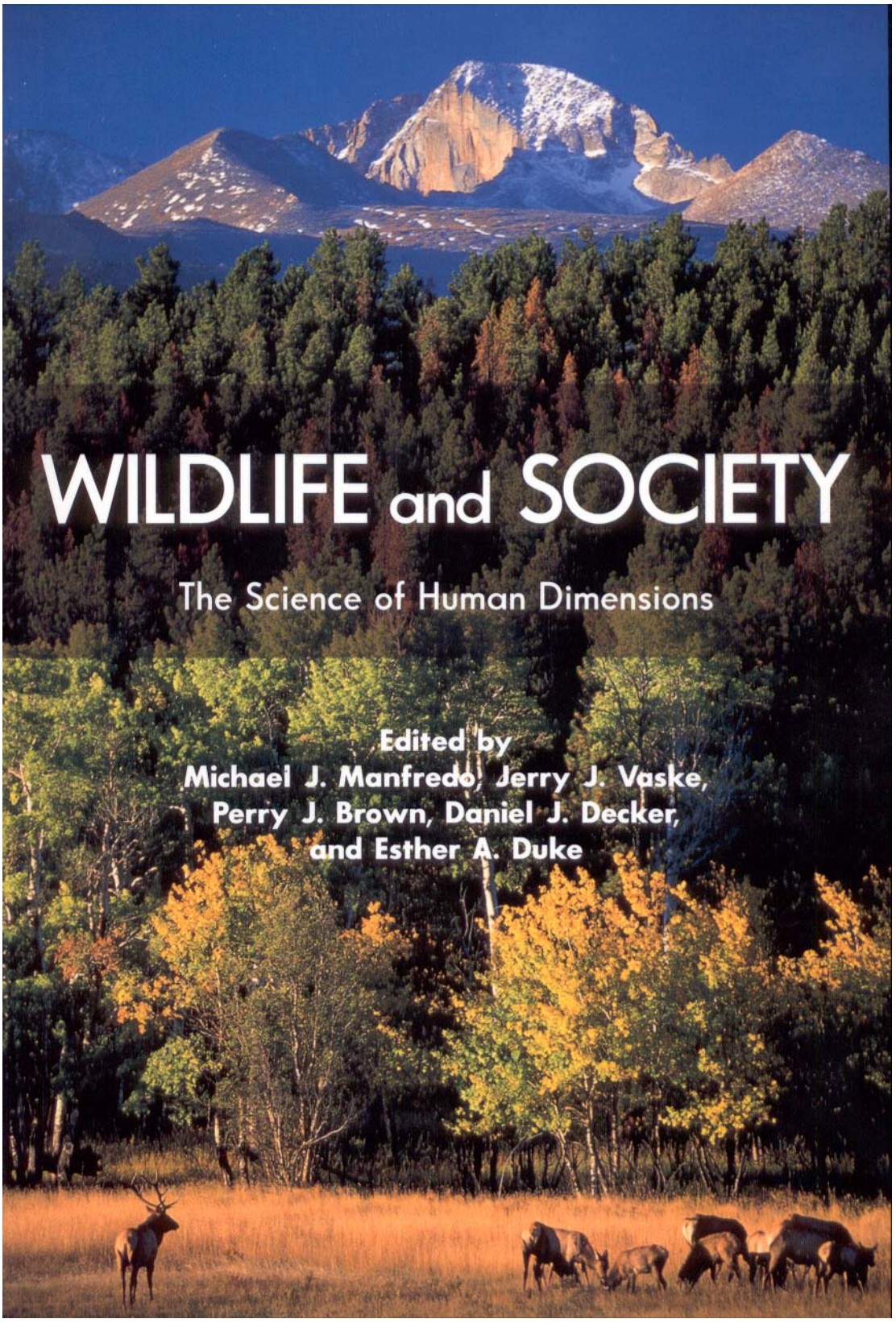
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CHAPTER 18

