

External Review of Chronic Wasting Disease Management in Wisconsin

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Executive Summary

On February 28, 2002, the Wisconsin Department of Natural Resources (DNR) announced that chronic wasting disease (CWD) had been detected in three wild white-tailed deer killed by hunters during the 2001 hunting season. The DNR, in cooperation with several other state and federal wildlife management, domestic animal health, and public health agencies, took immediate and aggressive actions to better define and begin managing this serious wildlife disease problem. The DNR is to be commended for its rapid and continuing response to the presence of CWD in Wisconsin's highly valued wild deer population.

The overall aim of "*minimizing the negative impact of chronic wasting disease on cervid populations, the state's economy, hunters, landowners and others who are affected by deer management policies*" is a comprehensive and laudable goal. The DNR's policy of eradicating CWD in the limited area where it occurs, before it can spread throughout the state and elsewhere, is entirely appropriate. Intensive CWD surveillance in the affected area and throughout the state already has provided essential information for directing management efforts. Concurrently, deer population reduction in the region surrounding the known affected area, restrictions on human transport of live cervids, and a statewide ban on baiting and supplemental feeding of deer were implemented to limit the spread of CWD. All of these approaches are supported by widely accepted guidelines for CWD management, including the *Plan for Assisting States, Federal Agencies, and Tribes in Managing Chronic Wasting Disease in Wild and Captive Cervids* (National CWD Plan) and the *Multi-state Guidelines for Chronic Wasting Disease Management in Free-ranging White-tailed Deer, Mule Deer, and Elk* (Multi-state CWD Guidelines).

The DNR has based its CWD management on the best scientific information and has modified management strategies as new data have become available. This adaptive strategy is essential because of certain gaps in the current understanding of CWD epidemiology and the efficacy of CWD management techniques in free-ranging populations. As additional information develops in Wisconsin and elsewhere, the DNR should continue to modify its CWD management strategies and techniques to increase their effectiveness. Because disease management strategies must fit local conditions to be effective, research efforts in Wisconsin are directed at CWD ecology and dynamics, white-tailed deer behavior and ecology, and human dimensions. Research on CWD is a critical component of the DNR's management plan, and a substantial amount of information already has been generated regarding CWD distribution and prevalence in Wisconsin, as well as sociological responses to the recognition of CWD and associated control efforts.

The Wisconsin policies and actions are based on the following assumptions: (1) Chronic wasting disease is a transmissible spongiform encephalopathy caused by prions that are spread by direct contact between animals but also may be transmitted indirectly via environmental contamination. (2) Chronic wasting disease recently was introduced into the state, and its distribution is limited to a defined area in southern Wisconsin. (3) Chronic wasting disease may have a significant negative impact on

white-tailed deer populations, and its presence diminishes the real or perceived value of deer and elk. (4) High host animal density and frequent animal contact are associated with increased prevalence of the disease. (5) Chronic wasting disease will not disappear spontaneously in the absence of management actions, and restrictions on human activity are necessary to prevent its spread into new areas. All of these assumptions are valid in view of the current scientific knowledge of CWD, and they provide the foundation for the strategies of the two widely accepted guidelines for CWD management.

The management of disease in free-ranging wildlife populations generally is difficult, expensive, and controversial, particularly when marked population reduction is a component of the plan. Additionally, management of CWD in a high density, free-ranging, white-tailed deer population is unprecedented, and some may regard the DNR's eradication policy as inappropriate because proven techniques are not available. Consequently, the DNR must address the concerns of all stakeholders, including laymen, as well as wildlife professionals and scientists, as it continues to develop and maintain support for its eradication policy.

The DNR has done a commendable job of providing accurate and timely information to the public, as well as offering forums for discussion with hunters, landowners, and the general public. However, opposition to the CWD management plan by the public, especially landowners in the Disease Eradication Zone, represents a potentially significant obstacle to CWD eradication because success of the DNR management plan is highly contingent upon public acceptance and participation. It is essential that the DNR recognizes this potential obstacle and engages landowners and hunters in the disease management area to gain their support and assistance. The message of the DNR to the public should clearly state the risks CWD poses to Wisconsin's deer herd and those who appreciate it; that the lack of proven techniques to eradicate CWD does not justify inaction; that the management plan employs the best available techniques; and that the DNR is engaged in data collection and research to assess management actions and will continue to modify them to increase their efficiency and decrease negative impacts on the stakeholders when possible.

The DNR should continue to closely monitor the effects of its management strategies on CWD in the state. Currently, it is not possible to predict whether CWD will be eliminated from Wisconsin, although the consequences of inaction or inadequate response are clear: The prevalence and geographic distribution of CWD will increase. Because the management of CWD in wild cervids must be regarded as experimental, the acquisition and analysis of data during control efforts are critical to measure the progress of the program and to adapt strategies to maximize the effectiveness of CWD management and minimize the negative impacts of the disease. The Program Review Panel commends the DNR, all cooperating agencies, landowners, hunters, and others for their efforts to eradicate CWD from the state. If they are successful, they will have protected the remainder of Wisconsin, as well as other states, from the spread of CWD. Furthermore, Wisconsin is providing valuable information for other wildlife managers throughout the country who may find themselves faced with CWD or other significant infectious diseases in wild deer or elk populations.

