AFWA Technical Report on Best Management Practices for Prevention, Surveillance, and Management of Chronic Wasting Disease

Association of Fish and Wildlife Agencies, Washington, D. C.

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Contents

1 - Introduction

Chronic wasting disease (CWD; Williams and Young 1980), is considered the most important disease threatening North American cervids. A fatal, transmissible, and degenerative disease of deer, elk, moose, and other species of the family Cervidae, CWD affects all native North American cervid species. The persistent, infective, environmental contamination caused by the causative agent means that state and provincial wildlife management agencies have relatively few options to mitigate the effects of this disease.

The intended audience of this document is the leadership of the United States and Canadian state, federal, provincial, and territorial fish and wildlife agencies, including directors, program administrators, and managers who make management and policy decisions for wildlife populations within their authorities and jurisdictions. The goal of this document is to provide directors, administrators and managers with an account of current tools and recommendations available so they can craft and implement their own suite of management practices to help in the fight against CWD on a state or provincial scale.

In the March 2017, the Association of Fish and Wildlife Agencies (AFWA) charged the AFWA Fish and Wildlife Health Committee with developing a set of concise best management practices (BMPs) for prevention, surveillance, and management of CWD. This guidance document represents contributions from more than 30 wildlife health specialists, veterinarians, biologists and agency leaders who are actively managing CWD across North America. The document is built on the best peer reviewed science and field-tested methods that can inform decisions regarding the prevention or management of CWD. The format provides AFWA Directors with topical summaries accompanied by best practices or guidance based on science, along with appropriate literature cited or other resources. Where appropriate, the document also provides agencies with options or alternatives, including those that may not feasible or practical for all jurisdictions or under every scenario. However, the authors approached this task with the objective of presenting the BMPs to exclude detect, and/or manage CWD within their jurisdictions. Because our knowledge of this disease continues to evolve, these BMPs are meant to be a dynamic, living document that can be updated when new information is available. It should also be noted that these BMPs are scientific guidance documents and cannot by themselves affect or alter any state's laws regarding public ownership of wildlife.

2 - Background

Chronic wasting disease (CWD) became well known to wildlife managers well after it appeared in North American free-ranging deer and elk populations in the early 1980s (Spraker et al. 1997, Miller and Kahn 1999, Miller et al. 2000). CWD is a transmissible spongiform encephalopathy (TSE) or "prion" disease affecting species in the family Cervidae. In North America, CWD has been documented in wild populations of deer (*Odocoileus* spp.), elk (*Cervus* elaphus.), and moose (*Alces alces*). The disease was first diagnosed in captive deer and elk at wildlife research facilities in Colorado and Wyoming (Williams and Young 1980, 1982). Scientists diagnosed CWD as a TSE through histopathological evaluation of brains from affected mule deer (*O. hemionus*) and elk showing clinical signs of neurological disease and physiological wasting (Williams and Young 1980, 1982). It has not been possible to determine, retrospectively, if CWD first occurred in captive or free-ranging animals (Williams and Young 1992, Williams et al. 2002), although modeling suggests that CWD likely was present in wild populations prior to its identification in captive facilities since the early 1960s, if not earlier (Miller et al. 2000). Additionally, the theoretical possibility exists of more than one introduction of CWD into wild cervids. Presumably, if CWD originated from scrapie, as has been hypothesized by Miller et al. 2000, then there could have been more than one instance of transfer to wild cervids (Miller and Fischer 2016). Captive elk exported from Saskatchewan to South Korea marked the first detection of the disease outside of North America (Williams et al. 2002). Recently, two forms of apparent CWD have also been discovered in reindeer (*Rangifer tarandus*) and moose in Norway (Benestad et al. 2016) and in Finland, but these cases have not been linked to North America.

CWD continues to spread across North America, likely through movement of infectious animals or materials, either naturally in migrating /dispersing wild populations, or through anthropogenic movement of infectious live animals, carcasses, or other materials. Over the past 50 years, CWD has been detected in captive and/or wild cervids in 25 states and three provinces (CWD Alliance http://www.cwd-info.org/ or USGS: (https://www.nwhc.usgs.gov/disease_information/chronic_wasting_disease/; Dube et al. 2006).