# Preparing for the Next Disease: The Human-Wildlife Connection

*Jerry J. Vaske, Lori B. Shelby, and Mark D. Needham*

Human dimensions (HD) research is essential for managing wildlife and understanding the societal consequences of wildlife diseases (Decker et al. 2006; Otupiri et al. 2000). Although there have been numerous studies on the pathology, transmission, and epidemiology of wildlife diseases, HD research on wildlife diseases is limited. Managers reluctant to make decisions without biological and ecological information should be equally hesitant without information about the general public and other interest groups. Disease risks can be mitigated by understanding and educating relevant stakeholders and implementing policies that incorporate public opinion. Simonetti (1995), for example, noted that understanding landowner attitudes was helpful for Chilean park managers to address foot-and-mouth disease in deer. HD research provides important information to managers by attempting to describe, predict, and affect human thought and action toward wildlife.

This chapter has three objectives: (1) highlight the range of wildlife diseases that can affect humans, as well as negatively affect wildlife, (2) suggest that human dimensions research for most diseases is sparse and does not follow a systematic paradigm of research, and (3) provide an illustrated approach to studying the human dimensions of wildlife diseases using chronic wasting disease as an example. Similar to biological research, a systematic program of HD inquiry is necessary to understand and prepare for the next wildlife disease crisis.

## An Overview of the Human-Wildlife Disease Connection

Diseases transmitted between animals and humans (i.e., zoonoses) caused more than two-thirds of emerging diseases in the last decade (Friend 2006). These diseases can be transmitted by direct or indirect contact with wildlife or domestic animals. Direct contact may occur through bites or contact with infectious fluids or tissues. Individuals also encounter diseases through direct contact as an occupational hazard (e.g., wildlife scientists, fish and wildlife law enforcement personnel, butchers). Consumptive recreationists (e.g., hunters, anglers, trappers) can be exposed to infected wildlife and game meat, and nonconsumptive recreationists are also at risk (e.g., hikers contracting Lyme disease, campers contracting hantavirus [Friend 2006]). Feeding wildlife, for example, increases contact with humans and encourages animals to unnaturally congregate, potentially spreading disease. People can be exposed to zoonoses from wildlife being kept as pets (e.g., some amphibians, reptiles, birds), domesticated pets (e.g., dogs, cats), and other animals (e.g., sheep, cattle). Domesticated animals can encounter zoonotic pathogens and transmit them to humans either directly or indirectly (e.g., transferring carriers such as ticks). Humans contract zoonoses indirectly by coming into contact with contaminated water or soil, or inhaling airborne pathogens (e.g., bat guano can be inhaled in caves once it is disturbed).

Three primary trends have made zoonoses a critical issue. First, human population growth has increased fragmentation of wildlife habitats and proximity of wildlife to humans, which increase the potential for humans to contract diseases from wildlife and for wildlife to contract diseases from humans. Second, globalization of travel and trade has led to increasing the rates of disease transmission and the spread of diseases. Severe acute respiratory syndrome (SARS), for example, caused economic losses in tourism owing to fear of rapid disease transmission. As global trade intensifies, the potential for spreading diseases increases (e.g., contaminated food supplies or transporting diseased wildlife). Third, increased participation in some outdoor recreation activities is increasing the proximity of wildlife to humans. The popularity of ecotourism and adventure tourism, for example, has increased exposure of wildlife and humans to diseases not common in their respective home environments (e.g., transmission of human tuberculosis to African wildlife, or whitewater rafters contracting leptospirosis in Costa Rica [Friend 2006]).

