (n = 901) across the continental United States to accomplish three objectives: 1) assess zoonotic disease risk perceptions, 2) identify sociodemographic and social psychological factors underlying these risk perceptions, and 3) examine the relationship between risk perception and agreement with wildlife disease management practices. Diseases we assessed in the surveys were rabies, plague, and West Nile virus. Risk perception as measured by an index consisting of severity, susceptibility, and dread was greatest for rabies and West Nile virus ($\bar{x}$ = 2.62 and 2.59, respectively, on a scale of 1 to 4) and least for plague ($\bar{x}$ = 2.39). The four most important

variables associated with disease risk perception were gender, education, prior exposure to the disease, and concern for health effects. We found that stronger risk perception was associated with greater agreement with wildlife disease management. We found particular concern for the vulnerability of wildlife to zoonotic disease and for protection of wildlife health, indicating that stakeholders may be receptive to messages emphasizing the potential harm to wildlife from disease and to messages promoting One Health (i.e., those that emphasize the interdependence of human, domestic animal, wildlife, and ecosystem health).

INTRODUCTION

Many wildlife diseases pose risks to human, domestic animal, and wildlife health and have negative economic and ecological effects (Wobeser 2007), making wildlife disease management amenable to risk management approaches. Technical risk assessments, such as epidemiological models, contribute to predictions about the likely occurrence of a specific disease (Miller 2007), however, wildlife disease management is influenced by public opinion in addition to biological and epidemiological factors (Heberlein 2004, O'Brien et al. 2006). Risk management decisions are inevitably social decisions (Glicken 2000), in part because a fundamental concern is "what is acceptable risk?", and answers to this question are influenced by deeply-held values and beliefs (Fischhoff et al. 1981, Wildavsky and Dake 1990). Consequently, different stakeholder groups may assign and assess risks and benefits differently, resulting in divergent risk perceptions and beliefs about the best management approach for a given risk (Maule 2004). Particularly relevant to wildlife disease management is that experts and laypersons commonly perceive risks differently (Sjöberg 1999, Loewenstein et al. 2001). In general, risk from an expert's perspective tends to be based on probabilities and a narrow range of concerns while the public tends to be more focused on uncertainty and a broader range of

potential concerns (Slovic 2000, Hampel 2006). For example, in the case of chronic wasting disease in Wisconsin, experts emphasized the health benefits of disease eradication while local landowners focused on potential negative outcomes associated with wildlife disease management, including threats to property rights and changes to the population density of white-tailed deer (Heberlein 2004). Such disparities can lead to differing judgments about acceptable risks and appropriate management responses and can make risk communication particularly challenging (Hampel 2006).

Through their role in managing and communicating risks, agencies can help strengthen or weaken public risk perceptions, and therefore have an influence on societal debates about risk (Kasperson and Kasperson 1996). The ability to purposefully influence relevant beliefs can be enhanced when disease risks and wildlife disease management goals are communicated in ways that sync with stakeholder values and concerns (Decker et al. 2006). Research on risk perception helps managers understand how the public thinks about and responds to risks (Slovic 1987, Vaske 2010), aids in alignment of management objectives and stakeholder values (Morgan et al. 2002, Decker et al. 2006), sheds light on how publics are likely to respond to wildlife disease management efforts (Vaske 2010), and informs development, implementation, and evaluation of risk communication strategies (Gray and Ropeik 2002, Gore et al. 2009, Decker et al. 2010). Aside from studies emphasizing particular stakeholder groups and diseases (e.g., hunters and CWD), research on wildlife disease management risk perception has been limited. This gap is unfortunate given that there are many other diseases of interest to wildlife health professionals and there are diverse stakeholder groups that affect, and are affected by, wildlife disease management.

The science of estimating and understanding risk typically focuses on two aspects of risk. One is technical risk assessment to quantify risk probabilities and the other is risk perception which is influenced by cognitive (related to the perceived probabilities of an adverse outcome) and affective (a feeling state related to the adverse outcome) components (Slovic 1987, Renn 1992). Risk perception is commonly measured in terms of the concepts of severity, or how serious the risk is perceived to be; susceptibility, or the perceived likelihood of the risk occurring; and dread, or the degree of worry or fear associated with the risk (Sjöberg 1998, Gore et al. 2009). Risk perception research has identified several characteristics that influence risk judgments, including an individual's level of knowledge and sense of control related to the risk and characteristics of the risk itself such as how novel it is and the degree of uncertainty surrounding it (Fischhoff et al. 1978, Slovic 1987, Siegrist et al. 2000). Factors such as gender, level of education, worldview, and trust in experts or management authorities also influence risk perceptions (Palmer 1996, Finucane et al. 2000, Siegrist and Cvetkovich 2000).

To provide greater empirical knowledge of disease risk perceptions relevant to wildlife disease management, our objectives were to assess risk perceptions of three different zoonotic diseases (i.e., rabies, plague, West Nile virus), identify relevant sociodemographic and social psychological factors that influence these risk perceptions, and examine the relationship between risk perception and agreement with wildlife disease management practices.

MATERIALS AND METHODS

We collected data from a self-administered questionnaire mailed to a random sample of adults (n = 901) residing in the continental United States. We obtained an address sample from Survey Sampling International (Shelton, Connecticut). Addresses on the mailing list were stratified by rural, suburban, and urban classification and by region (northwest, southwest,

midwest, northeast, southeast). We designed and implemented the questionnaire according to Dillman's (2007) standard four wave procedure. An initial survey was mailed on April 1, 2011; a postcard reminder was mailed on April 15, 2011; a second survey was mailed on May 11, 2011; and a third and final survey was mailed on June 1, 2011. Research methods were approved for use by the Michigan State University Social Science Institutional Review Board (IRB# 09-874).

The key dependent variable, risk perception, was measured using three conceptual elements widely used in the risk literature: severity (Table 4-1, A), susceptibility (Table 4-1, B), and dread (Table 4-1, C). For each respondent, we calculated a risk perception index score (severity + susceptibility + dread / 3). We used one of three different zoonotic disease examples in each geographic region to increase salience to respondents and to maximize response rate. Plague was the disease used in the northwest and southwest, rabies in the northeast, and West Nile virus in the midwest and southeast. We also measured risk perception across five different risk targets (i.e., entities affected by a risk): self, others, pets, domestic livestock, and wildlife.

We examined several independent variables based on practical and theoretical considerations: age; gender; education level; whether the respondent hunted; whether the respondent had children under the age of 18; whether the respondent lived in a rural area, suburban area, or city; respondent's knowledge of preventive measures (Table 4-1, D); respondent's exposure to the disease (Table 4-1, E); respondent's concern about health (Table 4-1, F and G); and respondent's beliefs about the influence of humans on nature (Table 4-1, H). We also examined relationships between risk perception and agreement with six wildlife disease management practices of varying intensity: letting the disease run its course, monitoring and

surveillance, public education, non-lethal management, selective killing (i.e., killing of relatively few individuals without the goal of reducing the population), and population reduction.

We examined relationships between variables using linear regression and assessed differences in means using paired samples and independent samples t-tests (Vaske 2008). To check for non-response bias in our sample, we conducted phone interviews with 100 randomly selected non-respondents who were asked a subset of 18 questions from the original questionnaire. We compared respondents and non-respondents using independent sample t-tests (Vaske 2008). We chose not to weight variables. Although weighting the data by demographic characteristics makes them more representative of the American population as a whole, doing so introduces additional biases and may compromise internal validity (Teel et al. 2002, Gore et al. 2005). Moreover, in addressing risk perceptions, it is important to consider the values of active stakeholders (e.g., those most likely to respond to the questionnaire) rather than treat the public as a single, homogeneous entity (Bennett et al. 2010).

RESULTS

The number of deliverable surveys was 5,073 from which 901 (17.8%) surveys were completed. Despite the overall low response rate, the sample size was adequate for generalizing to a large population at a 95% confidence level with a ±5% margin of error (Dillman 2007, Vaske 2008). Based on a post hoc telephone survey, we did not find evidence of significant non-response bias. Nearly two-thirds (65.1%) of our survey respondents were male. The median age of respondents was 58 years and 48.3% had at least a four-year college education. All geographic regions of the United States were adequately represented, ranging from 14 to 20% of total respondents. Respondents reported that they lived in rural areas (27.7%), suburban areas (20.1%), small towns (23.1%), mid-sized cities (16.5%), and large cities (12.7%). When asked

about participation in wildlife-related activities, 85.9% of respondents stated that they watch or observe wildlife often or from time to time and 28.7% hunted often or from time to time.

Risk perception index scores were greatest for rabies (2.59; SD = .52) and West Nile virus (2.62; SD = .62), which were not statistically different from each other, and least for plague (2.39; SD = .53). Respondents' risk perceptions were greatest when evaluating effects of disease on wildlife (2.72; SD = .68) and were lowest for effects of disease on humans, including others (2.44; SD = .61) and self (2.39; SD = .63). For the individual risk constructs, risk severity was judged to be higher for humans (self and others), but risk susceptibility and dread were judged to be higher for non-human targets such as wildlife and domestic animals. The consequences of contracting zoonotic disease were reported as most serious for humans (self and others) and least serious for pets and wildlife (Table 4-2). Overall mean risk severity (across diseases and risk targets) was 3.32 (SD = .66). A gradient of perceived severity occurred for the three diseases with mean severity greater for rabies than plague (t = 2.01, P = .045) and greater for plague than WNV (t = 2.95, P = .003).

Wildlife was reported as being most susceptible to zoonotic disease, followed by pets and livestock, with humans rated as least susceptible. Overall mean risk susceptibility (across diseases and risk targets) was 2.17 (SD = .67). Mean susceptibility was evaluated as being greatest for WNV (t = 3.82, P ≤ .001), then rabies, then plague (t = 3.09, P = .002). For the dread construct, respondents were most worried or fearful of zoonotic disease affecting wildlife, followed by domestic livestock and pets, and were least worried or fearful about zoonotic disease affecting humans (Table 4-2). Overall mean dread (across diseases and risk targets) was 2.13 (SD = .83). Mean dread was greatest for WNV (t = 2.22, P = .027) and least for plague (t = 4.58, P ≤ .001).

The four strongest predictors of zoonotic disease risk perception were gender, level of education, previous exposure to the disease, and concern for health effects of zoonotic disease (adjusted $R^2 = .45$). Women judged disease risks to be greater than did men (t = 3.40; P = .001)(Table 4-3) and respondents with at least a four-year college degree expressed lower risk perceptions than those without a four-year college degree (t = 6.90; P ≤ .001). Respondents who had been, or knew someone who had been, affected by rabies, plague, or WNV reported greater risk perceptions than those who did not (t = 3.30; P ≤ .001). Concern for health was associated with greater risk perception, whether the concern was general (i.e., the survey question asked about concern for health without specifying a disease; t = 6.94, P ≤ .001) or specific (i.e., the survey question asked about concern for health effects of rabies, plague, or West Nile virus; t = 25.18, P ≤ .001).

Disease risk perception increased with age of respondents (t = 3.10; P = .002) and was also greater for those who agreed that environmental problems are caused by humans interfering with nature and that disease has been made worse by humans (t = 2.37; P = .02). Risk perception was lower (t = 2.57; P = .01) for respondents who had children under the age of 18. We did not detect a difference between hunters and non-hunters in their risk perception index scores. However, when the three risk constructs were examined separately, hunters reported being more worried about zoonotic disease than non-hunters (t = 2.89; P = .004). Significant differences in disease risk perception were not detected based on whether a person lived in a rural area, suburban area, or city.

Respondents with greater disease risk perceptions were more likely to agree with wildlife disease management in general (t = 3.04; P = .003). With respect to specific wildlife disease management practices, individuals with greater disease risk perceptions were less likely to agree

with letting disease run its course (t = -5.11; P ≤ .001) and more likely to agree that public education (t = 3.60; P ≤ .001), non-lethal management (t = 3.64; P = .009), and selective killing (t = 2.49; P = .013) were acceptable management interventions. For wildlife population reductions, only the construct of risk severity had a positive influence on agreement (t = 2.30; P = .02). The positive association between agreement with wildlife disease management and risk perception occurred for all risk targets except "you personally" (t = 1.64; P = .102). The association was strongest for risks to domestic livestock (t = 3.34; P = .001) and wildlife (t = 3.19; P = .002).