The effects of CWD on populations of the affected species are significant in some areas. Research and predictions via simulated modeling have indicated that CWD is likely additive to white-tailed deer population mortality and could impact populations, particularly at higher prevalence (Edmunds et al. 2016), to the extent that hunter opportunity would also be impacted (Foley et al. 2016). Mule deer research also showed populations declines with a CWD prevalence >20% versus stable populations without CWD present (DeVivo et al. 2017). Recently published research on CWD and elk also concluded that mortality from CWD can exceed that of natural deaths (Galloway et al. 2017), reduce survival of adult females, and decrease population growth of elk herds (Monello et al. 2014). The disease is invariably fatal in infected animals. Williams (2005) found in mule deer that the pathogen has early widespread distribution of specific protease-resistant disease-associated prion protein (PrP^{cwd}) in lymphoid tissues, and only later is PrP^{cwd} evident in central nervous system (CNS) and peripheral tissues. The pathogen ultimately causes normal prions in neurological tissue of the CNS to convert to the abnormal PrP^{cwd}. These abnormal prions accumulate in the brain (and other tissues), and eventually cause neurological disease, emaciation, and death. A long incubation period (16–18 months to 5 years or longer for some genotypes of deer and elk) between acquiring the infection and showing clinical signs makes managing CWD extremely challenging. The maximal incubation period is unknown; however, CWD prions are shed from an infected animal into the environment during this extended incubation period, meaning that non-clinical animals may be infectious before signs appear (Tamgüney et al. 2009). Some genotypes, currently believed to be rare in wild populations, may exhibit varying incubation periods; however, no genotype is fully resistant. These individuals may have prolonged incubation periods and therefore shed prions into the environment longer than the more common genotypes. The rarity of these genotypes in wild populations raises questions about their genetic fitness. Currently, CWD infection is fatal to all North American deer, elk, and moose challenged experimentally, in captive settings, or in free-ranging populations (Williams et al. 2014).

A prion is a 'proteinaceous particle' consisting only of protein, with no nucleic acid genome (DeArmond and Bouzamondo 2002, Prusiner 2004). The abnormal prions are similar to normal prions found in the membranes of normal cells, but the PrP^{cwd} has an altered shape, or conformation. Distorted PrP^{cwd} can bind to normal prions and cause alteration in their conformation, producing a reaction that begins the disease process and generates new infectious material. Other pathogens like bacteria and viruses have nucleic acids that allows them to reproduce but also makes them susceptible to ultraviolet light and disinfectants. Misfolded prions are resistant to many common disinfectants, heat, sunlight, and freezing, as well as many of the other methods used to kill conventional pathogens (Travis and Miller 2003). They have been shown to persist in the environment for years, potentially decades, and remain infectious to susceptible animals. Research conducted since the discovery of CWD in the 1980s suggests that CWD probably is transmitted by direct contact between infected and susceptible animals and indirectly via consumption or exposure to materials contaminated with prions shed in the urine, saliva, feces (Mathiason et al. 2009), or from decomposed carcasses of infected animals (Miller et al. 2004).

Researchers also have shown that CWD prions are able to bind to montmorillonite, a type of clay in soil, suggesting that some soils and soil minerals may facilitate CWD infectivity (Johnson et al. 2006). Although the maximum length of time that prions can remain infective in the soil is unknown; if CWD is similar to other TSEs such as scrapie then environmental prions may be infectious years to decades. Related research also has shown certain plants can assimilate and uptake small, nearly undetectable levels of the CWD prion from contaminated substrate, suggesting a potential route for susceptible animals to ingest the pathogen from contaminated habitats (Rasmussen 2014). The prolonged incubation period, persistent shedding by clinically normal animals, along with environmental contamination and persistence of CWD prions, make the disease difficult to detect early and manage before it spreads. Depopulation of an entire wild or captive herd may not eradicate the disease because of untreatable and widespread persistence of infectious CWD prions in a highly contaminated environment. Subsequent reintroduction of susceptible animals can and likely will result in new infections.