Understanding the *scope, biology,* and *human impacts* of wildlife disease is essential for developing a systematic paradigm of HD

*Continued on p. 248*

TABLE 18.1 **Wildlife Diseases by Wildlife Type and Their Impacts on Humans**

| WILDLIFE TYPE | DISEASE | SOME HUMAN IMPACTS AND CHARACTERISTICS |
|---|---|---|
| Amphibians and reptiles | Salmonellosis | Handling of pets (e.g., lizards, turtles) has been a major source in humans<br>Found worldwide in animals such as mammals, birds, reptiles, amphibians, and crustaceans<br>Transmission to humans also through food, occupational, and recreational exposure |
| Birds | Avian influenza | Worldwide zoonosis transmitted through contact exposure<br>Noted for transmission to poultry, humans, cats, and swine in Asia<br>Concern that this virus could evolve and be spread by humans |
| | West Nile fever (West Nile virus) | Transmission to mammals (e.g., humans, horses) and birds through mosquito bites<br>Transmission also through blood transfusion, tissue transplant, and rarely milk<br>Found throughout the world, but spread particularly fast in U.S. horses with 25 known cases in 1999 rising to 15,000 in 2007 |
| Freshwater fish | Whirling disease | Decimates fish populations, leading to economic consequences (e.g., fish hatcheries, commercial and noncommercial anglers)<br>Introduced to the United Kingdom through translocation of rainbow trout from the United States |
| Marine mammals | Brucellosis, tuberculosis, leptospirosis, influenza | Transmission to humans through direct handling of animals |
| Terrestrial mammals | Bovine spongiform encephalopathy (BSE, mad cow) | Economic impacts due to loss of cattle<br>Eating infected beef linked to cases of Creutzfeldt-Jakob disease in humans primarily in the United Kingdom, Europe, and Canada |
| | Bovine tuberculosis | Worldwide zoonosis primarily in cattle, swine, monkeys, bison, deer, elk, and other animals<br>Has been associated with feeding deer and elk<br>Transmissions to humans through ingestion of meat, inhalation, and occupational exposure |

Modified from Friend (2006) and Kahn, Line, and Aiello (2006).
*Disease examples may be applicable to other types of wildlife and have other human impacts not listed*

TABLE 18.1 (CONTINUED)

| WILDLIFE TYPE | DISEASE | SOME HUMAN IMPACTS AND CHARACTERISTICS |
|---|---|---|
| Terrestrial mammals | Brucellosis | Strains found in cattle, bison, elk, caribou, goats, sheep, camels, wild pigs, dogs, and coyotes<br>Transmission to humans from occupational exposure, recreational exposure, and milk<br>Brucellosis in elk associated with feeding of elk<br>Transmission from wildlife to farm animals a concern |
| | Foot-and-mouth disease | Found in cattle, swine, and other cloven-hoofed animals in Asia, Africa, and South America<br>Economic impacts such as loss of livestock and farmer compensation in the United Kingdom |
| | Hantavirus | Worldwide transmission to humans by contact with urine, feces, or saliva of deer mice or other rodents (e.g., through bites, inhalation, or contaminated soil) |
| | Human immunodeficiency viruses (HIV) | Primate harvesting and meat processing believed to be origin of HIV and AIDS in humans |
| | Johne's disease | Widespread disease of ruminants (e.g., deer, bison, goats)<br>Associated with Crohn's disease in humans and economic impacts on farmers |
| | Leptospirosis | Worldwide zoonotic disease with hosts ranging from rodents to large mammals<br>Transmission to humans by contaminated recreational waters and occupational means |
| | Lyme disease | Found in deer and rodents worldwide and transmits to humans through ticks |
| | Rabies | Found primarily in carnivores (e.g., skunks, raccoons, foxes, coyotes) and bats<br>Translocation of raccoons to northern United States resulted in rabies as a zoonosis in multiple states<br>Transmission through bites of diseased animals and inhalation in enclosed areas (e.g., caves) |
| | Severe acute respiratory syndrome (SARS) | Zoonosis in China and Southeast Asia transmitted by direct contact<br>Likely originated in civet cats<br>Caused severe economic impacts due to decreased tourism |