DISCUSSION

When stakeholders evaluate wildlife disease risks they are not concerned solely with effects on humans (Cooney and Holsman 2010). In our study, risk perception was judged to be greatest in terms of effects on wildlife which indicates a belief in and concern for the vulnerability of wildlife to disease. Understanding key health concerns and the extent to which stakeholders emphasize one risk target over another (e.g., wildlife or humans) is important to promote public support for wildlife disease management actions and to help frame communication messages in ways that garner such support (Cooney and Holsman 2010). Different health priorities among stakeholder groups can be a source of significant conflict in wildlife disease management. For instance, in the case of brucellosis management in and around Yellowstone National Park, considerable conflict has developed from the perception of some stakeholder groups that agencies emphasize the health of domestic livestock at the expense of native wildlife (Bidwell 2010). Concern for the vulnerability of wildlife to zoonotic disease, together with the positive association between risk perception and concern for health protection, suggests that many stakeholders will be amenable to messages specifically emphasizing the

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threat disease presents to wildlife health and ways in which specific management actions are anticipated to benefit wildlife health.

Health protection is a common frame used by agencies to explain and justify wildlife disease management activities, with threats to human health typically receiving the most attention (Wobeser 2007). Our findings demonstrated broad health concerns related to zoonotic disease and wildlife disease management and raise the possibility that the public will be responsive to One Health messages (i.e., those that emphasize the interdependence of human, domestic animal, wildlife, and ecosystem health). Although the One Health paradigm is gaining prominence in the medical, veterinary, and conservation professions (King et al. 2008) its public appeal has not been closely examined, yet many of the most significant disease threats are zoonotic and therefore have potential for application of One Health-oriented messages.

Our data also indicated that disease risk perceptions are greatest among those who believe more strongly that disease and environmental problems are largely caused by humans. This result is consistent with other risk research that when a particular risk is viewed as involving negative and immoral human interference with nature, people tend to view the risk as being worse (Sjöberg 2000). Similarly, risks believed to be caused by human actions or failures, rather than by nature, are viewed with greater concern (Hampel 2006). It is helpful to understand this association between risk and naturalness because the perception that disease in wild animals is largely a natural phenomenon can lead to complacency, the belief that wildlife disease management is not important, and possible opposition to wildlife disease management practices (Wobeser 2007). Communication efforts that emphasize the influence of anthropogenic changes on zoonotic disease transmission and occurrence may be effective at influencing beliefs, thereby gaining greater public support for wildlife disease management programs. For example, diseases

such as Hanta virus, plague, West Nile virus, and Lyme disease can be linked to human influences on the environment such as changing weather patterns, flooding, and landscape alteration (AVMA 2008).

Our findings that gender and education level are strongly related to risk perception are consistent with other risk research. Gender consistently influences risk perception, with males expressing the lowest risk judgments across a variety of risks (Flynn et al. 1994, Finucane et al. 2000). The association between lower education level and higher risk perception related to wildlife has been observed by others (Sjöberg 1998, Riley and Decker 2000), although it remains unclear whether the difference is due to amount of knowledge, opposing value orientations, or other factors such as worldview or ideology (Wildavsky and Dake 1990, Sjöberg 1999). In light of evidence that risk denial (i.e., judging oneself to be less vulnerable to risks), gender, and education level influence risk perceptions, managers of disease risks can tailor communication messages to specifically vulnerable social and cultural groups to improve awareness of risks (Renn 2008). For example, one study specifically measured West Nile virus perceptions and prevention behaviors of women in the southeastern United States with the intent of being used to help develop West Nile virus prevention campaigns aimed at women in that region (Yerby 2007).

Our results suggest that level of risk perception influences stakeholder agreement with specific wildlife disease management practices and that the effect of risk perception on agreement with wildlife disease management exists regardless of whether the risk targets are human or non-human. This finding further supports the notion that stakeholders are concerned with health risks to animals (domestic or wild) as well as humans. Previous research suggests perceived risks to human health and safety can be strong influencers of attitudes about wildlife

and appropriate wildlife management practices (Fulton et al. 2004, Dorn and Mertig 2005, Jonker et al. 2009). Future research in this area that includes categories beyond human health and safety, such as One Health and wildlife health, will provide greater detail about the breadth of stakeholder health concerns related to wildlife disease management.

Our results have implications for researchers interested in the nature of risk perceptions related to wildlife health and management of wildlife disease and for managers who seek to improve communication with the public about wildlife health and disease issues. In an era of decreasing public trust in the expertise of health professionals (Jacobs 2005), effective risk communication is a critical component of wildlife disease management, particularly as it relates to prevention and mitigation of zoonotic diseases. Our research indicates that communication messages that emphasize the negative effects of disease on wildlife health specifically and that focus on the impacts of humans on zoonotic disease occurrence may encourage more supportive attitudes toward wildlife disease management practices. It seems evident that much of the public views wildlife as particularly vulnerable to disease and that public response to wildlife disease management is likely to be more supportive when the anticipated benefits to wildlife are made clear.

Table 4-1. Survey questions and measurement scales.

A. If the following were to contract [plague, rabies, West Nile virus], how serious do you think the consequences would be…?	1 – 4 (not serious, somewhat serious, serious, very serious)
B. In your opinion, how likely to contract (or catch) [plague, rabies, West Nile virus] are…?	1 – 4 (very unlikely, unlikely, likely, very unlikely)
C. Do you worry about or feel fearful of [plague, rabies, West Nile virus] affecting…?	1 – 4 (not at all, rarely, from time to time, a great deal)
D. Are you aware of practical, effective measures you can take to prevent [plague, rabies, West Nile virus]?	Yes or no
E. Have you, or do you know someone, who has contracted or otherwise been affected by [plague, rabies, West Nile virus]?	Yes or no
F. How concerned are you that [plague, rabies, West Nile virus] could affect the health of…[humans, pets, domestic livestock, wildlife, the overall ecosystem]?	1 – 5 (1 = not at all concerned, 3 = somewhat concerned, 5 = extremely concerned)
G. In general, how concerned are you about protecting the health of [humans, domestic animals, wildlife, the overall ecosystem]?	1 – 5 (1 = not at all concerned, 3 = somewhat concerned, 5 = extremely concerned)
H. Do you agree or disagree that: most environmental problems are caused by humans interfering with nature, the occurrence of disease (in general) has been made worse by humans and their activities?	1 – 5 (strongly disagree, disagree, neither agree nor disagree, agree, strongly agree)

Table 4-2. Perceived risk severity, susceptibility, and dread for five risk targets averaged across three zoonotic diseases.

Target	Mean severity (SD)	Mean susceptibility (SD)	Mean dread (SD)
Self	3.44 (.77)	1.81 (.78)	1.95 (.94)
Others	3.39 (.75)	1.95 (.76)	2.00 (.90)
Pets	3.22 (.83)	2.15 (.78)	2.15 (.93)
Livestock	3.34 (.74)	2.33 (.80)	2.25 (.95)
Wildlife	3.24 (.79)	2.61 (.84)	2.34 (.97)

Table 4-3. Factors influencing risk perception rankings for three zoonotic diseases.

Variables and direction	t and P values
Gender: women > men	t = 3.40 (P = .001)
Age: older > younger	t = 3.10 (P = .002)
Education: 4-year college degree < no degree	t = 6.90 (P ≤ .001)
Children under age 18 < no children	t = 2.57 (P = .01)
Exposure to disease > no exposure	t = 3.30 (P ≤ .001)
General concern for health: high concern > low	t = 6.94 (P ≤ .001)
Specific concern for health: high concern > low	t = 25.18 (P ≤ .001)
Tampering with nature: strong agreement > weak agreement	t = 2.37 (P = .02)

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CHAPTER 5

USING HEALTH BEHAVIOR THEORY AS A MODEL FOR UNDERSTANDING PUBLIC AGREEMENT WITH WILDLIFE DISEASE MANAGEMENT

ABSTRACT In support of the Association of Fish and Wildlife Agencies National Fish and Wildlife Health Initiative, the objectives of this research were to evaluate public agreement with different wildlife disease management strategies, assess factors influencing agreement, and test a health behavior theory, the Health Belief Model, as a theoretical framework for understanding agreement with wildlife disease management. We obtained data from a mail survey of United States residents (n = 901). Of six wildlife disease management strategies examined, there was strong disagreement with allowing disease to run its course and strongest agreement with public education and non-lethal management. Mean agreement with wildlife disease management was highest when the goal was to protect "one health" and lowest when the goal was to protect health of pets. The best predictor of agreement with wildlife disease management was whether respondents believed that it was likely to result in benefits they considered important. Based on path analysis, the Health Belief Model, consisting of the variables of perceived risk severity and susceptibility, concern for health, exposure to zoonotic disease, social trust, and belief in wildlife disease management having important benefits, was found to be a useful theoretical model for understanding factors that influence stakeholder agreement with wildlife disease management.

INTRODUCTION

Emerging and persistent zoonotic disease threats affect and are affected by wildlife, emphasizing the importance of effective wildlife management decisions that promote wildlife health. Good management decisions depend on accurate information about biological facts and about stakeholder values, preferences, and priorities (Gregory et al. 2006). The challenges faced

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in wildlife disease management demand interdisciplinary collaboration by all relevant disciplines (Deem et al. 2001). This includes human dimensions expertise since wildlife disease management entails managing people in addition to organisms and habitat (Henke et al. 2007, Wobeser 2007). Social science insights shed light on potential drivers of human behavior and inform managers of beliefs and attitudes that influence health concerns (Ostfeld et al. 2002). Prior experiences have shown that disease management driven chiefly by the perspectives of experts can lead to problems with public acceptance (Heberlein 2004, Beck et al. 2005, O'Brien et al. 2006). Understanding public attitudes toward management interventions helps agencies gauge public support for or opposition to future management policies and guides development of communications to gain public support for potentially controversial strategies (Carroll and Bright 2009).

Human dimensions research has revealed several factors that influence stakeholder agreement with wildlife management. Individual cognitive factors such as normative beliefs (Zinn et al. 1998); risk perceptions (Needham et al. 2004, Peterson et al. 2006); social trust (Vaske et al. 2004, Needham and Vaske 2008); wildlife value orientations (Zinn et al. 1998); and beliefs and attitudes about management actions (Fulton et al. 2004, Dorn and Mertig 2005, Bruskotter et al. 2009) affect agreement with management. Additionally, how a particular situation is perceived by stakeholders, including incident extremity and the specific management response, also affects agreement with management methods (Zinn et al. 1998, Manfredo et al. 1998, Loker et al. 1999, Reiter et al. 1999, Fulton et al. 2004, Decker et al. 2006, Jonker et al. 2009). A large body of research supports the conclusion that as threats to human health and safety increase, acceptance of more intensive (e.g., lethal) management strategies tends to increase (Dorn and Mertig 2005, Zinn et al. 1998, Peterson et al. 2006, Needham et al. 2004,

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Loker et al. 1999, Koval and Mertig 2004, Fulton et al. 2004, Jonker et al. 2009). However, human dimensions research focused specifically on wildlife disease management has been limited in scope with several studies exclusively examining chronic wasting disease (CWD) and hunters.

Research on the human dimensions of wildlife disease management can benefit from a theoretical focus. Theory helps identify the beliefs that need to be targeted to change people's attitudes and behavioral intentions and it is particularly useful for informing communication campaigns (Fishbein and Yzer 2003). Undergirding stakeholder judgments about appropriate management responses is a decision making process that leads to an expressed preference. Multiple theories exist about how humans decide on such preferences and one important group is that of the expected utility theories. Theories in this category hold that people "make decisions that maximize some subjective measure of value or welfare" (Slovic 1995: 364). The Theory of Reasoned Action (TRA) is an example of an expected utility theory based on evidence that beliefs about the likelihood of important outcomes inform attitudes toward a behavior which in turn influence intentions to engage in the behavior (Ajzen and Fishbein 1980). The TRA framework has been used to understand beliefs and attitudes related to wildlife management. For example, one study found that people were more likely to agree with white-tailed deer management strategies they believed would result in important, positive outcomes (Fulton et al. 2004).

No previous human dimensions research has quantitatively assessed agreement with wildlife disease management using health behavior theory as the theoretical framework. Since management of wildlife disease is commonly aimed at promoting health (e.g., wildlife, domestic animal, and/or human health), insights from theories of human health behavior have the potential

to add to our understanding of public acceptance of wildlife disease management. The Health

Belief Model (HBM) is one such theoretical approach. The HBM, which is a value expectancy

theory and is closely related to the TRA (Kretzer and Larson 1998), was developed by social

psychologists to describe how specific beliefs influence health behavior and behavioral decision-

making under conditions of uncertainty (Sharma and Romas 2008). Key elements of the HBM

include beliefs about: susceptibility to a health risk; seriousness or severity of the health risk;

perceived benefits (i.e., the extent to which a management strategy is believed to actually reduce

risk susceptibility and/or severity); perceived barriers (i.e., the extent to which significant

barriers are associated with a management strategy); and self-efficacy, or one's ability to

successfully engage in a health behavior (Janz and Becker 1984, Rosenstock et al. 1988, Koch et

al. 2005). Additional HBM constructs include general health motivation and cues to action,

which refer to events that influence people to change their behavior (Abraham et al. 1999).