Key Findings of the Program Review Panel

- The Wisconsin policy to attempt eradication of CWD from free-ranging and captive cervids is appropriate.
- Failure to contain and eradicate CWD in its current location will result in spread of CWD throughout Wisconsin's white-tailed deer population.
- The integrated, multi-agency approach to CWD eradication is commendable.
- The emphasis on CWD research and adaptive management specific to the Wisconsin situation is critical.
- The system developed for collection, transport, testing, and disposal of samples for CWD is impressive and has resulted in unprecedented data acquisition in a very short period of time.
- Disposal of carcasses and heads is a significant management and resource issue for the state.
- The combination of high densities of free-ranging white-tailed deer and a large dispersed captive cervid industry necessitates close coordination between managers and regulators of these entities.
- Wisconsin is providing timely and accurate information to the public about CWD.
- Public opposition to the DNR's management plan, particularly by landowners in the affected area, represents a potentially significant obstacle to the successful eradication of CWD from the state.

Key Recommendations of the Program Review Panel (not in order of priority)

- The goal of statewide CWD eradication should be consistently stated.
- Baiting and feeding of deer should be prohibited throughout the state.
- Consistent terminology should be used when discussing the CWD management areas.
- Passive (targeted) surveillance for CWD should be continued and expanded.
- Active CWD surveillance using hunter-harvested samples should continue in order to provide statistically valid data on CWD distribution in Wisconsin and to focus efforts around sites of higher risk.
- Spatial information gathered on CWD positive animals should be used to develop more immediate strategies to eliminate foci of high CWD prevalence.

Key Recommendations of the Program Review Panel (*continued*)

- Wisconsin should develop policies to prohibit transport out of the CWD area of materials from deer other than boned meat, antlers, hides, and clean skull plates.
- Wisconsin should work with landfill operators and the public to make the use of landfills a more cost effective and less contentious method for carcass disposal.
- Appropriate resources should be made available to the Wisconsin Department of Trade and Consumer Protection to educate captive cervid owners and enforce regulations regarding CWD in the cervid industry.
- Better fencing options for white-tailed deer should be developed to separate captive and free-ranging white-tailed deer.
- The DNR should develop and publicize its restoration plan for the CWD management zone.
- A more organized and structured plan for stakeholder education and participation should be developed.
- Because the Cary model underpins the need for aggressive actions to control and eradicate CWD in Wisconsin, an independent outside review of the model, preferably resulting in publication in a peer-reviewed journal, should be conducted.

Introduction

Chronic wasting disease is a member of the family of diseases known as transmissible spongiform encephalopathies (TSE). Other TSEs include Creutzfeldt-Jakob disease (CJD) of humans; scrapie of sheep and goats; and bovine spongiform encephalopathy (BSE), also known as “mad cow disease.” Chronic wasting disease is distinctly different from the other TSEs, and unlike BSE, it never has been linked epidemiologically to human neurological disease. Furthermore, CWD never has been demonstrated to infect species other than white-tailed deer, mule deer, and elk under natural conditions.

The origin of chronic wasting disease (CWD) is unknown. It was first recognized as a syndrome in captive mule deer in Colorado research facilities in the 1960s but was not identified as a transmissible spongiform encephalopathy (TSE) until the late 1970s. In the 1980s and 1990s, CWD was found in free-ranging deer and elk in northeastern Colorado/southeastern Wyoming, and since 1996, it has been documented in captive elk or white-tailed deer herds in eight states and two Canadian provinces. The recognized geographic distribution of CWD in wild cervids has increased dramatically since 2000, when many states and provinces initiated or increased CWD surveillance. The size of the original endemic area in Colorado/Wyoming now is recognized to be larger, and foci of wild cervid infection have been found at locations remote from the endemic area.

The DNR began active CWD surveillance among hunter-killed deer in 1999, and approximately 1,000 animals from 72 of the state’s 130 deer management units were tested with assistance from USDA-APHIS during the first 3 years. On February 28, 2002, the DNR learned that 3 hunter-harvested deer from a single deer management unit in southern Wisconsin had tested positive for CWD infection. Chronic wasting disease, which previously had been regarded as a “western problem,” had been found for the first time in densely populated, wild white-tailed deer east of the Mississippi River. Within days of the announcement, the DNR, in cooperation with other state and federal agencies, landowners, and others, began aggressive efforts to determine the geographic distribution and prevalence of CWD infection in wild deer in the affected area. Within approximately 1 month, 516 deer were collected and tested from a 415-square mile area, and a total of 18 infected deer ultimately were identified within this region through May 2002.

In the summer of 2002, the DNR, in cooperation with the Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP); Wisconsin Department of Health and Family Services; and other state and federal agencies, announced that it would implement an adaptive, interagency management plan to control and minimize the impact of CWD in Wisconsin. The DNR used the newly obtained distribution data to establish a CWD Management Zone in southern Wisconsin, including a 361-square mile Disease Eradication Zone in which all wild deer were targeted for removal to eradicate CWD before it could spread. Intensive CWD surveillance of approximately 50,000 wild deer throughout the state was identified as an essential element of the CWD management plan for 2002-2003. Additional actions taken by the interagency management group during the spring and summer of 2002, included implementation of rules that prohibited baiting

and feeding of wild deer statewide and stringently regulated importation and CWD monitoring of captive cervids, as well as public forums to discuss CWD and its management with stakeholders. Furthermore, research projects were developed to increase the understanding of CWD and deer ecology, evaluate effectiveness of the CWD management program, and analyze the human dimensions of CWD management.