research. Only a limited number of diseases have been studied from a human dimensions perspective, yet wildlife diseases span a variety of species and environments (e.g., rodents to large mammals; marine mammals to freshwater fish). Table 18.1 illustrates a sample of these wildlife diseases and their associated human impacts for different types of wildlife (see Childs, Mackenzie, and Richt 2007; Friend 2006; Kahn, Line, and Aiello 2006; Williams and Barker 2000; Wobeser 2007 for reviews). Understanding the biology of wildlife diseases facilitates HD research by defining the range of the problem and the issues involved (e.g., Is the disease transmittable to humans? Can education decrease the transmission of the disease? What wildlife species are involved?). Human impacts of wildlife disease shown in table 18.1 include economic, social and recreational, and human health. Human dimensions of wildlife disease research needs to consider each of these potential consequences, as well as human impacts on wildlife.

## Human Dimensions of Wildlife Diseases

Compared with research on the epidemiology and transmission of wildlife diseases, few studies have examined the HD of these diseases (see table 18.2 for examples). Diseases such as bovine tuberculosis (Brook and McLachlan 2006; Dorn and Mertig 2005; Stronen et al. 2007), foot-and-mouth (Poortinga et al. 2004), fowl pest (i.e., Newcastle disease [Brunet and Houbaert 2007]), Johne's disease (Daniels et al. 2002), Lyme disease (Deblinger et al. 1993; Kilpatrick and LaBonte 2003), and rabies (Gibbons et al. 2002; Sexton and Stewart 2007; Schopler, Hall, and Cowen 2005) have received some attention in the HD literature. Although the specific studies listed in table 18.2 have contributed to our knowledge, most HD research on wildlife diseases, with the exception of chronic wasting disease (CWD), can be characterized as one-shot cross-sectional studies that are applied in focus. A systematic and theory-based program of HD wildlife disease research is needed to address the range of potential human and wildlife impacts. Theoretical concepts (e.g., knowledge, risk perceptions, beliefs, attitudes, behavioral responses) drawn from a variety of disciplines (e.g., social psychology, economics, communication) used by HD researchers can facilitate understanding of the human component of wildlife diseases and broaden the generalizability, reliability, and validity of the findings. Human dimensions research on chronic wasting disease illustrates this recommended systematic approach.

## Human Dimensions of Chronic Wasting Disease

Unlike other diseases discussed in this chapter, there is a body of HD research on CWD. In the past five years, at least twenty-three HD journal articles on CWD have appeared (see table 18.3). This section briefly describes CWD and synthesizes the results from current HD studies on CWD. This body of work directly incorporated concepts found in social psychological, economic, and communication theory to understand the beliefs, attitudes, and behaviors of multiple stakeholders (e.g., hunters, nonhunters, guide outfitters) across multiple states in the United States, often using identical surveys instruments. Although different wildlife diseases (e.g., tables 18.1 and 18.2) pose specific human dimensions questions (e.g., relevant stakeholders), the general approach utilized by HD research on CWD can be applied in each case.

CWD is a neurological disease of deer, elk, and moose that is similar to scrapie in sheep, bovine spongiform encephalopathy in cattle (i.e., mad cow), and Creutzfeldt-Jakob disease in humans. CWD was identified in captive deer and elk in the 1960s and 1970s and free-ranging herds in the 1980s and 1990s in Colorado and Wyoming. The disease is currently known to exist in free-ranging herds in eleven states (Colorado, Illinois, Kansas, Nebraska, New Mexico, New York, South Dakota, Utah, West Virginia, Wisconsin, Wyoming) and two Canadian provinces (Alberta, Saskatchewan). CWD exists in captive herds in additional states (e.g., Minnesota, Montana, Oklahoma) and countries (e.g., South Korea). In all infected animals, CWD causes emaciation, abnormal behavior, and death. There is no evidence that CWD poses a human health risk, but transmission to humans cannot be dismissed (see Williams et al. 2002 for a review).