This research supports the National Fish and Wildlife Health Initiative, a policy

framework developed to strengthen the ability of fish and wildlife agencies to address health

issues and to minimize the negative impacts of fish and wildlife health issues (AFWA 2007).

The research objectives were to evaluate agreement with wildlife disease management strategies,

to assess factors influencing agreement with wildlife disease management, and to test the HBM

as a theoretical framework for helping to understand and evaluate agreement with wildlife

disease management.

METHODS

Research data were obtained from self-administered mail surveys. Addresses in the

sample (N = 5,393) were obtained from Survey Sampling International (Shelton, Connecticut)

and were randomly selected from within the continental United States. The sample was stratified

by rural, suburban, and urban classification and into five regions: northwest, southwest, midwest, northeast, and southeast. Data collection involved a four-wave mailing strategy (Dillman 2000) beginning with a survey mailed on April 1, 2011; a postcard reminder mailed on April 15, 2011; a second survey mailed on May 11, 2011; and a third and final survey mailed on June 1, 2011. To encourage recipients to complete the survey, a lottery incentive (a chance to win one of 25 $50 gift cards) was used for the final mailing. To check for potential non-response bias, phone interviews were conducted with 100 randomly selected non-respondents who were asked a subset of 18 questions from the original questionnaire. This research was approved by the Michigan State University Social Science Institutional Review Board (IRB# 09-874).

The key dependent variables were mean agreement with each of six specific wildlife disease management strategies: the disease should be left alone and allowed to run its course, monitoring and surveillance, public education, non-lethal management such as vaccination, selective killing of diseased animals, and population reduction of the wildlife species to reduce disease spread. Another dependent variable was overall mean agreement with wildlife disease management which was calculated as average agreement across all six specific management strategies. Respondent agreement with wildlife disease management strategies was assessed across five different health protection goals: human health; health of pets; health of domestic livestock; wildlife health; and one health, which refers to protecting health of humans, domestic animals, and wildlife simultaneously. Respondents rated their agreement on a scale with response options of "strongly disagree," "disagree," "neither agree nor disagree," "agree," and "strongly agree." In conducting analyses, responses of "neither agree nor disagree" were dropped since such responses indicate a lack of opinion.

The key independent variables (Table 5-1) used to test the HBM were perceived risk severity [RISKSEV], perceived risk susceptibility [RISKSUSC], benefit index [BENEFIT], cost index [COST], health concern [HEALTH], experience with disease [EXPERIENCE], and trust in management authorities [TRUST]. The two risk perception elements, RISKSUSC and RISKSEV, were assessed in relation to one of three specific zoonotic diseases: rabies, plague, or West Nile virus. To maximize salience of the disease used in the survey, a different disease was selected for each geographical region: rabies in the northeast, plague in the northwest and southwest, and West Nile virus in the midwest and southeast. TRUST, an indicator of willingness to rely on those who have formal management and decision making responsibilities (Cvetkovich and Winter 2003), was used in lieu of the HBM variable of self-efficacy since the research question focused on actions carried out by wildlife management entities rather than the respondent personally. Data were analyzed using IBM SPSS Statistics 19 (2011). Differences in mean agreement levels were examined using a paired samples t-test or analysis of variance, associations between variables were tested using linear regression, and the HBM was analyzed using path analysis.

RESULTS

The total number of deliverable surveys was 5,073 and 901 surveys were completed, giving a final response rate of 17.8%. Upon comparing mail and telephone respondents, one estimate was found to differ ($P > .05$) between the two groups of respondents. Essentially, respondents were more likely to fish than non-respondents. Because this was not a variable important to the research question, non-response error was not considered to be problematic for the study.

Mean agreement with the individual wildlife disease management strategies ranged from 1.69 to 3.31 (Table 5-2). Agreement was greatest for non-lethal management and public education ($t \geq 3.82$, $P \leq .001$). Agreement with letting the disease run its course was significantly less than for all other management strategies ($t \geq -25.78$, $P \leq .001$). Mean agreement with wildlife disease management, excluding the let the disease run its course option, for the different health protection goals ranged from 3.10 for protection of pet health (SD = .43) to 3.17 for protection of one health (SD = .47). Mean agreement for one health was statistically higher than human health ($t = 2.24$, $P = .025$); pet health ($t = 5.23$, $P \leq .001$); livestock health ($t = 2.43$, $P = .015$); and wildlife health ($t = 3.12$, $P = .002$). Mean agreement for pet health was statistically lower than human health ($t = -3.13$, $P = .002$); livestock health ($t = -3.76$, $P \leq .001$); wildlife health ($t = -2.40$, $P = .016$); and one health.

Nearly two-thirds (65.1%) of survey respondents were male and the median age was 58 years. Nearly half of respondents (48.3%) had at least a four-year education. Geographically, all regions (northwest, southwest, midwest, northeast, southeast) were well represented in the sample, ranging from 14 to 20% of respondents. More respondents characterized their place of residence as rural (27.7%) than as suburban (20.1%), small town (23.1%), mid-sized city (16.5%), or large city (12.7%). When asked about participation in wildlife-related recreation, 85.9% of the sample responded that they watch or observe wildlife from time to time or often and 28.7% responded that they hunt from time to time or often.

Women had greater agreement than men with public education ($t = 3.70$, $P \leq .001$) and non-lethal management ($t = 2.47$, $P = .014$) and were less likely than men to agree with selective killing ($t = -2.06$, $P = .039$) and population reduction ($t = -2.77$, $P = .006$). Hunters were more likely than non-hunters to agree with letting disease run its course ($t = 2.93$, $P = .003$), selective

killing (t = 2.93, P = .004), and population reduction (t = 2.75, P = .006). Non-hunters were more likely to agree with monitoring and surveillance (t = 2.69, P = .007), public education (t = 3.28, p=.001), and non-lethal management (t = 3.10, P = .002). We observed no significant effects on agreement with wildlife disease management based on geographic region, age, education level, or urban/rural living areas.

Mean RISKSEV was 3.32 (SD = .66) and mean RISKSUSC was 2.17 (SD = .66). The mean for HEALTH was 4.30 (SD = .70). Concern was greatest, and did not statistically differ, for protecting health of humans and the ecosystem. The mean for TRUST was 1.86 (SD = 1.45). For EXPERIENCE, 10.8% of the sample responded affirmatively. Figures 5-1 and 5-2 show assessed importance of and agreement with the statements used to measure BENEFIT and COST. For the variable BENEFIT, the three most important outcomes were protecting human health, preventing the disease from spreading, and protecting ecosystem health, with 84.9%, 81.1%, and 79.8%, respectively, rating these outcomes important or extremely important. For the variable COST, the two most important outcomes were reducing uncertainty before managers act and being able to continue activities that one enjoys, with 86.9% and 69.3%, respectively, rating these outcomes important or extremely important.

Path analysis revealed four observed, endogenous variables: mean agreement with wildlife disease management, BENEFIT, RISKSEV, and RISKSUSC (Figure 5-3). The three observed, exogenous variables were HEALTH, TRUST, and EXPERIENCE. The chi-square goodness-of-fit test (X^2 = 56.42, P ≤ .001) and Comparative Fit Index (CFI = .927) values indicated adequate fit of the model to the data. The model is considered a good fit when the ratio between X^2 and degrees of freedom is < 2 (Ullman 1996) and when CFI is > .90 (Hu and Bentler

1999). The variable BENEFIT had the greatest direct effect on wildlife disease management

agreement and acted as a mediating variable for RISKSEV, HEALTH, and TRUST.

DISCUSSION

Agreement with management methods depends partly on stakeholder perceptions of the

problem and its proposed solution and can be influenced by how the situation is framed (Decker

et al. 2006). One key way that agencies frame wildlife disease management is in terms of

protecting health, whether human, wildlife, or domestic animal health (Wobeser 2007). The

finding that mean agreement changed only slightly for different health goals supports the idea

that framing wildlife disease management in "one health" terms (e.g., emphasizing the

interconnectedness of all health categories), when applicable, may be an effective way of

communicating with the public to explain and justify wildlife disease management. In contrast

with the commonly held belief that the public will only support wildlife disease management

when framed in terms of human health benefits, this research suggests there is likely to be a solid

foundation of public support for the One Health concept. One Health has been endorsed by

health professionals in many fields as a promising approach for more effective management of

zoonotic diseases (Decker et al. 2011). However, success of the One Health message in

promoting wildlife health may be contingent upon wildlife being framed as a victim of disease

rather than a perpetrator (Muter et al. 2009) to avoid the development of negative attitudes

toward wildlife if they become perceived as disease vectors.

Communication programs aimed at influencing stakeholder perceptions of wildlife

disease will be more effective if grounded in behavioral theory (Decker et al. 2011). The TRA

was supported by the finding that beliefs about positive and negative outcomes influenced

agreement with particular wildlife disease management strategies. Similar results have been

reported for white-tailed deer management in a national park in Ohio, where it was observed that differences in the acceptability of no action and lethal control management alternatives were strongly related to beliefs about, and evaluation of, outcomes associated with those management alternatives (Fulton et al. 2004). However, this study is unique in finding support for the TRA with respect to attitudes toward wildlife disease management at a national scale. These findings confirm that acceptance of management actions is influenced by preferences for particular outcomes of management as well as beliefs that the action will result in those desirable outcomes and not cause other, negative outcomes (Enck et al. 2006). In other words, management preferences are driven by anticipated consequences, both positive and negative, of actions. Further investigation of the extent to which management attitudes are influenced by these expected outcomes (ends) versus specifics of management actions (means) would provide valuable insights for understanding public attitudes related to wildlife disease management and other wildlife management actions.

Factors having the greatest influence on agreement with wildlife disease management strategies were risk perception and beliefs about the likelihood and importance of positive and negative outcomes related to wildlife disease management. These are key components of the HBM which hypothesizes that health related decisions and behaviors are influenced by saliency of health issues to the individual, belief that the health issue is serious and that one is susceptible to it, and belief that particular behaviors will be beneficial in reducing the health risk (Rosenstock et al. 1988, Sharma and Romas 2008). The low response rate obtained for this survey may be indicative of a general low saliency of zoonotic disease issues to much of the public. Yet, path analysis using HBM variables indicated that it is a useful model for understanding attitudes toward wildlife disease management. In addition to the direct effects of

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beliefs about the likelihood and importance of positive outcomes, perceived risk susceptibility

and severity, general health concern, agreement that wildlife management agencies make good

decisions (an indicator of trust), and prior experience with zoonotic disease had significant

indirect effects on agreement with wildlife disease management.

The HBM has been used as a framework with respect to zoonotic diseases in other

studies. For example, it has been used as a theoretical framework to guide focus group

discussions about wildlife biologists' use of personal protection equipment to reduce zoonotic

disease risks (Bosch et al. 2010) and to understand personal protective behaviors related to West

Nile virus (Aquino et al. 2004, Yerby 2007). All of these studies identified important barriers to

health behaviors which can be used to develop communication messages. Potentially important

barriers to agreement with wildlife disease management that emerged from my research include

high uncertainty surrounding management and negative effects of management on activities one

enjoys. Key positive outcomes, or benefits, were protection of human and ecosystem health and

preventing disease from spreading. Other important explanatory variables are not included in the

model but, based on the good fit of the HBM to survey data, agreement with wildlife disease

management may be improved by the use of communication messages that highlight the various

components of the HBM, including the nature of disease risks, benefits and barriers associated

with wildlife disease management, and health impacts of wildlife disease.

All wildlife management efforts should ensure that the outcomes of management are in

harmony with socially relevant impacts (Riley et al. 2003). An important implication of this

research is that to influence stakeholder agreement with wildlife disease management, wildlife

professionals need to address specific beliefs about the outcomes of management. This research

provided a suite of beliefs relevant to wildlife disease management generally, but it is also

important that managers and researchers identify outcome beliefs salient to immediate stakeholders to ensure well-designed communication campaigns (Fishbein and Yzer 2003). This research indicates that agreement with wildlife disease management is influenced by multiple health concerns and not all stakeholders are most concerned with protecting human health; in fact, ecosystem health was considered equally important which indicates that many stakeholders have a holistic perspective of health. Messages about risk severity and risk susceptibility are also important, although efforts to amplify or attenuate risk perceptions to promote wildlife disease management can backfire by negatively affecting public trust. Consequently, risk communication should be developed carefully (WHO 2002, Beck et al. 2005) and with the recognition that messages provided by wildlife professionals are just one of many potential sources of information about wildlife diseases available to the public (Heberlein and Stedman 2009). Finally, stakeholders consider both potential benefits and costs in evaluating wildlife disease management strategies and this implies that in conveying to the public the how and why of management, it will help to emphasize desirable, anticipated benefits and how feared negative outcomes will be minimized or mitigated.