There has been unprecedented reaction of the media, politicians, hunters, landowners, and the general public to the recognition of CWD in Wisconsin, as well as to CWD management policies and actions undertaken by the DNR and cooperating agencies. Wisconsin has an extremely rich outdoor recreation tradition: White-tailed deer are a key component of this heritage, and management actions impacting this important species could be expected to generate controversy. The DNR has enjoyed strong support from several groups for their CWD management efforts since the disease was found in the state while also enduring criticism from other groups within Wisconsin and elsewhere.

In April 2003, the DNR formed an external Program Review Panel to evaluate its management policies and actions regarding CWD. The panel convened in a public forum on April 21-22, 2003, in Madison, Wisconsin, where it received briefing materials and oral reports covering all aspects of the state's CWD management program. Informational items included the *State of Wisconsin CWD Management Plan* (January 21, 2003 Draft), *Overview of CWD and Research Needs for Wisconsin*, documents concerning alternative theories regarding the cause of CWD and on alternative management strategies, statewide CWD surveillance data for 2002-03, preliminary results of field studies, and other reports. The panel met with the Wisconsin Natural Resources Board and fielded questions regarding the state's management approach to CWD, particularly the statewide ban on supplemental feeding and baiting of deer that was implemented during the summer of 2002. The panel also received a tour of the CWD-affected area, including the sample processing facility at Black Earth.

The Program Review Panel was asked to:

- 1. Assess management goals, policies, and ongoing strategies**
- 2. Evaluate underlying assumptions**
- 3. Assess merits of alternatives**
- 4. Assess potential consequences**
- 5. Identify other areas for consideration**

The Program Review Panel evaluated the Wisconsin program in the context of two similar, widely accepted CWD management plans rather than on the basis of potentially arbitrary criteria established by the Program Review Panel or others. The *Plan for Assisting States, Federal Agencies, and Tribes in Managing Chronic Wasting Disease in Wild and Captive Cervids* (National CWD Plan) was completed on June 26, 2002, by a joint task force representing the U.S. Department of Agriculture and the U.S. Department of the Interior, as well as numerous state universities, wildlife management

agencies, and animal health agencies. In April of 2003, the *Multi-state Guidelines for Chronic Wasting Disease Management in Free-ranging White-tailed Deer, Mule Deer, and Elk* (Multi-state CWD Guidelines) were adopted by the wildlife management agencies of several states that assisted in their development. To date, 19 state fish and wildlife agencies, including the Wisconsin DNR, have formally adopted these non-binding guidelines, indicating broad acceptance by agencies responsible for conservation of publicly owned natural resources.

1. Assess management goals, policies, and strategies

Although attention naturally focuses on the reactive disease management policies, extensive consideration must be given to proactive strategies to prevent CWD introduction and establishment in other areas of Wisconsin. Several aspects of the CWD management plan, especially those concerning baiting and feeding, captive cervid management, live animal movement, and carcass handling have a strong preventive component. There is no substitute for disease prevention as a strategy for managing disease in populations, and it is this panel's firm belief that prevention is the most efficient strategy to be employed in combating diseases in free-ranging wildlife. The extreme difficulty and expense of controlling diseases in wild animals are clearly evident in Wisconsin. The costs also are evident in Michigan, where several state and federal agencies have been working together to eradicate bovine tuberculosis since it was recognized in free-ranging deer in 1994, and in the Greater Yellowstone Area, where interagency programs have been working to eradicate brucellosis from elk and bison.

The overall aim of the interagency CWD management effort in Wisconsin focuses on "minimizing the negative impacts of CWD on cervid populations, the state's economy, hunters, landowners and others who are affected by deer management policies." To accomplish this comprehensive goal, the DNR and cooperating agencies have established the primary objective of CWD eradication in the known affected area via depopulation of wild deer within the Disease Eradication Zone combined with preventing the spread of CWD outside this area. Additionally, the interagency team will conduct research to increase the knowledge of CWD distribution, ecology, management, and human dimensions and use results obtained in Wisconsin and elsewhere to adapt its CWD management strategies accordingly. These goals are appropriate in view of the current knowledge of CWD and the management of disease in free-ranging wildlife, and they are consistent with the goals of the National CWD Plan and Multi-state CWD Guidelines. The Program Review Panel recommends the goal of CWD eradication consistently be stated to include the entire state of Wisconsin. The goal of statewide eradication is easily justified by the risk that CWD poses to cervids wherever it is found, the investment Wisconsin already has made to eradicate CWD in the known affected area, and the substantial evidence that CWD is not yet widely distributed in the state.

Extensive statewide surveillance data, including CWD test results from more than 41,000 wild cervids, strongly suggest that CWD was introduced in Wisconsin relatively recently and is confined to a comparatively small geographic area. From a disease control standpoint, the current situation affords the opportunity to implement aggressive

measures with optimal chances for success. A similar approach has been used effectively for infectious disease control in livestock and poultry, most often via localized depopulation or massive immunization programs. In the absence of vaccines and other disease control methods, depopulation or marked population reduction of the host species is the strategy of choice for CWD eradication in wild cervids.

Criticism of the Wisconsin CWD Management Plan arose, in part, because the DNR chose a strategy that has not yet been proven effective for CWD management in free-ranging cervids, and therefore, its success could not be guaranteed. Wildlife disease management strategies are based upon manipulation of the disease agents, the hosts, the environment, and human activities. Disease control efforts often are hindered by a number of factors, including the inherent difficulties of dealing with free-ranging wildlife and a paucity of tools documented to be effective under field conditions. Nevertheless, the lack of proven methods for management of CWD or other diseases in wild populations cannot be used to justify inaction by agencies charged with conserving valuable natural resources: Increased infection rates and geographic spread of CWD are the anticipated consequences of an inadequate management response.