No vaccine, treatment, or medical cure for CWD currently exists. Although live animal tests have been used in research applications, in captive cervid operations as a whole-herd test, and for some interstate publicly owned, free-ranging interstate cervid translocations, no practical or validated live animal test for individual animals is available. The tests that are available are for detection of disease in cervids and should not be regarded as food safety tests. The minimum infectious dose of CWD prions is unknown, so determination of the level or degree of infectivity is unknown. Species in the family Cervidae appear to be the only animals naturally infected with CWD, although infection in other species outside this family has been demonstrated with varying success in experimental inoculation studies. Researchers at the National Institutes of Health were unable to demonstrate transmission to non-human primate test subjects (Race et al. 2009; 2018). However, unpublished work from a Canadian and German research team indicates apparent of CWD transmission to macaques via several inoculation methods including consumption of meat from infected, clinically normal deer (Czub et al. 2017). Apparent transmission of bovine spongiform encephalopathy to humans indicates that the species barrier may not completely protect humans from animal-borne prion diseases (Belay et al. 2004). To date, no human CWD infections have been reported, although humans undoubtedly consume CWD-infected animals. Public health authorities recommend that animals that test positive for CWD should not be consumed, nor should any animal that appears unhealthy.

Movement of infected live animals is considered one of the greatest risks for spreading CWD to new locations (Williams et al. 2002; Joly et al. 2003; Travis and Miller 2003; Belay et al. 2004). Movements of wild animals via migrations or dispersal have been implicated in the spread of CWD (Miller et al. 2000; Conner and Miller 2004; Miller and Williams 2004; Miller et al. 2006; Potapov et al. 2016) including probable transmissions from New Mexico to Texas, West Virginia to Virginia, Wisconsin to Iowa, and from Saskatchewan to Alberta. CWD also has been spread via human-facilitated live captive cervid movements including 1) the spread of CWD to 38 captive elk herds in Saskatchewan that received elk directly or indirectly from a single infected herd (Argue et al. 2007) that apparently imported infected elk from South Dakota , and 2) the spread of CWD to captive elk herds in Colorado and one in Kansas when elk from a single infected facility in Colorado were shipped to 19 states and more than 40 other captive facilities within Colorado (unpublished SCWDS Briefs April 2002, Vol.18, No. 1) . CWD -infected elk were shipped from Canada to South Korea in 2001 (Sohn et al. 2002) causing major international animal import trade concerns from the resulting epidemiological investigation. The disease re-occurred in a captive elk in the affected Korean area in 2004 and has since occurred in additional cervid case in 2005 and 2010 (Lee et al. 2013), resulting in the closure of that nation to international trade of captive elk. However, documented movement of live animals cannot explain all new CWD detections.

To control movement of the disease in the captive cervid industry within the United States, the USDA-APHIS's National Herd Certification Program (HCP) was fully implemented in 2012 (Code of Federal Regulations: 9 CFR Part 55 https://www.law.cornell.edu/cfr/text/9/part-55) to regulate interstate shipment of live cervids. Participation in the HCP is voluntarily; however, only animals from HCP-certified herds may be shipped interstate. Prior to implementation of this federal program, individual states regulated the movement of captive cervids. The national HCP certifies herds in approved state CWD programs as being at low risk for having CWD after five years of disease-free monitoring. However, there is no "CWD-free" certification of captive cervid herds. Individual states may implement regulations more stringent than the national HCP and their regulations preempt the Federal requirements with one exception: states must allow transit of captive cervids through the state, even if they do not allow captive cervid operations within the state.

From 2002–2012, federal funding was available to states for surveillance, monitoring, and management of CWD in wild and captive cervids and to the captive cervid industry for indemnity payments to owners/managers if their herds became infected and required depopulation. Since 2012, no funding for state surveillance, monitoring, or management of CWD in wild deer has been available and the economic burden has fallen solely on the states. House Bill 4454 (Chronic Wasting Disease Management Act) was introduced in the 115th Congress (2017–2018) to provide funding "To support State, provincial, and tribal efforts to develop and implement management strategies to address chronic wasting disease among deer, elk, and moose populations, to support applied research regarding the causes of chronic wasting disease and methods to control the further spread of the disease, and for other purposes".