Table 5-1. Health Belief Model variables used in path analysis.

RISKSEV (1 – 4 scale)	Respondents were asked one question with five parts: "If [X] were to contract [Y], how serious do you think the consequences would be?" X = you personally, people in your community, pets, domestic livestock, and wildlife. Y = West Nile virus, rabies, or plague, depending on the respondent's geographic region. This variable reflects each respondent's mean response across the five categories.
RISKSUSC (1 – 4 scale)	Respondents were asked one question with five parts: "In your opinion, how likely to contract [X], are [Y]?" X = West Nile virus, rabies, or plague, depending on the respondent's geographic region. Y = you personally, people in your community, pets, domestic livestock, and wildlife. This variable reflects each respondent's mean response across the five categories.
BENEFIT	Respondents were asked to rate their agreement with seven potential positive outcomes, or benefits, of wildlife disease management and the importance of each of these benefits to them personally. This variable is an index of agreement x importance. Individuals with higher scores on this variable believe positive outcomes that are important are more likely to occur.
COST	Respondents were asked to rate their agreement with seven possible negative outcomes, or costs, of wildlife disease management and the importance of each of these costs to them personally. This variable is an index of agreement x importance. Individuals with higher scores on this variable believe negative outcomes that are important are more likely to occur.
HEALTH (1 – 5 scale)	Respondents were asked "In general, how concerned are you about protecting the health of [X]?" X = humans, domestic animals, wildlife, the overall ecosystem. This variable reflects each respondent's mean response across the 4 categories.
EXPERIENCE (Yes or no)	Respondents were asked "Have you, or do you know someone who has, contracted or otherwise been affected by [Y]?" Y = West Nile virus, rabies, or plague, depending on the respondent's geographic region.
TRUST (1 – 4 scale)	Respondents were asked "Do you agree or disagree that wildlife management agencies make good wildlife management decisions?"

Table 5-2. Agreement with wildlife disease management options by health protection goal.[1]

	Human health	Health of pets	Health of domestic livestock	Health of wildlife	One health	Mean agreement
The disease should be left alone and allowed to run its course	1.73 (.70)	1.83 (.69)	1.72 (.67)	1.90 (.75)	1.70 (.70)	1.69 (.60)
Monitoring and surveillance of the disease	3.07 (.65)	3.05 (.63)	3.09 (.66)	3.12 (.60)	3.14 (.69)	3.13 (.57)
Public education	3.26 (.60)	3.24 (.54)	3.25 (.58)	3.25 (.55)	3.28 (.59)	3.29 (.50)
Management of the disease with non-lethal methods	3.28 (.57)	3.27 (.55)	3.25 (.58)	3.22 (.56)	3.28 (.57)	3.31 (.48)
Selective killing of diseased animals	3.14 (.63)	3.05 (.63)	3.12 (.64)	3.10 (.61)	3.13 (.62)	3.16 (.54)
Population reduction of the wildlife species to reduce disease spread	2.97 (.75)	2.91 (.73)	2.97 (.75)	2.97 (.72)	3.01 (.73)	3.01 (.67)

[1]Agreement measured on a four point scale: 1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree.

Figure 5-1. Mean agreement and importance for beliefs about positive outcomes of wildlife disease management.[1]
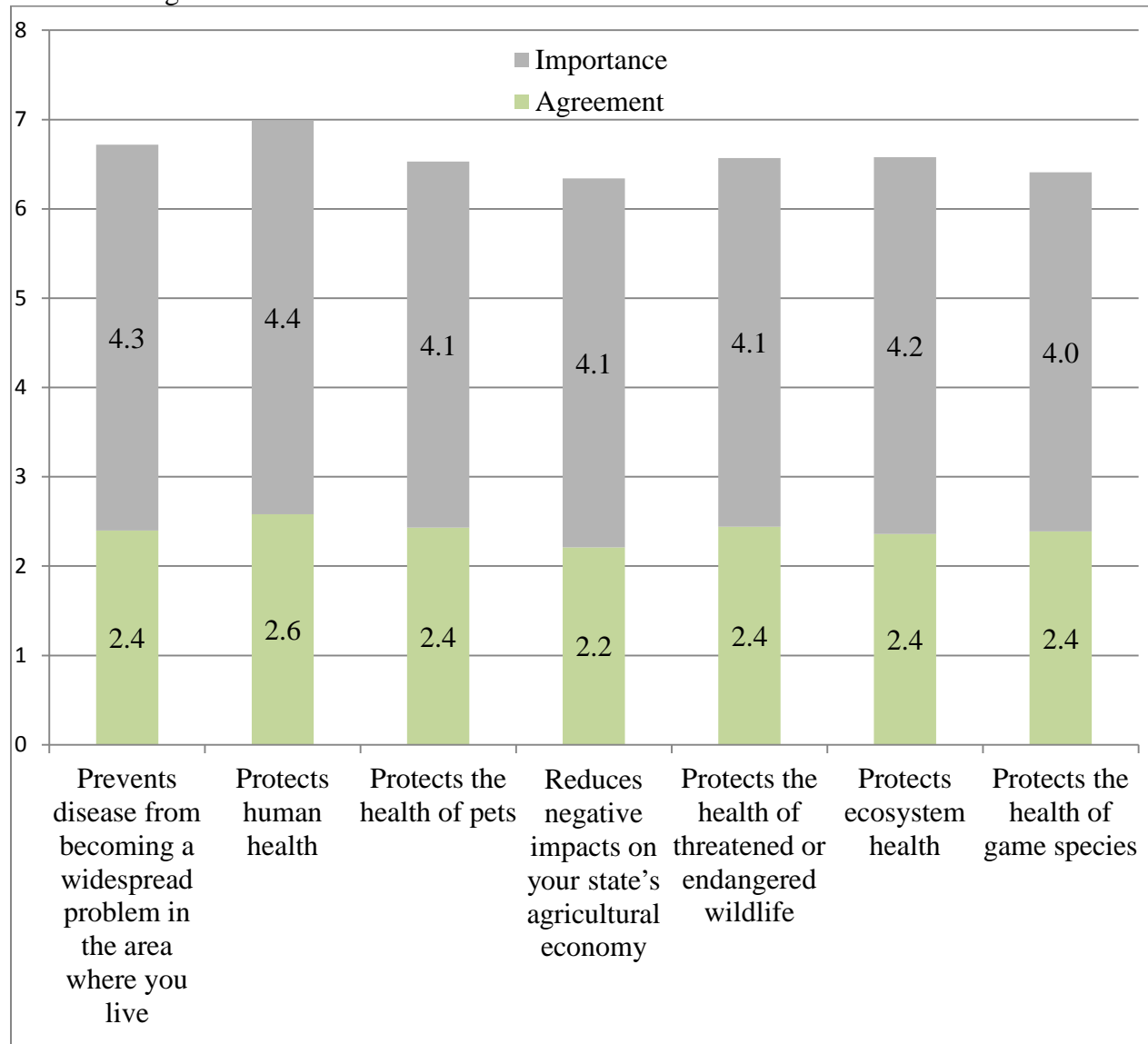
[1] Importance measured on a five point scale. Agreement measured on a four point scale.

Figure 5-2. Mean agreement and importance for beliefs about negative outcomes of wildlife disease management.[1]
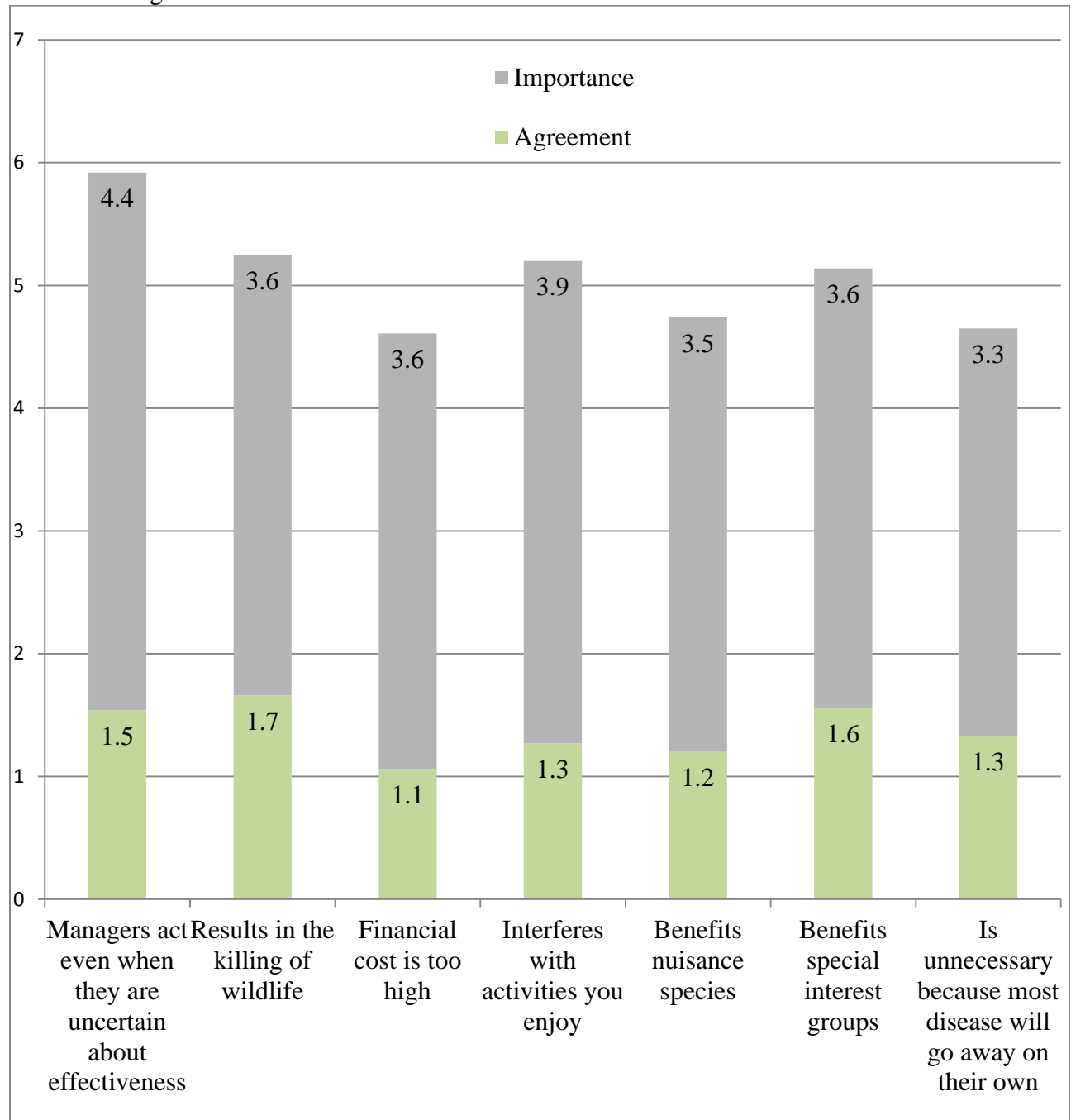
[1] Importance measured on a five point scale. Agreement measured on a four point scale.