One of the primary stakeholder groups affected by CWD is hunters. As a result, most HD research on CWD has examined hunters': (a) participation in response to the disease, (b) perceptions of potential human health risks associated with CWD, and (c) concerns about impacts of the disease on wildlife (Brown et al. 2006; Gigliotti 2004; Miller 2003, 2004; Needham et al. 2007; Needham, Vaske, and Manfredo 2004, 2006; Stafford et al. 2007; Vaske et al. 2004, 2006a, 2006b). Studies have also measured hunters' knowledge of CWD, acceptance of management (e.g., testing, herd reduction), and trust in agencies to address the disease (Brown et al. 2006; Miller 2003; Needham and Vaske 2008; Vaske et al. 2006b). Research has compared subgroups of hunters (e.g., deer/elk, residents/nonresidents [Needham, Vaske, and Manfredo

*Continued on p. 254*

TABLE 18.2 **Human Dimensions Research on Wildlife Disease**

| DISEASE | FOCAL SPECIES | SAMPLE* |
|---|---|---|
| Bovine tuberculosis | Deer | Stakeholders in MI |
| Bovine tuberculosis | Elk, cattle | Farmers near Riding Mountain National Park, Manitoba, Canada |
| Bovine tuberculosis | Wolves | Farmers near Riding Mountain National Park, Manitoba, Canada |
| Foot-and-mouth disease | Livestock | Two communities (Norwich, Bude) in the United Kingdom |
| Fowl pest (Newcastle disease) | Birds | Multiple stakeholders |
| Johne's disease | Multiple | Farmers in east Scotland |
| Lyme disease | Deer | Hunters on Richard T. Crane, Jr. Memorial Reservation and Cornelius and Miné Crane Wildlife Refuge in MA |
| Lyme disease | Deer | Residential community in Groton, CT |
| Multiple | Multiple | Public and wildlife agency personnel in MI |
| Multiple | Multiple | Residents in CO |
| Rabies | Bats | National Speleological Society convention attendees |
| Rabies | Bats | Residents in Fort Collins, CO |
| Rabies | Bats | Residents in MN |
| Rabies | Multiple | Wildlife rehabilitators in NC |
| Zoonoses | Multiple | Laypersons and expert perceptions within food sector |
| Zoonoses | Multiple | Teton County, ID |
| Zoonoses | African wildlife | 17 rural Central African villages |
| Zoonoses | Cattle | Slaughterhouse butchers in Ghana |

* Two-letter postal codes are used for U.S. states.
*There have also been numerous studies on chronic wasting disease (see table 18.3).*

| CONCEPTS | CITATIONS |
|---|---|
| Attitudes, knowledge, communication | Dorn and Mertig 2005 |
| Risk perception, acceptability of management actions | Brook and McLachlan 2006 |
| Attitudes | Stronen et al. 2007 |
| Attitudes, risk perception, trust | Poortinga et al. 2004 |
| Risk perception, communication | Brunet and Houbaert 2007 |
| Risk perception, beliefs, behavior | Daniels et al. 2002 |
| Beliefs, concerns | Deblinger et al. 1993 |
| Public perceptions, expectations | Kilpatrick and LaBonte 2003 |
| Attitudes toward lethal management to control wildlife diseases | Koval and Mertig 2004 |
| Cognitive hierarchy, acceptability of trapping to control wildlife diseases | Manfredo et al. 1999 |
| Knowledge, risk perception | Gibbons et al. 2002 |
| Familiarity, knowledge, risk perception, cognitive hierarchy, communication | Sexton and Stewart 2007 |
| Knowledge | Liesener et al. 2006 |
| Knowledge, policy | Schopler, Hall, and Cowen 2005 |
| Risk perception, communication, values, morals | Jensen et al. 2005 |
| Attitudes | Peterson, Mertig, and Liu 2006 |
| Risk perception, hunting patterns | LeBreton et al. 2006 |
| Knowledge, attitudes, beliefs, behaviors | Otupiri et al. 2000 |