The Program Review Panel commends the DNR, all cooperating agencies, landowners, hunters, and others for their efforts to eradicate CWD from the state. If successful, the remainder of Wisconsin, as well as other states, will be protected from the spread of CWD from this focus. Currently, it is not possible to predict whether CWD will be eliminated from Wisconsin, although the consequences of inaction or inadequate response are clear: The prevalence and geographic distribution of CWD will increase. Because CWD management in wild cervids must be regarded as experimental, acquisition and analysis of data during control efforts are critical to measure the progress of the program and to adapt strategies to maximize the effectiveness of CWD management and minimize the negative impacts of the disease. Wisconsin's experience is providing invaluable information for other wildlife managers throughout the country who may find themselves faced with CWD in wild deer or elk populations.

Baiting and feeding

Although precise modes of CWD transmission have not been delineated, the disease agent clearly spreads laterally from animal to animal, it may be transmitted indirectly via environmental contamination, and consumption of the disease agent causes infection of deer and elk. These facts support prohibition of practices that cause artificial congregation of deer. Baiting and feeding cause unnatural congregation of wild animals that normally are dispersed. These conditions enhance direct contact between infected and uninfected animals, as well as contact with feed or other materials contaminated with the disease agent from infected animals.

Many significant wildlife disease problems are associated with artificial feeding. In Michigan, baiting and feeding are strongly associated with establishment of bovine tuberculosis for the first time ever in a wild deer population in the United States, while winter feeding has been linked to bovine brucellosis in elk in the Greater Yellowstone

Area. These diseases became well established in wildlife receiving supplemental feed before the problems were recognized, and it is unlikely that they will be eliminated as long as the artificial practices persist.

Feeding and baiting should be prohibited throughout the state to reduce opportunities for CWD, or other significant infectious diseases, to become established in Wisconsin's wild deer herd. Testing of more than 41,000 wild deer in Wisconsin last year produced evidence that CWD is not widespread throughout the state. Nevertheless, a ban on baiting and feeding is warranted because our incomplete understanding of the risk factors for CWD introduction does not allow us to state categorically that the disease is absent. The recent identification of CWD in wild deer in Walworth County emphasizes the importance of recognizing limitations of even the most intensive surveillance programs.

The Program Review Panel also recommends that shooting over bait not be used as a population control tool in the Disease Eradication Zone by landowners or agency personnel. This practice, which may not be significantly more effective than shooting without bait, sends a mixed message to the Wisconsin public and potentially erodes support for the much-needed statewide prohibition of baiting and feeding.

Population reduction

Population reduction is at the center of CWD eradication efforts in Wisconsin, and it may also play a key role in prevention of CWD introduction to other areas of the state. The Herd Reduction Zone, in which deer population density is to be reduced to 10 deer per square mile, surrounds the Disease Eradication Zone and is designed to minimize the risk of CWD transmission from the affected area to adjacent areas. Additionally, Zone-T seasons are conducted in specific deer management units around the state where it has been determined that normal hunting pressure will not remove deer to a level compatible with the carrying capacity of the land.

Within the Disease Eradication Zone, the stated goal is depopulation of all wild deer within approximately 4.5 miles of any positive animal. Although, the DNR recognizes total depopulation of wild deer in the affected area is unlikely, this goal strongly indicates the intention of the DNR to reduce the deer population density to a level at which CWD cannot be maintained. Because this threshold density is unknown and because CWD is maintained in low-density wild cervid populations in some western states, attempts to depopulate the Disease Eradication Zone are appropriate.

Public hunting is the most efficient method to accomplish management of deer populations. In the Disease Eradication Zone, public hunting has been supplemented by personnel from state and federal agencies shooting deer in order to reach surveillance and management objectives. All of these options must remain open to minimize costs and maximize the efficiency of CWD management actions, and additional methods should be considered. A reward system for hunters who submit deer that test positive for CWD already has been initiated. Consideration also should be given to the judicious

application of additional techniques, including night shooting and shooting of deer from aircraft, by agency personnel to supplement current methods.

CWD testing and surveillance

The strong collaboration between the DNR, Wisconsin Veterinary Diagnostic Laboratory, and USDA-APHIS allowed testing of more than 41,000 samples collected through the 2002 hunting season. The implementation of a computerized system to track specimens from the hunter to the final report is a notable accomplishment. Use of retropharyngeal lymph node greatly increased the efficiency and numbers of animals that could be tested in a given time and also decreased the cost of testing.

Use of immunohistochemistry, regarded as the “gold standard,” for testing all samples collected during the 2002 season was appropriate because it was the only technique approved by the USDA at the time the surveillance program was planned. With the infrastructure in place for large-scale immunohistochemistry testing, this method is appropriate for continued surveillance as well as for use as a confirmatory test. Consideration also should be given to the use of other testing methods validated and licensed within the last year.

It is essential that testing for CWD continue to be conducted in facilities that have been approved by the USDA in order to assure the reliability and consistency of test results from laboratory to laboratory. The lobbying by some private companies for use of unlicensed tests for CWD was unfortunate and served as a distraction for personnel attempting to implement an enormous surveillance program. Furthermore, apparently false positive CWD results obtained from use of one unlicensed test were reported in the media causing undue public concern and additional distraction to agency personnel.