The U.S. federal HCP has not prevented the continued spread of CWD or eliminated CWD in captive herds enrolled in the program. Since implementation of the HCP in 2012, CWD has been detected in additional captive cervid herds, including HCP-certified herds. Intra- and interstate movement of animals from HCP-certified herds later found to be infected is well documented and has resulted in infection of linked herds within the same state as well as at one Wisconsin herd that received an infected deer from a certified Pennsylvania herd. According to information provided by officials in affected states, all certified herds had been monitored for more than the five years required by the HCP before CWD was detected. Similar situations have been documented in Saskatchewan. Until there is a highly-sensitive antemortem test for CWD, live animal movements remain a significant risk for the spread of the disease. Evidence for long-term persistence of prion proteins in the environment, combined with the long incubation periods observed in many prion diseases, suggests that the current five-year monitoring period may be inadequate. Regulators need to be aware that HCP (U.S.) and VHCP (Canada) may create a false sense of security among the public and industry that CWD cannot be spread through movement of live animals from certified herds. The fact CWD continues to be detected in HCP-certified captive herds after more than five years of monitoring suggests the certification program may not be as effective as desired.

The management of CWD in captive cervid operations in Canada is a joint responsibility of captive cervid producers, provinces/territories, and the federal government. Chronic Wasting Disease is a "reportable disease" under the Health of Animals Act and all suspected cases must be reported immediately to the Canadian Food Inspection Agency (CFIA). The CFIA implemented a national CWD eradication policy in 2000 and in 2002 adopted national standards for a Voluntary Herd Certification Program (VHCP) similar to that in the U.S. In recent years, the CFIA determined that eradication of CWD was not achievable and revised the national policy including the VHCP and biosafety standards applied to captive cervids in the national program (Canadian Food Inspection Agency (CFIA) CWD program information: http://www.inspection.gc.ca/animals/terrestrial-animals/diseases/reportable/cwd/herd-certification/eng/1330187841589/1330187970925.)

Canada applies appropriate standards regarding international trade in captive cervids to meet U.S., European, and other countries' import criteria. Similarly, high standards are required to bring live cervids or their products into Canada. More restrictive import criteria are applied by most provinces and territories. Within Canada, surveillance of CWD in captive and wild cervids is conducted under the authority of individual provinces and territories.

Extensive, repeated, and complex animal movements within the captive cervid industry can make epidemiological investigations challenging, and many trace forward cases are lost to follow up if animals are shipped to nonparticipating facilities such as shooting enclosures. Additionally, captive cervids often are regulated by state or provincial agricultural agencies; thus, wildlife managers may not have ready access to captive cervid records. Consequently, epidemiological investigations may be difficult to conduct and will depend on a high level of coordination and cooperation between agencies.

Escapes of animals from captive cervid facilities are common and poses a serious threat of CWD exposure of uninfected wild cervid populations. An audit in Wisconsin in 2003 found that 432 deer that escaped between 2000 and 2002 never were recovered. Many of the escapes occurred because a gate was left open. In 2002 in Wisconsin, an escaped captive deer was killed outside the fence and tested positive for CWD six months after it had escaped from a facility known to be affected by CWD. This occurred again in 2015 when two animals from an affected Wisconsin facility tested positive for CWD months after their escape and miles from the affected facility. The escape of infected captive cervids leads to contamination of the surrounding environment and an increased risk of exposure for the free-ranging cervids around the captive facility. Similarly, exposure of captive cervids likely occurs from free-ranging animals entering captive facilities through compromised fencing, through fenceline contact (Vercauteren et al. 2007, Miller and Fischer 2016), or from environmental contamination occurring prior to facility establishment.

There is evidence that increased hunting pressure to sustain long-term population reduction of wild cervids in disease hotspots may be effective for CWD control. Further modeling efforts suggest that optimizing harvest to target portions of the population most likely to be infected may be effective in limiting CWD (Potapov et al. 2016; Jennelle et al. 2014). In studies conducted in Illinois and Wisconsin, sustained culling by sharpshooters was the only management action that appeared to control CWD (Uehlinger et al. 2016). It is possible that this strategy may eliminate CWD in a focal area with few infected animals. However, in regions, states, or provinces where the disease is established, this strategy would require extensive funding and other resources (Bishop 2010), and may have differing levels of success in reducing prevalence. Ultimately, very few CWD management strategies have been implemented and measured (Uehlinger et al. 2016), highlighting the need for new experimental applications and evaluation of CWD management strategies.