TABLE 18.3 **Human Dimensions Research on Chronic Wasting Disease**

| CONCEPTS* | SAMPLE† | CITATIONS |
|---|---|---|
| Social psychology | | |
| Values, trust, knowledge, risk perception | Big-game guides and outfitters in CO and WY | Anderies 2006 |
| Behavioral intentions, satisfaction, information, communication, trust, knowledge | General public and deer hunters in NY | Brown et al. 2006 |
| Concerns, behavior | Deer hunters in Black Hills, SD | Gigliotti 2004 |
| Attitudes, behavior | Hunters in WI | Holsman and Petchenik 2006 |
| Behavior, risk perception, information | Seven counties in northern IL | Miller 2003 |
| Beliefs, behavior | Deer hunters in IL | Miller 2004 |
| Behavior, acceptability, risk perception | Deer hunters in 8 states (AZ, CO NE, ND, SD, UT, WI, WY); elk hunters in 3 states (CO, UT, WY) | Needham, Vaske, and Manfredo 2004 |
| Behavior, risk perception, recreation specialization | Deer hunters in 8 states; elk hunters in 3 states | Needham et al. 2007 |
| Attitudes, behavior, knowledge | Landowners residing in WI's southwest CWD eradication zone | Petchenik 2006 |
| Beliefs | Hunters and nonhunters residing in WI's southwest CWD eradication zone | Stafford et al. 2007 |
| Attitudes, behavior, acceptability | Deer hunters in WI | Vaske et al. 2006a |
| Behavior, risk, trust, similarity | Deer hunters in WI | Needham and Vaske 2008<br>Vaske et al. 2004 |

TABLE 18.3 (CONTINUED)

| CONCEPTS* | SAMPLE† | CITATIONS |
|---|---|---|
| Demographic groups | | |
| Beliefs across states, years, and interest groups | Deer hunters in 8 states; elk hunters in 3 states<br>Hunters and nonhunters residing in WI's southwest CWD eradication zone | Needham and Vaske 2006 |
| Risk behavior across state and residency differences | Deer hunters in 8 states; elk hunters in 3 states | Needham, Vaske, and Manfredo 2006 |
| Communication | | |
| Communication, information | State wildlife agency Web sites | Eschenfelder 2006; Eschenfelder and Miller 2007 |
| Information sources, knowledge | Hunters in CO and WI | Vaske et al. 2006b |
| Economics | | |
| Economic impacts | Existing data | Bishop 2004 |
| Economic impacts | Existing data and public information sources | Seidl and Koontz 2004 |
| Other | | |
| Policy | Existing data in WI | Heberlein 2004 |
| Organizational capacity | 24 state wildlife and agricultural agencies in 12 states | Burroughs, Riley, and Taylor 2006 |
| Managerial frameworks | Existing information | Decker et al. 2006 |

*Many studies listed here cover multiple concepts and types of information, including economic, communication, and social psychology.

†Two-letter postal codes are used for U.S. states.

2004, 2006]) and perceptions of other stakeholder groups (e.g., landowners [Stafford et al. 2007] and guide outfitters [Anderies 2006]). Some studies have addressed the capacity of agencies to manage CWD and the extent to which they use various channels such as the Internet to disseminate information about the disease (Eschenfelder 2006; Heberlein 2004). Research has also estimated economic impacts of CWD on hunting, wildlife viewing, tourism, and the captive deer and elk industry (Bishop 2004; Seidl and Koontz 2004). Similar to the CWD research, HD research needs to identify and analyze the stakeholder groups for each wildlife disease of interest.

*Behavioral Intentions*

Studies conducted soon after discovery of CWD in some states showed that few hunters (less than 10 percent) would change their hunting frequency or location (e.g., Gigliotti 2004; Miller 2003, 2004). At current CWD prevalence levels, hunters were likely to watch for abnormal behavior in animals, test animals, and/or not eat meat from harvested animals (Brown et al. 2006; Gigliotti 2004; Miller 2003, 2004; Vaske et al. 2004). If prevalence increases dramatically, however, substantial changes in participation are more probable.