Surveillance programs for CWD have three general objectives: (1) early detection in areas not known to be affected; (2) determination of the distribution and prevalence of CWD in newly identified areas; and (3) measurement of the response to CWD management strategies. Wisconsin is doing an excellent job with objectives 1 and 2, has made a good start on number 3, and should be commended for developing and implementing an extensive statewide CWD surveillance program in a very short time. The plan was based on sampling deer (every deer taken within the Disease Eradication Zone, 500 deer 18 months or older from each of 15 Deer Management Units comprising the CWD Management Zone, and 500 deer per county or group of counties statewide) in order to provide nearly 99% confidence of detecting CWD if it were present in approximately 1% of deer in each population. This surveillance strategy is dependent upon voluntary and mandatory submission of heads of hunter-killed deer for testing. Although the numbers of animals tested did not quite meet the goals stated for the 2002 hunting season, in nearly 90% of sampling units there is $\geq 90\%$ chance that CWD would have been detected if present in approximately 1% of animals. Furthermore, it should be possible over the next few years to bring the confidence level up to 99% that CWD would have been detected if it were present in 1% or more of the wild deer throughout the state.

Wisconsin leads the nation in having a statistically valid understanding of CWD distribution.

The data collected with Wisconsin's CWD samples is very useful. Knowledge of the precise location of deer from which samples were collected is essential for monitoring changes in CWD over time for management and research. Localization to the section level (640 acres) is especially important for identifying small areas of high prevalence ("hot spots"), because CWD, like most wildlife diseases and wildlife populations, is not distributed uniformly across the landscape. Identification of "hot spots" might aid in eradication by concentrating deer depopulation activities and therefore be more acceptable to landowners and the public.

Wisconsin's CWD surveillance program also has provided a significant level of assurance that the disease is not widely distributed throughout the state. However the possibility that CWD could be present outside the affected zone, due to the highly clustered distribution of the disease, was realized in August 2003, with the announcement of a positive wild deer in Walworth County. Because it is impractical and cost-prohibitive to test every hunter-harvested deer in the state, random surveillance programs should be combined with targeted surveillance to test those deer most likely to be infected. The infected Walworth County animal was identified through targeted surveillance, highlighting the importance of this tool for CWD detection.

Future surveillance recommendations include targeted surveillance statewide for clinically affected animals; random surveillance of hunter-killed deer in areas of the state based on risk factors, including positive captive cervids, high numbers of unmonitored captive cervid facilities, and proximity to positive wild deer in Wisconsin and Illinois; as well as intensive hunter-harvested and cull surveillance in the expanded Disease Eradication and Herd Reduction Zones. Future surveillance programs should be adaptive, science-based, and practical in terms of manpower, money, and laboratory capacities.

Carcass issues

Although carcasses of infected hunter-killed animals have not been documented as a source of CWD introduction into new areas, it is prudent to take measures to reduce the likelihood of such an event. The Program Review Panel recommends that Wisconsin develop policies similar to those in Colorado which prohibit transport out of the affected area of materials from deer other than boned meat, hides, antlers, and clean skull plates. Additionally, the Wisconsin DNR should advise its residents that those who hunt out of state should follow regulations and recommendations regarding carcasses in the areas where they hunt.

Based on current knowledge, Wisconsin's handling and disposal procedures for carcasses of infected animals are more than adequate. Processes should be employed that reduce the amount and activity of the disease-associated protein (PrP^{CWD}), and CWD-contaminated materials should be disposed of in ways that prevent exposure of wildlife,

domestic animals, or humans. Destruction or inactivation of PrP^{CWD} is difficult, and there are few treatments documented to be completely effective; however, proper incineration and alkaline digestion are two such treatments. Wisconsin has used incineration for disposal of CWD-positive carcasses and landfilled carcasses in which the CWD agent was not detected and is in the process of setting up an alkaline digester.

Disposal methods for carcasses of animals with TSEs vary around the world, as well as within the United States. In Great Britain, treatment and disposal of carcasses of animals with bovine spongiform encephalopathy (BSE) or scrapie are quite rigorous because of the connection of new variant Creutzfeldt-Jakob disease in humans to consumption of BSE-contaminated beef and the uncertainty regarding the origin of BSE. Scrapie animals in the United States currently are incinerated, buried, or disposed at landfill in accordance with state and local regulations; on-site disposal of carcasses or ashes is allowed as long as state and local requirements are met. Now that intensive surveillance has been completed and the distribution of CWD in Wisconsin is better defined, disposal options, particularly at landfills, should be expanded in those areas where CWD has not been found.

Management of farmed deer and elk

The presence of more than 900 captive cervid facilities warrants extensive industry involvement in CWD management if the disease is to be eliminated from Wisconsin. Despite relatively low levels of monitoring to date, CWD has been recognized in three captive deer or elk herds in Wisconsin, as well as in a white-tailed deer that escaped from one of the facilities. To prevent future occurrences, complete epidemiologic investigations should be conducted to identify possible sources of CWD introduction in these facilities, as well as potential spread of the disease to other premises.

Since CWD was recognized in Wisconsin's wild deer, several steps have been taken to monitor and eliminate CWD from captive cervids, including initiation of a state CWD program for captive deer and elk. The Wisconsin captive cervid CWD program, which includes importation restrictions and requirements for individual animal identification and CWD monitoring, is consistent with the framework of the proposed USDA-APHIS program (*Chronic Wasting Disease Herd Certification Program and Interstate Movement of Captive Deer and Elk*). Wisconsin's implementation of intrastate movement requirements equivalent to APHIS' proposed interstate movement requirements insures that producers moving animals within the state have an incentive to participate in surveillance programs and should serve as a model for other states.