Figure 5-3. Path diagram showing standardized path coefficients for the Health Belief Model as applied to understand agreement with wildlife disease management.
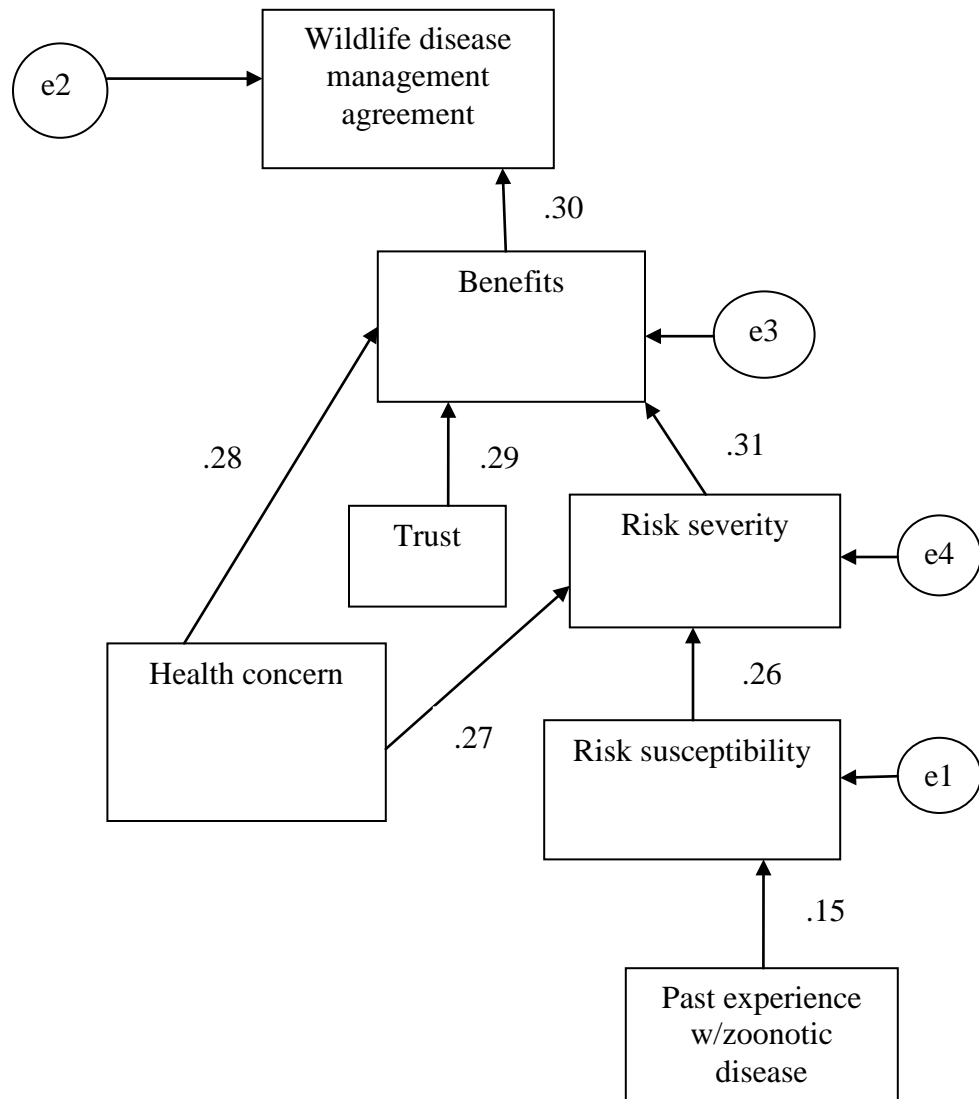
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CHAPTER 6

THE UPSHOT: RECOMMENDATIONS TO WILDLIFE DISEASE MANAGERS

"Public education is a valuable component of many management programs; both to gain public support through demonstrating the need for management and to change human activities that influence the disease." (Wobeser 2002)

"[D]ecision-making…is a social and political process and…decisions are neither objective nor defensible if based on clinicians' own interests and value systems." (Sorensen and Iedema 2007)

My research has aimed to shed light on expert and lay stakeholder understandings of wildife health, zoonotic disease, and related management interventions. This goal is based in the belief that wildlife management will have reduced success if it consistently emphasizes wildlife professionals' values, worldview, and associated beliefs at the expense of understanding the perspectives of the public. In the face of complex natural resource problems such as wildlife disease management, it seems important to recognize that relevant knowledge is not limited to scientific experts (McDaniels et al. 1999), and that management requires an understanding of, and respect for, different stakeholders' perspectives (Bosch et al. 2003). It is, after all, for the citizens' benefit that wildlife professionals have been given the responsibility to protect, conserve, and manage wildlife species (Conover 2002).

Although the culture of wildlife biology has been slow to accept it, the wildlife management system necessarily includes sociocultural elements. Human dimensions entails improving understanding of stakeholder values, beliefs, and attitudes so that better—that is biologically sound and socially legitimate—management decisions can be made. Greater inclusion of human dimensions knowledge is a critical step but how wildlife professionals view the role of human dimensions should go beyond provision of social data (Patterson and Williams 1998). Moving beyond that perspective requires explicit recognition of the integral role of both

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facts and values in management decisions. Wildlife disease management has been slower to

integrate human dimensions insights than has wildlife management generally, perhaps because

disease, health, and veterinary medicine are still viewed as highly technical issues, and it is,

consequently, still dominated by an expert-authoritative approach to stakeholder involvement

(Decker and Chase 1997). Yet, past experiences with domestic animal and wildlife diseases have

demonstrated the power of public opinion in hindering the achievement of disease management

goals. Examples include chronic wasting disease in Wisconsin, bovine tuberculosis in Michigan,

brucellosis in the Greater Yellowstone Area, and foot and mouth disease and bovine spongiform

encephalopathy in the United Kingdom; efforts to manage these diseases have revealed the great

chasm that sometimes exists between expert and lay risk perceptions related to the disease itself

and the proposed management solutions (Heberlein 2004, O'Brien et al. 2006, Shumaker et al.

2012, Wilkinson et al. 2010, Beck et al. 2005).

Why do these differences in perspective occur when, as discussed in Chapter 2, health is

essentially viewed as a universal good? My research suggests it isn't that experts and laypersons

have starkly different perspectives on the meanings of wildlife health and disease. In comparing

expert and layperson mental models, I found a high degree of conceptual common ground. Both

groups emphasized that key elements of wildlife health include population sustainability,

physical health of animals, habitat quality, and ecosystem health. Key differences were that

experts more frequently included population resiliency as a characteristic of wildlife health

whereas laypersons more frequently applied the concept of balanced populations (i.e., within

carrying capacity) to wildlife health. Experts also viewed wildlife health as being very distinctly

a multidisciplinary concept and as influenced by multiple stressors. It also seems evident that

experts are more likely to view wildlife disease as being anthropogenic, whereas laypersons are

more likely to view it as a natural phenomenon. As one of the Delphi panel experts commented, "Pathogens and parasites are natural organisms within ecosystems. What is not natural is how humans have changed which ones are present."

Although expert and layperson conceptualizations of wildlife health and disease were largely similar, the differences may be important. As discussed in previous chapters, the perspective that "disease is natural" can hinder support for management. If laypersons view the notion of population balance, especially as it relates to avoiding overabundance, as more important than wildlife professionals, disconnect and conflict are more likely to occur when, for example, the public desires management and experts prefer a "hands off" approach. In addition, a common theme expressed in the focus groups as a factor influencing participants' evaluations of wildlife disease management was uncertainty and a desire to know that managers understand the outcomes of what they plan to do. This emphasis on predicting consequences clearly presents a challenge because wildlife disease management is often characterized by uncertainty, both about the disease itself and the best management response. When a human-wildlife conflict is characterized by high uncertainty and high stakeholder concern about uncertainty, how wildlife disease managers address the risks and uncertainty surrounding the issue is critical. It is also particularly important to include stakeholders in these management decisions because failure to involve stakeholders or to effectively communicate uncertainty can backfire and negatively affect stakeholder trust in management authorities (Renn 2008). Generally, individuals with greater trust in the management authority responsible for a particular hazard judge risks associated with that hazard to be lower (Siegrist and Cvetkovich 2000, Vaske et al. 2004). Given the close connection of disease management to so precious, and tenuous, a thing as

health—be it human, wildlife, domestic animal, or ecosystem health—the importance of maintaining trust can hardly be overstated.

My focus group research indicated that stakeholders are not only concerned about risks from the disease itself but also risks from management. The weighting of these different risks by experts and laypersons is a crucial aspect of conflict over wildlife disease management, a lesson that has been learned from management of bovine spongiform encephalopathy and foot and mouth disease in the United Kingdom where many stakeholders emphasized animal welfare concerns while experts emphasized eradication (Wilkinson et al. 2010). Similarly, with respect to CWD management in Wisconsin experts were focused on deer health and eradicating the disease whereas landowners were concerned about issues such as trespassing, hunting practices, and deer density (Heberlein 2004).

A recurring theme throughout my dissertation has been the importance of developing communication messages that explain risk and associated management not from a technical, expert-centered perspective, but in a way that is relevant to stakeholder values, beliefs, and attitudes. Such an approach does not seek to encourage irrationality but rather recognizes that experts and laypersons have different frames of reference for evaluating a given risk (Morgan et al. 2002) and that these different perspectives will often lead to different opinions on the acceptability of risk and associated management interventions. As noted by Blaine and Powell (2001: 179), "the challenge is to incorporate public perceptions...without abdicating the leadership role of [biological] science." Wildlife disease management efforts will be more likely to succeed if the public understands why and how management will be conducted (Wobeser 2007). Yet without the recognition that stakeholders will not necessarily agree with managers'

assessments of the need for management, regardless of how plainly and clearly that message is communicated, truly effective communication will be hindered.

Communication can, at best, alter old beliefs or change new ones and, therefore, effective communication strategies will focus on appropriate beliefs that influence attitudes (Fishbein and Yzer 2003). With this in mind, my research supports communication messages that address expected outcomes of wildlife disease management—individuals were more likely to support management when they believed important positive outcomes were likely to occur. At the same time, individuals who believed more strongly that important negative outcomes were likely to occur were more supportive of "hands off" strategies such as letting the disease run its course or monitoring the disease, so it is important to also understand and address concerns about negative effects of management. A model based in health theory which included the variables of agreement with positive outcomes, perceived severity of disease risks, concern for health, and trust in wildlife management agencies was tested and found to be a good fit for understanding agreement with wildlife disease management. The model indicates that influences on attitudes toward management include cognitive factors related to expected outcomes of management, the importance of protecting health, seriousness of the disease, and trust in wildlife management agency decisions. These beliefs can be addressed in wildlife disease communication messages by providing evidence of the benefits of wildlife disease management, emphasizing health implications of the disease, educating stakeholders about disease risks, and engaging in trust-building planning processes.

Risk perception, as measured by the constructs of severity, susceptibility, and dread related to three zoonotic diseases (rabies, plague, West Nile virus), was found in this study to influence attitudes toward wildlife disease management. Stronger risk perception was associated

with less support for letting the disease run its course and greater support for other management strategies, including lethal and non-lethal approaches. Factors that most strongly influenced risk perception were gender and education, with women and those with less formal education having greater risk perceptions; prior exposure to the disease, likely due to increased perception of susceptibility to disease; and concern for the effects of zoonotic disease on health. Stronger beliefs that environmental problems generally and disease specifically are amplified by human actions were associated with greater risk perception. Although managers can attempt to alter stakeholder risk perceptions through communication efforts, for example by highlighting efficacy messages (Decker et al. 2012) and contextualizing risk probabilities, risk perception has an affective, often fear-based, component that may prove more difficult to influence (Gray and Ropeik 2002). Additionally, there are several factors that influence risk perception that are outside the control of wildlife managers, including gender, age, worldview, and even media influence (Gore et al. 2005). Of all the factors that influence stakeholder agreement with wildlife disease management, risk perception requires particular caution. Although stronger risk perceptions tend to encourage greater agreement with wildlife disease management, overstating disease risks could damage stakeholder trust in agencies and could lead to public backlash against wildlife that are viewed as vectors of disease (Cooney and Holsman 2010, Decker et al. 2011).

A factor that makes wildlife disease management unique, particularly when the relevant disease is zoonotic, is the complex interplay of risks and benefits. Evaluation of disease management outcomes by stakeholders is not simple when at times the main goal may be to protect human health, the agricultural economy, or wildlife health. There is likely to be an ambiguous effect of pro-wildlife value orientations and attitudes on agreement with wildlife

disease management because of these varying goals, particularly in situations where management involves lethal methods such as culling. For example, although an individual may support the general notion of improving wildlife health, they may disagree with specific methods or prioritize certain species over others. Consequently, situational specifics are likely to have a stronger influence on decisions about the acceptability of wildlife disease management than on issues that are perceived to be more black and white by many stakeholder groups (Decker et al. 2006). Because of these situational nuances, pre-existing attitudes may also be less likely to bias information processing related to agreement with disease management, making the potential greater for framing by others, such as via communication messages designed by wildlife professionals, to influence judgments (Wilson and Bruskotter 2009).

The future holds promising opportunities to communicate and interact with stakeholders about wildlife health, zoonotic disease, and disease management. The findings of my research are, I believe, encouraging. Survey respondents were equally concerned about protecting the health of humans and the ecosystem, thereby demonstrating a broad perspective of health, and they also showed a high degree of concern for the effects of zoonotic disease on multiple categories of health as well as signs of support for a one health-focused approach to wildlife disease management. If wildlife managers continue to build off these positive indicators by proactively communicating about disease issues and ensuring the inclusion and consideration of stakeholder understandings of *all* the significant risks relevant to a management scenario, they should find themselves in a better position to make decisions that promote the health of our wildlife resources.

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APPENDICES

<center>**APPENDIX A**</center>

<center>**METHODOLOGICAL CONSIDERATIONS: THE DELPHI METHOD, FOCUS GROUPS, AND SURVEYS**</center>

The Delphi method

The Delphi method is a structured communication process using participants chosen for their expertise in the subject matter (Dalkey and Helmer 1963, Linstone and Turoff 1975, Moore 1987). The Delphi method is an iterative process that entails anonymous feedback of individual contributions, assessment and sharing of collective judgments, and opportunities for individuals to assess differing viewpoints and revise their own views (Linstone and Turoff 1975). It can be conducted by email and thus works well for geographically distant participants. Originally, the Delphi method was used for developing group consensus on a topic but it can also be used to determine alternatives, explore underlying assumptions, reveal group values, and aid in concept/framework development (Turoff 1970, Moore 1987, Okoli and Pawlowski 2004). The organization for this review of the Delphi method entails brief overviews of several Delphi-related papers.