In a series of articles (Needham, Vaske, and Manfredo 2004, 2006; Needham et al. 2007), hunters in eight states responded to hypothetical scenarios of increasing CWD prevalence levels and human health risks (i.e., death). If 50 percent of the deer or elk across the state were infected, 38 percent of residents and 52 percent of nonresidents would stop hunting deer or elk in their state. In scenarios where hunters died from CWD at this prevalence level, 53 percent of residents and 64 percent of nonresidents would quit. Arizona and North Dakota hunters were most likely to change behavior. Given that CWD is not in these states, it may pose a new risk. In Wisconsin, where hunting is a strong tradition, hunters were least likely to change behavior. Across scenarios and states (a) hunters were more likely to quit hunting deer or elk rather than switch states to hunt these species, (b) residents were more likely to quit hunting and nonresidents were more likely to hunt in other states, and (c) novice hunters or those new to hunting were more likely to quit and veteran hunters would switch states. These findings are important because hunting declines attributable to CWD can impact wildlife agency revenues (e.g., license sales) and programs, erode support of these agencies, and constrain cultural traditions and the socioeconomic stability of communities dependent on hunting.

*Concerns and Perceptions of Risk*

Studies have examined hunters' concerns and perceptions of risk associated with CWD. Needham and Vaske (2006, 2008), for example, found that the majority of hunters in eight states agreed that CWD poses a risk to humans, should be eliminated, and may cause disease in humans and that they and their families were concerned about eating deer or elk. Hunters disagreed that the threat of CWD has been exaggerated.

Gigliotti (2004) reported that two-thirds of South Dakota hunters were worried about CWD. In Illinois, many hunters were concerned about effects of CWD on deer and believed that the disease could infect humans (Miller 2004). The majority of New York hunters were concerned about effects of CWD on hunting, human health, and deer health (Brown et al. 2006). Following discovery of CWD in Wisconsin, hunters who did not hunt because of CWD were sixteen times more likely than hunters to perceive risks associated with the disease (Vaske et al. 2004). Research such as this facilitates an understanding of the concerns and perceptions of risk in the general public and stakeholder groups for a wildlife disease, which is essential for determining the necessity and potential effectiveness of management techniques and information campaigns.

*Information Sources and Knowledge*

Vaske et al. (2006b) examined hunters' information sources and knowledge about CWD. In response to several true-false questions about CWD, 32 percent of Wisconsin hunters and 44 percent of Colorado hunters failed to answer at least half of the questions correctly, suggesting that many hunters in the states are not highly knowledgeable about CWD despite agency efforts to provide information about the disease. Effective sources for improving hunters' CWD knowledge were newspapers, wildlife agency Web sites, and hunting regulations brochures.

Miller (2003) found that most hunters in northern Illinois were aware of CWD and knew where the disease was located in Illinois and other states. Most hunters received CWD information from newspapers, friends or relatives, television reports, and magazines. In New York, most hunters knew that CWD was in the state, were familiar with CWD, and heard or read about the disease mostly from newspapers and the television news (Brown et al. 2006). Understanding relationships among knowledge and commonly used and effective sources of information on a disease may allow agencies to improve information and education about the disease.

*Trust in Wildlife Agencies*

The majority of hunters trust wildlife agencies to manage CWD to the best of their abilities. Hunters in eight states, on average, trusted their respective state agency to inform the public about CWD and disease management (Needham and Vaske 2008). Despite controversial actions taken to address CWD in Wisconsin (e.g., dramatic herd reduction to eradicate CWD), hunters still trusted the Wisconsin Department of Natural Resources (Stafford et al. 2007). Similarly, the majority of hunters in Illinois and New York were satisfied with agency efforts to address CWD and inform the public about the disease (Brown et al. 2006; Miller 2003).