Although the DATCP has been working with Wisconsin's captive elk producers for some time, regulatory authority over captive white-tailed deer was transferred from the DNR to DATCP in January 2003. The Program Review Panel recommends that appropriate resources be made available for the DATCP to educate captive cervid owners and to enforce regulations for this sizable industry currently consisting of 575 registered white-tailed deer herds.

It is critical to maintain complete separation of captive and free-ranging cervids in order to prevent transmission of CWD, or other diseases, between the two groups. Escapes from captive cervid herds or movement of wild deer in and out of captive facilities represent potential sources of CWD introduction into Wisconsin's wild deer herd. Conversely, entry of infected free-ranging animals into captive facilities could introduce CWD into farmed cervids in areas where CWD is present in wild deer. Fencing must be adequate to keep farmed cervids within their premises and wild cervids out of captive cervid facilities. White-tailed deer present a particular challenge in this regard because they are able to move in and out of facilities that would effectively contain elk or other cervid species, and a recent audit of white-tailed deer farms in Wisconsin documented several hundred escapes throughout the state. Wisconsin already has experienced a worst case scenario in this respect when, in late 2002, a deer was culled from the wild and tested positive for CWD six months after it had escaped from a CWD-infected captive white-tailed deer facility in Walworth County. However, preventing the escape of captive cervids is a national problem, not just a Wisconsin problem. The cooperative relationships between deer producers as well as state and federal wildlife management and animal health agencies in Wisconsin provide a unique opportunity to explore better fencing options for white-tailed deer and the Program Review Panel recommends that this work be pursued.

Monitoring, measurement, and adaptive management

The extensive surveillance program and associated research efforts in Wisconsin allow the DNR to monitor progress towards the elimination of CWD, as well as to identify features that may be exploited to increase the efficiency of management efforts. The interagency CWD team has identified and prioritized research needs for the development of information that will be critical for directing and modifying management strategies.

Research priorities in Wisconsin fall into three general categories: CWD ecology and dynamics, ecology of white-tailed deer, and sociology. Study of these topics in Wisconsin is greatly facilitated by the fortuitous presence of scientists with appropriate expertise within the state. Scientists from the DNR, the University of Wisconsin, the National Wildlife Health Center (U.S. Geological Survey), and other agencies are working on a variety of CWD studies following a plan developed by the interagency CWD team. These studies are integrated within the state and nationally and will provide information necessary for wildlife managers and the public to make decisions about CWD management in Wisconsin. It is too early to evaluate many of Wisconsin's research projects because they are in early stages of development and implementation; however, significant progress already has been made in some areas.

Although there is some overlap between Wisconsin research projects and CWD studies in western states and provinces, it is essential that local information be developed because several differences exist between the Wisconsin and western situations. Differences including species (white-tailed deer vs. mule deer and elk), cervid density (70-120 deer per square mile vs. 3-5 deer per square mile), and habitat (rolling

agricultural and mixed hardwood vs. prairie and montane) may have a profound influence on CWD transmission and dynamics. Local information is critical for development of site-specific CWD management plans. The study of CWD ecology and dynamics is made possible by the massive statewide surveillance program to determine geographic distribution, prevalence, demography, and epidemiology. Researchers and managers also are obtaining and archiving valuable frozen and fixed tissues for use in collaborative CWD studies which require work directly with the CWD agent from Wisconsin deer.

Another CWD research question concerns the potential for the disease to be naturally transmitted to other species, including wildlife, domestic animals, and humans. Several projects have been conducted or are underway in Wisconsin and elsewhere to develop information on this topic. The Wisconsin CWD Management Plan identifies the Department of Health and Family Services as the key agency to study any possible human health aspects of CWD. Active surveillance will be conducted for Creutzfeldt-Jakob disease (CJD) and unusual clusters of human illnesses that could suggest a novel source for CJD or CJD-like illnesses. This area of research is essential in view of the need for information to provide to hunters and others who consume venison, as well as the public concerns that have been fueled by intense media coverage of neurological diseases in Wisconsin hunters.

Research regarding the biology associated with intraspecific transmission and geographic spread of CWD in Wisconsin primarily is directed at the movements and social behavior of white-tailed deer. White-tailed deer ethology and ecology have been subjects of considerable research, and there is a body of knowledge on the subject. However, the white-tailed deer is a highly variable species over its large geographic range, and its behavior has been found to be unusually labile, depending on environmental and population parameters. Therefore, information obtained from other populations may not apply very well to the affected area in Wisconsin.

Areas of particular interest in cervid biology research in Wisconsin should include social groupings, reproductive behavior, and communication systems, particularly those involving direct contact or semiochemicals. Careful studies of infected animals in relation to all deer tested in the affected area already are providing information and may reveal clues as to how CWD is transmitted under field conditions. Results in Wisconsin and Colorado indicate higher CWD prevalence in males than in females, especially in older age groups. White-tailed deer social behaviors potentially related to higher prevalence in males may include signposting activities and pheromonal communication systems. Research to enhance detection of the CWD agent is critical to determine if it is present in saliva, urine, feces, as well as apocrine, and/or sebaceous secretions.