The Delphi technique provides a structured process for collecting and examining group agreement on a topic (Becker and Roberts 2009). It can be used without face-to-face contact, thus facilitating a wider group of participants. It is a structured process in which panel members individually respond to statements and a system of repeated rounds providing feedback of information and iteration is used. The Delphi technique requires that due care be taken in the choice of expert participants, development of statements, methods of analysis, and determination of consensus to avoid bias and misrepresentation. Participants in a Delphi exercise should have

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the capacity and willingness to contribute to the exploration, time available, access by e-mail, and ability to communicate in English (Becker and Roberts 2009).

The Delphi technique is a systematic method for reaching consensus among experts in which absolute, quantitative answers are either unknown or unknowable (Clark et al. 2006). It is an iterative process characterized by anonymity among the participating experts, controlled feedback via the principal investigator, and a statistical estimator of group opinion. Dalkey (1969) showed that the anonymous controlled-feedback process made group estimates more accurate than estimates resulting from face-to-face discussions. Applied to complex issues, it also has the advantage of allowing participants time to consider the questions (Clark et al. 2006).

The Delphi method operates on the principle that several heads are better than one in making subjective conjectures about the future, and that experts will make conjectures based upon rational judgment and shared information rather than merely guessing (Weaver 1971). It is assumed that experts are experts because they are objective, take into account new information, and construct logically sound deductions about the future based upon a thorough and disciplined understanding of particular phenomena (Weaver 1971). In order to accomplish structured communication, the Delphi method provides: feedback of individual contributions of information and knowledge; assessment of the group judgment or view; opportunity for individuals to revise views; opportunity to react to and assess differing viewpoints; and anonymity for individual responses (Linstone and Turoff 1975). Delphi panelists are chosen for their expertise in the subject matter rather than through a random process.

The objective of the Delphi method is to achieve a reliable consensus of expert opinion (Dalkey and Helmer 1963). It seeks to accomplish this by a series of intensive questionnaires interspersed with controlled opinion feedback. The questions, which are all centered around

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some central problem, are designed to bring out the respondent's reasoning that went into his reply to the primary question and the factors he considers relevant to the problem. The Delphi method is considered to be very conducive to development of preliminary insights on the subject even though the opinion consensus may not have high reliability (Dalkey and Helmer 1963).

One of the Delphi method's principal uses has been to make future projections and forecasts. However, it can also be used to identify goals and objectives, array possible alternatives, establish priorities, reveal group values, and gather information. A Delphi exercise is useful when: a problem does not lend itself to precise analytical techniques but can benefit from subjective judgments on a collective basis; more individuals are needed than can effectively interact in a face-to-face exchange; time and cost make frequent group meetings infeasible (Linstone and Turoff 1975).

In a Delphi exercise, an expert panel of ten is probably ideal, but more than ten may be used (Crance 1987). Overrepresentation by stakeholders or individuals from a single agency, interest group, or geographical area should be avoided where possible. The number of rounds required to complete an exercise can be kept to a minimum by providing the panelists clear objectives, definitions, guidelines, and instructions at the beginning of round 1. The quality of Delphi responses is very much influenced by the interest and commitment of the participants (Crance 1987). The questionnaire is the essential tool of the Delphi method. The assumptions of the Delphi method are that respondents are selected because they are experts on the subject and the purpose is to pool judgments and/or give advice, not to generalize about a population. Nominal groups and ideawriting (and presumably focus groups) are useful techniques for front-ending the Delphi (Moore 1987).

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A Policy Delphi is a variant of the Delphi method that can be used to analyze lines of divergence within the policy community (Buck 1993). The Policy Delphi was introduced in 1970 as a means of defining and differentiating the viewpoints of advocate groups rather than establishing the consensus of unbiased experts; it is used as a means of analysis instead of a tool for decision making. The Policy Delphi is a reiterative statistical technique used to discern differences in perspective among and within groups responsible for formulating policy. Each group in the policy community has a different operational perspective and hence a potentially different perception of the overall goals of the policy process. The Delphi can answer questions such as where and to what extent do differences exist on the relative importance of policy goals?

Possible objectives of a Policy Delphi include: to explore or expose underlying assumptions or information leading to differing judgments; to correlate informed judgments on a topic spanning a wide range of disciplines; to educate the respondent group as to the diverse and interrelated aspects of the topic. Turoff (1970: 151) stated that, "A policy question is one for which there are no experts, only advocates and referees. An expert or analyst may contribute a quantifiable or analytical estimation of some effect resulting from a particular resolution of a policy issue, but it is unlikely that a clear-cut (to all concerned) resolution of a policy issue will result from such an analysis; the issue then ceases to be one of policy." A Policy Delphi deals largely with statements, arguments, comments, and discussion. To establish some means of evaluating the expressions of the respondents group, rating scales must be established for such items as the relative importance, desirability, confidence, and feasibility of various policies and issues (Turoff 1970).

The Delphi method has traditionally been used to generate a group opinion or statistical consensus from a panel of experts on technical or prognostic issues. An underlying assumption

of the Delphi technique is that the statistical information provided to each panelist in successive

rounds brings about a reconsideration of previous estimates and thereby generates a higher

degree of consensus. For example, the Policy Delphi method has been used to test for

differences and consistency in the perception of legislative goals and objectives among and

within the various participant groups who create and implement policy (Buck 1993). The

following Delphi features were used in that particular study: anonymity, controlled feedback, and

statistical measurement of agreement and dissent. The criteria used to decide when to terminate

the Delphi process were stability and convergence. Two panels of participants were established,

the first group had 20 members and approximated an 'expert panel' in the classical Delphi sense.

The second panel, a 'policy panel,' consisted of position advocates in the implementation

process. This policy panel was given the task of assigning relative weights to each of the goals

and objectives developed by the expert panel (Buck 1993).

The two main applications of the Delphi method have been forecasting and issue

identification/prioritization and concept/framework development (Okoli and Pawlowski 2004).

The literature recommends ten to 18 experts on a Delphi panel. The Delphi method can be used

by researchers in a number of ways related directly to theory building. It can help them to

identify the variables of interest and generate proposition and it can help with definition of

constructs and creation of a common language for discourse (Okoli and Pawlowski 2004). One

study in particular selected the Delphi method for the following reasons: the topic was complex

and the authors thought a Delphi study would answer their questions more appropriately; a panel

study does not require experts to meet physically; Delphi panel size requirements are modest;

and the Delphi study is flexible in its design and amenable to follow up interviews which allows

collection of richer data leading to deeper understanding. The Delphi study administration

process includes three main phases, each of which involves one or more questionnaires (Okoli and Pawlowski 2004):

Phase 1: Brainstorming

Within this phase, Questionnaire 1 entails open-ended solicitation of ideas and Questionnaire 2 entails validation of categorized list of factors, asks experts to verify that their responses have been correctly interpreted, and refines the categorizations of the factors.

Phase 2: Narrowing down factors

Within this phase, Questionnaire 3 entails sending the lists to each expert and asking them to rank factors according to their importance. Factors selected by over 50% of experts are retained in the next list iteration.

Phase 3: Ranking relevant factors

In this phase, Questionnaire 4 strives to reach a consensus in the ranking of the relevant factors which entails each panelist ranking factors on the pared-down list (they are also asked to explain or justify their rankings). The mean rank for each item is calculated and consensus is assessed using the statistic Kendall's W.

Focus groups

A focus group is a special type of group interview that is structured to gather detailed opinions and knowledge about a particular topic from selected participants (Bader and Rossi 2002). The focus group process provides a structured, organized method to collect input from groups (Bader and Rossi 2002). "The purpose of a focus group is to listen and gather information…a focus group study is a carefully planned series of discussions designed to obtain perceptions on a defined area of interest in a permissive, nonthreatening environment" (Krueger

and Casey 2000). The intent of the focus group is to promote self-disclosure among participants, to find out what they really think and feel (Krueger and Casey 2000).

Focus groups are not random discussions among a group of individuals who are brought together haphazardly. Rather, they are group discussions among carefully selected individuals guided by a skilled moderator who follows a well-constructed interview guide (Stewart and Shamdasani 1990). Five particular features of focus groups are: (1) people who (2) possess certain characteristics and (3) provide qualitative data (4) in a focused discussion (5) to help understand the topic of interest (Krueger and Casey 2000).

Focus groups can be used when: you are looking for the range of ideas or feelings that people have about an issue/topic; you are trying to understand differences in perspectives between groups or categories of people; the purpose is to uncover factors that influence opinions, behavior, or motivation; and/or you want ideas to emerge from the group (Krueger and Casey 2000). Advantages of using focus groups include: focus group data reveals more information than do surveys, they provide detailed qualitative data that allows for greater depth of understanding, and they allow participants to express their opinions and concerns without much preparation or effort (Bader and Rossi 2002).

One of the key disadvantages of using focus groups is transcription management, though Scott et al. (2009) noted that the use of professional court reporters for conducting "real-time transcription" is a reliable and valid way of transcribing focus group interviews. Advantages of using court reporters are increased accuracy, timely receipt of transcripts, less distraction for focus group facilitators, time saved reviewing transcripts, and convenience.

The most important step in planning a focus group is agreeing on the purpose for the session. Six questions guide development of the purpose statement: 1) What is the reason behind

the decision to use focus groups?; 2) What is the general issue?; 3) What are the specific issues?; 4) What goals do you hope to meet using focus groups?; 5) What purpose will the information serve?; and 6) From whom do you want to collect information? (Bader and Rossi 2002, Krueger and Casey 2000).

The interview guide sets the agenda for a focus group discussion. When designing the interview guide it is important to remember that its purpose is to provide direction for the group discussion rather than acting as "a verbal version of a survey questionnaire" (Stewart and Shamdasani 1990). A focus group should not last more than 2 hours, although some topics create "cognitive fatigue" more quickly than others. Different groups will spend very different amounts of time on individual topics but, generally, the more complex a topic, the more emotionally involving the topic, or the greater the difference in views about the topic, the fewer the topics and specific questions that can be covered. In practice, most interview guides consist of less than a dozen questions (Stewart and Shamdasani 1990).

It isn't always the case that less structure is better in focus group interviews. Some people need help in articulating a response; providing a key word or cue may help respondents to formulate answers. On the other hand, the interviewer should not "lead" the respondent to answer a certain way. Because the objective of a focus group is to stimulate discussion, questions that call for a direct, one- or two-word response should be avoided. Questions that include words such as how, why, under what conditions and similar probes are useful. Questions should be phrased simply and in language that respondents understand. Pretesting of the interview provides an opportunity to determine whether the wording of questions is appropriate, to determine whether the questions elicit discussion, and to identify questions that are not understood easily (Stewart and Shamdasani 1990).

Two critical elements in successful focus group research are the recruitment of participants and the design of the interview guide. Only by careful definition of the research question can the type of group required for a focus group be identified. Once the research question has been articulated clearly, it is possible to move on to the recruitment of participants and the design of an interview guide (Stewart and Shamdasani 1990). The intent of virtually all focus groups is to draw some conclusions about a population of interest, so the group must consist of representative members of the larger population. When pre-existing lists are not available, the only alternative is to contact individuals by telephone, by mail, or by intercepting them in public places. The first step in recruiting a focus group is an initial contact (by mail, telephone, or in person) to invite participation (Stewart and Shamdasani 1990).

The purpose drives the study (Krueger and Casey 2000). When deciding who to invite to participate in a focus group, think about the purpose of the study and what kind of people can give you the information you're looking for. Is the target audience distinctive, identifiable, and reasonable to locate? The goal with focus groups is to have a homogeneous group. A focus group should have homogeneity but with sufficient variation among participants to allow for contrasting opinions (Krueger and Casey 2000).

The optimal size for a focus group is ten to 12 participants (Bader and Rossi 2002). However, Krueger and Casey (2000) recommend that for non-marketing research involving complex topics, the ideal size is 6-8 participants (they advise never to have more than ten people in a focus group). Mini-focus groups with four to six people are even becoming popular because they are easier to recruit and host and participants feel more comfortable (Krueger and Casey 2000).

The rule of thumb is to plan three to four focus group sessions with any one participant group. Once these have been conducted, determine if you've reached "theoretical saturation" (the point at which you've heard the range of ideas and aren't getting new information). Single category design focus groups only interview one participant group. Multiple category design focus groups interview multiple groups, either sequentially or simultaneously; the researcher can make comparisons from one group to another within a category and from one category to another category. A double layer design focus group involves multiple "layers"; one layer could be geographic region and the second layer is the different audiences (e.g., experts and the public)(Krueger and Casey 2000).