Needham and Vaske (2008) examined the extent to which hunters perceived personal health risks associated with CWD and the influence of trust in state wildlife agencies to manage the disease as a determinant of this risk. Hunters who trusted the agencies perceived less risk associated with CWD, but trust only explained up to 8 percent of the variance in risk. Hunters trusted the agencies but still perceived personal health risks associated with CWD. It is important to understand public trust in agencies tasked to manage wildlife diseases because lack of trust can increase perceptions of risk, which may cause people to change behavior (e.g., quit hunting). Efforts to maintain agency trust can foster positive relationships with constituents and increase support for management actions.

*Acceptance of Management*

A number of studies have examined hunters' attitudes toward current and potential strategies for managing CWD (e.g., Needham, Vaske, and Manfredo 2004, 2006; Petchenik 2006; Vaske et al. 2006a). Among hunters in most states and studies, (a) testing harvested animals for CWD and using hunters to reduce herds in CWD areas were *acceptable* strategies, (b) agencies taking no action and allowing CWD to take its natural course were considered *unacceptable*, and (c) using agency staff to reduce herds in CWD areas was *controversial*. Hunters also generally supported efforts to minimize spread of CWD and eliminate the disease from animal herds. Incentives such as longer hunting seasons and free licenses and tags were supported by most hunters, whereas monetary incentives for harvesting infected animals were less preferred (Petchenik 2006). HD research that considers the acceptability of management actions provides information that encourages incorporating public opinion. Such research may also illuminate public education or communication needs. Having public and stakeholder support facilitates the success of wildlife disease management.

*Other Stakeholders*

A few CWD studies have focused on groups other than hunters. Stafford and colleagues (2007), for example, found that nonhunting landowners in Wisconsin trusted the state wildlife agency to manage CWD, agreed that the disease should be managed, and were concerned about deer health and safety of venison. Compared with hunters, nonhunters were less concerned about hunting. Brown et al. (2006) reported that compared with hunters, the general public in New York was: (a) less familiar with and knowledgeable about CWD and how officials were informing the public about the disease and (b) equally concerned about potential effects of CWD on wildlife and humans. In the only study to examine guide outfitters' responses to CWD, Anderies (2006) found that most outfitters were knowledgeable about CWD, trusted agencies to manage the disease, and were concerned about impacts of CWD on their company and industry. In general, HD of wildlife disease research should incorporate multiple constituency groups. Different stakeholders may have different beliefs regarding acceptable strategies for controlling wildlife disease.

*Economic Impacts*

Potential economic effects of CWD include (a) hunting declines and impacts on revenue sources such as license sales and tourism, (b) reduced wildlife viewing, (c) trade restrictions and perceptions of meat safety affecting the captive industry, (d) federal indemnity payments for herd reduction and depopulation, and (e) funding for research and testing (Seidl and Koontz 2004). In Wisconsin, for example, the largest single-year decline in hunting license sales (11 percent) occurred in 2002, the year following discovery of CWD in the state (Heberlein 2004). Economic consequences of this decline approached $55 million in 2002 and were estimated at $33 million in 2003 (Bishop 2004). Six million dollars was lost per year in nonresident license sales and more than $15 million was spent combating the disease in the state (Bishop 2004). HD research can provide information about the public and other interest groups that is useful for predicting and preparing for potential economic impacts of wildlife diseases.

## Conclusion

This chapter summarized the human-wildlife disease connection. Diseases transmitted between animals and humans are responsible for more than two-thirds of emerging diseases. These diseases have social,

economic, recreational, and environmental ramifications. Although the pathology and the epidemiology of wildlife diseases have received substantial attention, HD studies on this topic are limited. This chapter reviewed some of the sporadic HD research on most wildlife diseases. However, a systematic program of research on multiple HD aspects of wildlife diseases is needed. Recent research on CWD offers a starting point in this direction and highlights the types of HD information necessary to prepare for the next wildlife disease.

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