Another important area of cervid research is movement ecology of uninfected and infected cervids. University of Wisconsin researchers are investigating uninfected deer movements through radio telemetry studies in the Disease Eradication Zone and in an area in which population reduction is not occurring. Early findings include unusually long dispersals by does, and it has been suggested that depopulation efforts may result in increased dispersal among young females. The literature on whitetail dispersal suggests

that removal of adult does from an area may decrease dispersal among young bucks. These behaviors warrant further study because they may have a significant effect on the spread of CWD in wild populations. Studies to evaluate movements and behavior of infected animals prior to the development of obvious clinical signs are more appropriately conducted in endemic areas in western states because they are not consistent with Wisconsin's CWD eradication program.

Increased funding is becoming available for CWD and other TSE research. A team effort should be maintained by researchers in Wisconsin with others around the country to prevent inefficiencies, such as duplication of research. Coordination of CWD research and control efforts on a continental scale is vital.

Communications and human dimensions

It is essential to provide timely and accurate information about CWD to all persons potentially impacted by the presence of the disease in Wisconsin, including agency personnel, landowners, hunters, captive cervid farmers, the media, politicians, and the general public. The DNR and other Wisconsin agencies have maintained a high level of professionalism under excruciating circumstances, and care must be taken to guard and improve upon this excellence. Many of the ongoing Wisconsin outreach programs, such as the 1-800 numbers, agency websites, county liaisons, public meetings, and one-on-one sessions, are valuable and should be continued. Nevertheless, with the initial crisis-oriented phase over, effectiveness of communication efforts may be enhanced by evaluation and prioritization, as well as by the determination of clear objectives and a systematic approach to their implementation.

Strides have been made to better understand public reaction to CWD through focus groups and questionnaires. Town meetings were held; however, these venues potentially involve unidirectional communication with the organized flow of information principally from DNR to stakeholders. A structured process for collecting and interpreting information from stakeholders should be employed to preclude development of anecdotal synopses of stakeholder beliefs, attitudes, and expected behaviors. Additionally, agency personnel must be included in structured communication programs because they also are stakeholders with varying beliefs and attitudes regarding CWD and its management, and their opinions and actions have great influence on public perceptions of the DNR and its disease management policies.

Communication regarding CWD essentially is risk communication, which typically is defined as an interactive process of exchange of information and opinions among stakeholders concerning a specific risk. There are real or perceived health risks to humans and deer from CWD as well as secondary risks to economic, esthetic, cultural, and environmental values from the effects of the disease or its management. A key component of risk communication is a dialogue with stakeholders about risks and how to best manage those risks, many of which may be perceived risks for which "experts" cannot readily provide solutions. Investments in sociological research will be necessary

to achieve a level of understanding of human dimensions comparable with the desired understanding of environmental dimensions of CWD and its management.

In addition to appropriate risk communication, outreach activities must be used to enhance public support for CWD management policies and strategies. Opposition to the CWD management plan by the public, especially landowners in the Disease Eradication Zone, represents a potentially significant obstacle to CWD eradication because success of the DNR management plan is highly contingent upon public acceptance and participation. It is essential that the DNR recognizes this potential obstacle and engages landowners and hunters in the disease management area to gain their support and assistance. These outreach activities should be the product of research conducted to understand the public perceptions about CWD and its risks as well as the methods the public finds acceptable for management of the disease.

Environmental decontamination and restoration

Potential contamination of the environment from excretions, secretions, or decomposing carcasses of infected animals will be reduced under Wisconsin's CWD management strategy. However, it is not possible to know the extent of environmental contamination that has occurred to date or its potential contribution to maintenance of CWD in the remaining deer or reemergence of CWD following restoration. The Program Review Panel recommends that the Wisconsin interagency CWD team conduct or strongly support research to determine the potential role of environmental contamination in the epidemiology of CWD in Wisconsin and the efficacy of mitigation methods, and incorporate results of such research into the adaptive CWD management program, particularly during the restoration phase.

Restoration of animal herds destroyed in disease control operations is an essential part of any comprehensive management plan. It is important that the DNR publicize its restoration plan for the affected area and the scientific principles on which restoration will be based in order to facilitate public support and assistance with disease control measures. Acquisition of additional data will be necessary to make informed decisions regarding the timing of deer restoration in the Disease Eradication Zone in order to prevent reemergence of CWD in the area.

2. Evaluate underlying assumptions

The Wisconsin CWD Management Plan is based on several assumptions the Program Review Panel regards as validated by scientific information. (1) Chronic wasting disease is a transmissible spongiform encephalopathy caused by prions that are spread from infected animal to susceptible animal by direct or indirect contact, with a possible role for environmental contamination. (2) Chronic wasting disease recently was introduced into the state and its distribution is limited to a defined area in southern Wisconsin. (3) Chronic wasting disease may have a significant negative impact on cervid populations and its presence diminishes the real or perceived value of deer and elk. (4) High host animal density and frequent animal contact are associated with increased

prevalence of the disease. (5) Chronic wasting disease will not disappear spontaneously in the absence of management actions, and restrictions on human activity are necessary to prevent its spread into new areas.

The DNR is relying heavily on modeling for developing and adapting management plans. The objective of the model is to visualize, illustrate, and communicate alternative management approaches and consequences. As such, the Cary model is similar to previously published models on CWD management with the addition of spatial dynamics of disease transmission and its predicted impact on deer populations. The model follows a logical process and depicts an appropriate scale of analysis, and the author does a good job of stating assumptions and conducting sensitivity analyses.