An effective facilitator should be energetic, personable, organized, a good listener, experienced, and knowledgeable of the issue or topic. It is best to use the same facilitator for all focus group sessions (Bader and Rossi 2002). Participants are the central players in the focus group session because their input about needs, values, and perceptions delivers the end results. General rules for participant selection are: select only participants who are affected by the issue/topic; do not include volunteers; for each session, participants should be from the same organizational level (i.e., no mixing of staffers and bureau chiefs); select a representative sample, though it need not be random (Bader and Rossi 2002).

Surveys

A survey involves the gathering of data by use of some form of questionnaire administered to a sample of individuals (Vaske 2008). Survey research enables generalization from a sample to a population to allow inference about certain characteristics, attitudes, and/or behaviors of the population (Babbie 1990, Creswell 2009). The goal of conducting a survey is commonly "explanatory" in nature, i.e., to identify possible causal relationships and improve

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understanding of those relationships (Vaske 2008). Advantages of survey research include usefulness for describing characteristics of larger populations, ability to compare among groups because of standardization of questions, ability to gather data from large samples in a short amount of time, and ability to ask numerous questions in one survey (Vaske 2008). Disadvantages of survey research are that it requires all questions to be understandable to all potential respondents, questionnaires are not very flexible, survey questions can come across as artificial to respondents, and survey questions cannot capture the depth and complexity that qualitative data do (Vaske 2008).

The survey process involves more or less 6 steps: determining the research objectives, developing the questionnaire, designing the sampling approach, developing plans for data collection and processing, collecting and processing the data, and analyzing data (Biemer and Lyberg 2003). Vaske (2008) reduced the survey process to 3 major tasks: specification of questions or hypotheses, determination of survey methodology, and data analysis. The ideal survey question allows each potential respondent to interpret it in the same way, to respond accurately, and to be willing to answer (Dillman 2000).

Self-administered mail surveys require an address list of a sample from a population (Vaske 2008) so that the survey can be mailed to and potentially completed by each sample member. Data quality is closely related to the quality of the questionnaire design (Biemer and Lyberg 2003). Mail surveys are quicker and cheaper than interviews, and less prone to social desirability bias, but they are prone to low response rates (Vaske 2008). The Dillman total design method (Dillman 2000) provides a strategy for collecting mail survey data using a step by step process and social exchange theory (a theory of human behavior which holds that individuals' actions are motivated by the return their actions are expected to bring from others)

to increase response rates. Its goal is to reduce overall survey error (Dillman 2000). The 5 elements for achieving high response rates, according to Dillman (2000), are: a respondent-friendly questionnaire, multiple contacts (mailings) by first class mail, return envelopes with real first-class stamps, personalization of correspondence, and financial incentives.

The use of random sampling to conduct surveys has several advantages: it produces samples that are representative of the entire population; it provides a theoretical basis for statistical inference; it is fairly easy to apply; it entails reproducible methods; and it provides measures of precision of estimates that can be predetermined accurately by the researcher based on the sample size (Biemer and Lyberg 2003). In a simple random sample, every unit within the sampling frame has an equal probability of selection. When conducting statistical inference from a sample, although the closeness of an estimate to the actual population parameter is unknown, a confidence interval can be computed to give an idea of how close the estimate is to the parameter. A confidence interval is associated with a particular parameter (Biemer and Lyberg 2003). Stratification is the partitioning of the frame population into mutually exclusive groups which are internally homogeneous with respect to characteristics measured in the survey. Stratified sampling can produce estimates of the entire population that are more precise than unstratified sampling (Biemer and Lyberg 2003).

Sources of error in sample survey research include coverage error, measurement error, non-response error, and sampling error. Coverage error occurs when the list or frame from which the sample was drawn fails to contain all of the subjects in the population of interest. Measurement error relates to the instrument used to collect data and is reduced by using items that are valid, reliable, and unambiguous to the research subjects. Non-response error occurs when respondents and non-respondents differ in key characteristics such that the sample does not

accurately reflect the study population. Sampling error results from measuring a characteristic in some but not all of the people in the population of interest and can be reduced through use of larger samples but cannot be eliminated short of using a census (Dillman 2000, Lindner et al. 2001).

Addressing low survey response rates

Important properties of empirical measurement include external validity, internal validity, measurement reliability and validity, and research reliability (Vaske 2008). External validity is related to generalizability and addresses the question to what can the observed effects be generalized? Internal validity relates to the extent to which conclusions are causal or correlational and depends on the strength of the research design (e.g., experimental designs have higher internal validity). Measurement reliability refers to the degree to which respondents report the same or very similar answers on the survey. Measurement validity deals with the accuracy of generalizations and is concerned with whether the variables in the survey actually measure the concepts they were supposed to measure (includes content, criterion, and construct validity). Research reliability refers to the extent to which a survey yields the same results on repeated trials (i.e., repeatability of findings).

Although some sources denote 50% as an acceptable response rate, there really is no solid threshold response rate above which one doesn't have to worry about non-response bias. Babbie (2003) advised that a demonstrated lack of response bias is more important than a high response rate. To ensure generalizability of research findings, "the researcher must satisfactorily answer the question of whether the results of the survey would have been the same if a 100% response rate had been achieved" (Lindner et al. 2001: 50). Concerns associated with low response rate include chiefly non-response bias or error and low statistical power which is related

to inaccurate effect size estimation. Non-response bias occurs when those who responded to the questionnaire are different in some significant/systematic way from those who did not respond, thus limiting the extent to which survey results are representative. This kind of bias increases the risk of error in generalizing from the sample to the study population and threatens the external validity of survey findings.

Low statistical power and inaccurate effect size estimation make it difficult to detect effects, increase the risk of accepting a false null hypothesis, and threaten statistical conclusion validity by reducing the "power to detect relationships that exist and determine with precision the magnitude of these relationships" (Sivo et al. 2006: 355). Effect size is defined as "the strength of the relationship between the independent variable and the dependent variable" (Vaske 2008: 106). It provides an indicator of the strength of a statistically significant relationship and helps differentiate between statistical and practical significance; for example, when statistical significance is produced from very large sample sizes (Vaske 2008).

Methods for estimating non-response bias include comparison with known values for the population, subjective estimates, and extrapolation (Armstrong and Overton 1977). Post hoc methods to examine non-response bias can entail: comparison of demographic and socioeconomic characteristics of respondents to census data and then weighting accordingly (Vaske 2008); comparison of early and late responders on key variables since studies have shown that non-respondents tend to be similar to late respondents (Radhakrishna and Doamekpor 2008); and follow up telephone surveys. It is important that the subsample is also random and has a relatively large number of responses to avoid non-response error in the non-response survey itself (Sivo et al. 2006).

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DELPHI QUESTIONS

1. Please describe what wildlife health means to you; i.e., how do you define it?

2A. In your opinion, how are the concepts of wildlife health and wildlife disease different? How are they the same?

2B. Does a focus or emphasis on one or the other (health or disease) affect or influence the achievement of healthy wildlife populations?

3. In your opinion, what are the most important threats to the health of wildlife populations in North America? (Please list at least 5 specific threats.) Why do you think they're important?

4A. What do you think are the most significant risks posed by wildlife disease?

4B. Do you think there are cases where it's appropriate not to manage wildlife disease?

APPENDIX C

FOCUS GROUP INTERVIEW GUIDE

1. What comes to mind when you hear the term "wildlife health"?

2. What are some ways of measuring wildlife health?

3. What comes to mind when you hear the term "wildlife disease"?

4. What can you tell me about wildlife disease issues in your state?

5. What concerns do you have about zoonotic diseases?

6. Overall, are you most concerned about zoonotic diseases having impacts to humans, domestic animals, or wildlife populations?

7. Do you consider wildlife disease issues today to be largely natural or are they a "man made" problem?

8. When do you think humans (wildlife managers) should intervene in wildlife disease situations?

9. Are there situations where managers should not intervene?

10. What kind of information would be important to you in making a decision to support or oppose wildlife disease management actions?

Human, Animal, and Wildlife Health
A Survey of Your Opinions

A study conducted by **Michigan State University**
Department of Fisheries & Wildlife
13 Natural Resources Building
East Lansing, MI 48824

Hello, my name is Dr. Shawn Riley and I am asking for your participation in an important research project focusing on public views related to health and the management of disease. The attached questionnaire is part of a national study to help wildlife managers better understand your views and opinions about health topics and the management of disease in wildlife.

Your participation in this survey is desired even if you have no experience with or special knowledge about wildlife or wildlife disease issues. Although not something most of us think about every day, wildlife diseases (such as rabies, West Nile virus, avian influenza, plague, brucellosis, and chronic wasting disease) are important issues to agencies that manage America's natural resources. Your responses will help answer important questions about how the American public thinks about health issues and management of diseases that occur in wildlife.

Your participation in this study is completely voluntary. If you are willing to participate**,** please complete this brief questionnaire at your earliest convenience and **return it in the postage-paid envelope that has been provided. The survey will only take you about 15 minutes to complete.** If there are multiple adults (age 18 or older) living in your household, please have the adult who will next celebrate a birthday complete the questionnaire.

By completing and returning the questionnaire, you indicate your voluntary agreement to participate in the study. Your responses are confidential and your privacy will be protected to the maximum extent allowable by law. The questionnaire has an identification number only so that I may remove your name from the mailing list when your questionnaire is returned.

If you have any questions or concerns, you are welcome to contact me at MSU Dept. of Fisheries & Wildlife, 13 Natural Resources Bldg, East Lansing, MI 48824; by email at rileysh2@msu.edu; or by phone at (517) 432-4943. If you have any questions or concerns regarding your rights as a study participant, you may contact (anonymously, if you wish) the chair of the University Committee on Research Involving Human Subjects by phone at (517) 432-4503; by email at ucrihs@msu.edu; or by regular mail at 202 Olds Hall, East Lansing, MI 48824.

Thank you in advance for your time and consideration!

Please completely and carefully fill in each chosen circle with a #2 pencil or blue/black pen.

1. Listed below are some different ways that you might interact with or enjoy wildlife. (Wildlife includes wild birds, mammals, reptiles, and amphibians.) Fill in one circle per line.

How frequently do <u>you</u> participate in the following wildlife-related activities?	Never	Rarely	From time to time	Often
a. Reading about wildlife **(2.87)**	1	2	3	4
b. Hunting **(1.88)**	1	2	3	4
c. Fishing **(2.39)**	1	2	3	4
d. Watching/observing wildlife **(3.28)**	1	2	3	4
e. Feeding wildlife **(2.52)**	1	2	3	4
f. Watching movies or TV shows about wildlife **(3.15)**	1	2	3	4

2. Listed below are some beliefs you might have about the relationship between humans and wildlife. Fill in one circle per line. **SD = strongly disagree, D = agree, N = neither agree nor disagree, A = agree, SA = strongly agree.**

Do <u>you</u> agree or disagree that…?	SD	D	N	A	SA
a. Humans should manage wildlife to benefit people. **(3.16)**	1	2	3	4	5
b. Humans do more harm than good to wildlife. **(3.27)**	1	2	3	4	5
c. Humans should learn to better coexist with wildlife. **(4.15)**	1	2	3	4	5
d. Hunting wildlife is an activity that I support. **(3.45)**	1	2	3	4	5
e. It is important for humans to manage wildlife populations. **(3.81)**	1	2	3	4	5
f. The right of wildlife to exist is more important than the right of humans to use wildlife for their own purposes. **(3.29)**	1	2	3	4	5
g. Human needs should take priority over the needs of wildlife. **(2.97)**	1	2	3	4	5
h. All living things are interconnected. **(4.32)**	1	2	3	4	5

3. Listed below are some beliefs about the causes of environmental problems and disease. Fill in one circle per line. **SD = strongly disagree, D = agree, N = neither agree nor disagree, A = agree, SA = strongly agree.**

Do <u>you</u> agree or disagree that…?	SD	D	N	A	SA
a. Most environmental problems are caused by humans interfering with nature. **(1.53)**	1	2	3	4	5
b. The occurrence of disease (in general) has been made worse by humans and their activities. **(1.26)**	1	2	3	4	5
c. Disease (in general) is part of the balance of nature. **(1.53)**	1	2	3	4	5
d. The occurrence of disease (in general) will get worse with time. **(.91)**	1	2	3	4	5

4. Listed below are some beliefs concerning wildlife management agencies (e.g., governmental organizations, such as the Department of Natural Resources, that manage and conserve wildlife resources). Fill in one circle per line. **SD = strongly disagree, D = agree, N = neither agree nor disagree, A = agree, SA = strongly agree.**

Do <u>you</u> agree or disagree that wildlife management agencies…?	SD	D	N	A	SA
a. Make good wildlife management decisions. **(3.43)**	1	2	3	4	5
b. Provide reliable scientific information. **(3.63)**	1	2	3	4	5
c. Make decisions that reflect your values concerning wildlife. **(3.27)**	1	2	3	4	5
d. Are staffed by competent wildlife professionals. **(3.48)**	1	2	3	4	5

5. Listed below are 4 different categories of health. Fill in one circle per line. **1 = not at all concerned, 3 = somewhat concerned, 5 = extremely concerned.**

In general, how concerned are <u>you</u> about protecting the health of…?

a. Humans **(4.47)**	1	2	3	4	5
b. Domestic animals **(4.13)**	1	2	3	4	5
c. Wildlife **(4.16)**	1	2	3	4	5
d. The overall ecosystem **(4.42)**	1	2	3	4	5

The next set of questions (#6 - 11) relates to a specific disease, **RABIES [or] PLAGUE [or] WEST NILE VIRUS**, which can cause illness or death in humans, domestic animals, and wildlife. [Northwest/southwest = plague; Northeast/national = rabies; Midwest/southeast = West Nile virus.]