The chief issue around any model is the accuracy of the assumptions on which the model is based. A primary assumption of the Cary model is that CWD transmission is frequency-dependent rather than density-dependent. In a frequency-dependent model, an infected animal transmits disease to a given number of other animals, regardless of how many other animals are in the area. In contrast, the number of animals to which disease is transmitted becomes fewer as the population declines in a density-dependent model. If transmission actually is more density-dependent than frequency-dependent in Wisconsin, then the Cary model likely would overestimate the probable effects of CWD on deer populations. It is assumed that the Cary model will be refined as data are generated by research projects in Wisconsin and elsewhere.

The model is fairly complex, and efforts should be made to make the model more transparent in how it was developed, how it functions, and in its limitations for prediction. Additionally, the credibility of the DNR relative to their management actions could be improved if an independent outside review of this central document were conducted, including publication of the Cary model in a peer-reviewed scientific journal. Although landowners who have chosen not to participate in the deer reduction policy may not be swayed by a document generated in-state, they may be more willing to accept the predicted impact of CWD on the deer and support aggressive local control measures if they can be shown that outside scientists agree with the overall findings of the model.

3. Assess merits of alternatives

The Program Review Panel evaluated theories regarding the cause of CWD. They found that the preponderance of scientific evidence supports prions (proteinaceous infectious particles) as the cause of CWD and other TSEs. The panel found little valid information to suggest other causes including micronutrient deficiencies or excesses, exposure to chemical compounds such as insecticides, and more conventional infectious disease agents such as bacteria.

Alternative CWD management methods for Wisconsin have been proposed by various interest groups and stakeholders within and outside the state. Strategies that have been advocated include elimination of clinical suspects only, testing live deer with subsequent culling of positive animals, reliance on natural resistance, and treatment or

vaccination. Vaccines and treatments for CWD are not available, and scientific evidence suggests that there is very little, if any, genetic CWD resistance among white-tailed deer or that removal of individual live animals that are clinically affected or test positive is practical or effective for managing CWD at the population level. Additionally, alternative approaches often were based on assumptions for which the Program Review Panel found little scientific support. These assumptions included beliefs that CWD is widely distributed throughout Wisconsin, it is of no significance to wild deer populations, and/or that its elimination is unfeasible and management efforts should focus on “living with CWD.” Recent testing of more than 41,000 deer across Wisconsin has provided considerable evidence to refute the first assumption. Models, based on the best available science, indicate that in the absence of appropriate CWD management, the disease will spread and the infection rate will increase to a point where it has severe negative impacts on the deer population. While there currently is no scientific evidence or guarantee that CWD will be eliminated from Wisconsin, the potential consequences to the state and elsewhere warrant aggressive management by the interagency team to eradicate the disease while it is confined to a relatively small area.

4. Assess potential consequences

The anticipated consequences of CWD management actions in Wisconsin include containment and elimination of the disease from wild and captive cervids within the state, and progress toward this end will be monitored via intensive CWD surveillance. Potential adverse consequences of management actions include geographic spread of CWD via dispersal of deer in response to hunting pressure, spread/maintenance of CWD via attraction of unexposed deer to the area of lower deer density, spread/maintenance of CWD via changes in deer distribution, socioeconomic changes due to altered deer populations, and changing public perceptions of the DNR and other agencies involved in CWD management in Wisconsin. The research projects outlined in Wisconsin’s CWD Management Plan allow monitoring of CWD, deer movement and distribution, and human dimension aspects of the ongoing efforts to eliminate CWD from the state and should provide the information necessary to adapt management strategies to correct for any of these adverse developments.

The ultimate adverse consequence is failure of adaptive CWD management in Wisconsin to contain or eradicate CWD. The DNR should continue to closely monitor the effects of its management strategies on CWD in the state and should be prepared to shift to a more passive plan if the aggressive efforts to eradicate CWD via deer depopulation become clearly unsuccessful. Severe deer population reduction in affected areas is not a benign treatment, and like the disease, the deer depopulation process will have long-term negative effects on the hunting culture and tradition. Because of this, efforts to depopulate free-ranging deer should not be continued any longer than there is reasonable hope that they will be effective. However, it is important to reemphasize that as long as there remains a reasonable hope of eradicating or controlling spread of CWD, every effort must be made to that end.

5. Identify other areas for consideration

Wisconsin's science-based, adaptive management strategy to eliminate CWD is comprehensive and provides few opportunities to identify other areas for consideration. One issue to be considered is using the spatial data obtained via CWD surveillance in the Disease Eradication Zone to identify precise locations of higher infection rates among deer and target these areas for especially aggressive management. This approach affords the opportunity to remove greater numbers of infected deer that may serve as sources of infection for uninfected animals within the area and from adjacent areas, as well as greater numbers of infected deer that could potentially spread CWD to remote areas via long dispersals or wandering. Additionally, this strategy may be more acceptable to landowners and others who have not supported the management approach so far if they realize that deer in specific areas may be serving as a potential source of CWD infection for other deer.

Consideration should be given to the nomenclature used to describe disease management areas and actions. The use of Disease Eradication Zone, Intensive Harvest Zone, CWD Management Zone, Buffer Zone, and Herd Reduction Zone terminology may be confusing, and a minimal number of explicit terms should be adopted and used consistently. One suggestion would be to describe the entire area in which disease management is the highest priority as the "CWD Management Zone" that consists of only two zones: The core area (Disease Eradication Zone) and the surrounding area (Disease Buffer Zone). Because disease management is the highest priority for the deer population within this area, terminology used for disease work is appropriate, although use of this terminology could discourage some from hunting or consuming venison. However, use of disease terminology clearly conveys the primary intent of the deer management being employed in the area.