6. Listed below are 5 groups that could potentially be affected by rabies/plague/WNV. Fill in one circle per line. **1 = not at all concerned, 3 = somewhat concerned, 5 = extremely concerned.**

How concerned are <u>you</u> that [rabies/plague/WNV] could affect the health of…?

a. Humans **(3.85)***	1	2	3	4	5
b. Pets **(3.74)**	1	2	3	4	5
c. Domestic livestock **(3.81)**	1	2	3	4	5
d. Wildlife **(3.81)**	1	2	3	4	5
e. The overall ecosystem **(3.82)**	1	2	3	4	5

*Values given reflect average across all 3 diseases.

7. Are <u>you</u> aware of practical, effective measures you can take to prevent [rabies/plague/WNV]? (.56)	**Yes**	**No**
	1	0

8. Have you, or do you know someone, who has contracted or otherwise been affected by [rabies/plague/WNV]? (.11)	**Yes**	**No**
	1	0

9. If the following were to contract [rabies/plague/WNV], how serious do you think the consequences would be…?

	Not serious	Some-what serious	Serious	Very serious
a. You personally **(3.44)***	1	2	3	4
b. People in your community **(3.39)**	1	2	3	4
c. Pets **(3.22)**	1	2	3	4
d. Domestic livestock **(3.34)**	1	2	3	4
e. Wildlife **(3.34)**	1	2	3	4
f. The overall ecosystem **(3.24)**	1	2	3	4

*Values given reflect average across all 3 diseases.

10. In your opinion, how likely to contract (or catch) [rabies/plague/WNV] are…?

	Very unlikely	Unlikely	Likely	Very likely
a. You personally **(1.81)***	1	2	3	4
b. People in your community **(1.95)**	1	2	3	4
c. Pets **(2.15)**	1	2	3	4
d. Domestic livestock **(2.33)**	1	2	3	4
e. Wildlife **(2.61)**	1	2	3	4

*Values given reflect average across all 3 diseases.

11. Do you worry about or feel fearful of [rabies/plague/WNV] affecting…?

	No, not at all	Rarely	From time to time	A great deal
a. You personally **(1.95)***	1	2	3	4
b. People in your community **(2.00)**	1	2	3	4
c. Pets **(2.15)**	1	2	3	4
d. Domestic livestock **(2.25)**	1	2	3	4
e. Wildlife **(2.34)**	1	2	3	4
f. The overall ecosystem **(2.32)**	1	2	3	4

*Values given reflect average across all 3 diseases.

The next section (#12-15) relates to your attitudes toward **wildlife disease management**. Wildlife disease management includes a variety of actions that natural resource agencies may take to prevent or control diseases that affect human, domestic animal, and/or wildlife health. Examples of such diseases include rabies, plague, bovine tuberculosis, brucellosis, some types of influenza, and West Nile virus.

12. Listed below are some benefits that people may associate with wildlife disease management. Fill in one circle per line. **SD = strongly disagree, D = agree, N = neither agree nor disagree, A = agree, SA = strongly agree.**

In general, do <u>you</u> agree or disagree that wildlife disease management…?	SD	D	N	A	SA
a. Prevents disease from becoming a widespread problem in the area where you live. **(3.80)**	1	2	3	4	5
b. Protects human health. **(3.89)**	1	2	3	4	5
c. Protects the health of pets. **(3.80)**	1	2	3	4	5
d. Reduces negative impacts on your state's agricultural economy.**(3.71)**	1	2	3	4	5
e. Protects the health of threatened or endangered wildlife. **(3.82)**	1	2	3	4	5
f. Protects ecosystem health. **(3.76)**	1	2	3	4	5
g. Protects the health of game (hunted) species. **(3.79)**	1	2	3	4	5

13. Fill in one circle per line. **1 = not at all important, 3 = somewhat important, 5 = extremely important.**

How important is each of these management outcomes to <u>you</u> personally…?

a. Preventing disease from becoming a widespread problem in the area where you live. **(4.32)**	1	2	3	4	5
b. Protecting human health. **(4.41)**	1	2	3	4	5
c. Protecting the health of pets. **(4.10)**	1	2	3	4	5
d. Reducing negative impacts on your state's agricultural economy.**(4.13)**	1	2	3	4	5
e. Protecting the health of threatened or endangered wildlife. **(4.13)**	1	2	3	4	5
f. Protecting ecosystem health. **(4.22)**	1	2	3	4	5
g. Protecting the health of game (hunted) species. **(4.02)**	1	2	3	4	5

14. Listed below are some "costs" that people may associate with wildlife disease management. Fill in one circle per line. **SD = strongly disagree, D = agree, N = neither agree nor disagree, A = agree, SA = strongly agree.**

In general, do <u>you</u> agree or disagree that…?	SD	D	N	A	SA
a. Managers take wildlife disease management actions even when they are not certain about their effectiveness. **(3.36)**	1	2	3	4	5
b. Wildlife disease management results in the killing of wildlife. **(3.25)**	1	2	3	4	5
c. The financial cost of wildlife disease management is too high. **(2.87)**	1	2	3	4	5
d. Wildlife disease management interferes with activities you enjoy.**(2.37)**	1	2	3	4	5
e. Wildlife disease management benefits species that are a nuisance.**(2.88)**	1	2	3	4	5
f. Wildlife disease management benefits special interest groups. **(3.16)**	1	2	3	4	5
g. Wildlife disease management is unnecessary because most diseases will go away on their own. **(2.15)**	1	2	3	4	5

15. Fill in one circle per line. **1 = not at all important, 3 = somewhat important, 5 = extremely important.**

How important is each of these considerations to <u>you</u> personally…?

	1	2	3	4	5
a. Ensuring that managers have a good understanding of the effectiveness of wildlife disease management before they act. **(4.38)**	1	2	3	4	5
b. Avoiding the killing of wildlife. **(3.59)**	1	2	3	4	5
c. Keeping the financial cost of wildlife disease management low. **(3.55)**	1	2	3	4	5
d. Being able to continue activities you enjoy. **(3.93)**	1	2	3	4	5
e. Managing disease to avoid benefitting nuisance species. **(3.54)**	1	2	3	4	5
f. Managing disease to avoid benefitting special interest groups. **(3.58)**	1	2	3	4	5
g. Managing only the most dangerous diseases. **(3.32)**	1	2	3	4	5

The next set of questions (#16-20) asks about your agreement/disagreement with various management options for different goals of wildlife disease management. (The management options listed are not mutually exclusive.) Fill in one circle per line.

SD = strongly disagree, D = agree, N = neither agree nor disagree, A = agree, SA = strongly agree.

16. When the goal of wildlife disease management is to protect <u>human health</u>, do you agree or disagree that…?	**SD**	**D**	**N**	**A**	**SA**
a. The disease should be left alone and allowed to run its course (no management should occur). **(2.01)**	1	2	3	4	5
b. Monitoring and surveillance of the disease are acceptable. **(3.83)**	1	2	3	4	5
c. Public education is acceptable. **(4.11)**	1	2	3	4	5
d. Management of the disease agent with methods that are non-lethal to the animal is acceptable (e.g., vaccination). **(4.07)**	1	2	3	4	5
e. Selective killing of diseased animals is acceptable. **(3.91)**	1	2	3	4	5
f. Population reduction of the wildlife species to reduce disease spread is acceptable. **(3.63)**	1	2	3	4	5

17. When the goal of wildlife disease management is to protect the <u>health of pets</u>, do you agree or disagree that…?	**SD**	**D**	**N**	**A**	**SA**
a. The disease should be left alone and allowed to run its course (no management should occur). **(2.14)**	1	2	3	4	5
b. Monitoring and surveillance of the disease are acceptable. **(3.82)**	1	2	3	4	5
c. Public education is acceptable. **(4.09)**	1	2	3	4	5
d. Management of the disease agent with methods that are non-lethal to the animal is acceptable (e.g., vaccination). **(4.07)**	1	2	3	4	5
e. Selective killing of diseased animals is acceptable. **(3.77)**	1	2	3	4	5
f. Population reduction of the wildlife species to reduce disease spread is acceptable. **(3.55)**	1	2	3	4	5

18. When the goal of wildlife disease management is to protect the <u>health of domestic livestock</u>, do you agree or disagree that…?

	SD	D	N	A	SA
a. The disease should be left alone and allowed to run its course (no management should occur). **(1.97)**	1	2	3	4	5
b. Monitoring and surveillance of the disease are acceptable. **(3.85)**	1	2	3	4	5
c. Public education is acceptable. **(4.10)**	1	2	3	4	5
d. Management of the disease agent with methods that are non-lethal to the animal is acceptable (e.g., vaccination). **(4.09)**	1	2	3	4	5
e. Selective killing of diseased animals is acceptable. **(3.88)**	1	2	3	4	5
f. Population reduction of the wildlife species to reduce disease spread is acceptable. **(3.64)**	1	2	3	4	5

19. When the goal of wildlife disease management is to protect the <u>health of wildlife</u>, do you agree or disagree that…?

	SD	D	N	A	SA
a. The disease should be left alone and allowed to run its course (no management should occur). **(2.27)**	1	2	3	4	5
b. Monitoring and surveillance of the disease are acceptable. **(3.91)**	1	2	3	4	5
c. Public education is acceptable. **(4.09)**	1	2	3	4	5
d. Management of the disease agent with methods that are non-lethal to the animal is acceptable (e.g., vaccination). **(4.01)**	1	2	3	4	5
e. Selective killing of diseased animals is acceptable. **(3.87)**	1	2	3	4	5
f. Population reduction of the wildlife species to reduce disease spread is acceptable. **(3.66)**	1	2	3	4	5

20. When the goal of wildlife disease management is to protect the <u>health of humans, domestic animals, AND wildlife</u>, do you agree or disagree that…?

	SD	D	N	A	SA
a. The disease should be left alone and allowed to run its course (no management should occur). **(1.97)**	1	2	3	4	5
b. Monitoring and surveillance of the disease are acceptable. **(3.92)**	1	2	3	4	5
c. Public education is acceptable. **(4.13)**	1	2	3	4	5
d. Management of the disease agent with methods that are non-lethal to the animal is acceptable (e.g., vaccination). **(4.11)**	1	2	3	4	5
e. Selective killing of diseased animals is acceptable. **(3.90)**	1	2	3	4	5
f. Population reduction of the wildlife species to reduce disease spread is acceptable. **(3.70)**	1	2	3	4	5

This final set of questions will help us summarize demographic characteristics of survey participants.

21. Are you male or female? (Male = 65.1%)

Male	Female
0	1

22. Do you have children under the age of 18? (Yes = 21.7%)

Yes	No
1	0

23. How old are you? Please write the number under "Years" and fill in the appropriate circles. **(58.1 years)**

Years	
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

24. What is your highest level of education? Select only one.

High school or GED	Trade or vocational school	Some college	4-year college degree	Graduate or professional degree
1 **(20.9%)**	2 **(6.5%)**	3 **(24.3%)**	4 **(25.7%)**	5 **(22.7%)**

25. How would you describe the area where you currently live? Select only one.

Rural	Suburban area on edge of city	Small town/city (population <50,000)	Mid-size city (population of 50,000 to 250,000)	Large city (population >250,000)
1 **(27.7)**	2 **(20.1)**	3 **(23.1)**	4 **(16.5)**	5 **(12.7)**

THANK YOU FOR YOUR TIME and PARTICIPATION! Please return the survey in the postage-paid envelope provided. If you are interested in learning more about wildlife health issues, please visit: http://www.nwhc.usgs.gov/.