Potential costs and impacts of CWD to states and provinces include detection and management activities, reduced hunter participation, loss of public support for agency missions, and loss of license fees and excise tax revenues that fund wildlife conservation. Without effective education and outreach efforts, hunters can feel alienated and mistrustful of agency management decisions. The human dimensions challenges associated with CWD cannot be overemphasized. In many areas, particularly in rural and Indigenous communities, wild cervid meat is an important source of protein and any threat to wildlife populations threatens food security in these areas. Additional steps (e.g. mandatory check stations, waiting for a test result prior to consumption, and disposal of positive carcasses) may threaten a traditional way of life that has tremendous economic and sociocultural value. Many North American cervid populations are facing declines (e.g. caribou, moose, and mule deer) and the introduction of CWD into such herds could threaten the sustainability of the populations and indigenous rights to hunt.

Additional costs can include indemnity payments to owners/managers of affected captive herds, clean-up funds, surveillance and monitoring, contracted sharpshooters, testing laboratories, personnel for sample collection, and loss of other indirect expenditures (meals, lodging, transportation, etc.) by consumptive and non-consumptive users of the wildlife resource.

Prevention and management of CWD in free-ranging cervid populations is fiscally prudent and forward thinking as an investment by state and provincial agencies. History has shown (*Brucella* in elk and bison, bovine tuberculosis in deer, etc.) that prevention is the key to avoiding long-term population health and economic impacts caused by chronic transmissible diseases in wildlife. Science ultimately may reveal how to effectively manage CWD in free-ranging wildlife but, to date, no demonstrated agency action has been shown to eliminate CWD after it has become established in the wild (although the rapid response in New York seems to have eliminated an early spillover from a captive deer herd). The continued spread of CWD across the landscape has raised concerns about long-term viability of affected wild cervid populations among wildlife managers and the citizens who hunt, photograph, and appreciate wild deer, elk, and moose.

The following topical chapters define best practices supported by strategies of current science and experience-based knowledge with citations to relevant scientific literature.

(Portions of this background material were excerpted from Gillin, C. M. and J. R. Fischer. 2018. State management of wildlife disease, Chapter 12 *in* State Wildlife Management and Conservation, ed. T. J Ryder. John Hopkins University Press. 238 pp.)

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Section 1: PREVENTION of CWD Introduction and Establishment

3 - Movement of Live Cervids

Best Management Practice to reduce the risk of CWD transmission and establishment of CWD through the movement of live cervids:

- **To eliminate the risk of anthropogenic movements of CWD in potentially infected live animals, states, provinces and tribes should prohibit the movement of live cervids** including interstate/interprovincial translocations by the captive cervid industry and animal movements undertaken by wildlife management agencies to promote conservation. Similar to the previous chapter, this regulated import action is most effective when employed by states and provinces that do not have CWD documented in their state. However, from a regulation efficiency perspective, a ban across all states and provinces would largely eliminate new cases occurring other than via natural migrations.

Alternative Management practices include:

- **Importation ban on all live cervids from CWD-positive states and provinces where CWD has been detected in either captive or free-ranging cervid populations.** This restriction increases the risk of importing CWD, as CWD-infected animals may migrate from infected states/provinces/areas to adjacent or distant CWD negative areas and subsequently could be moved unknowingly. Also, animals infected in the early stages of the disease may not test positive in antemortem or postmortem diagnostic testing. As stated in previous chapters, certified low-risk herds have consistently been involved in the movement of CWD to new areas. USDA certified low risk captive herds should be rigorously evaluated prior to importation of animals. States/provinces should evaluate the level of risk for importation of CWD they are willing to accept given the shortcomings of the USDA CWD Program Standards, limitations in diagnostic testing of recently infected animals, unknown environmental contamination challenges, and recent repeated relocation of CWD from certified low risk herds.

    - **Due to the increase in positive CWD cases in certified captive herds as part of the federal herd certification program, states and provinces should evaluate their importation policies and standards** (i.e. consider a minimum of 10 years or more for facilities to be CWD free, require importing state/province to have tested all (100%) deceased animals ever residing in a certified facility including slaughter animals and animals sold to shooting facilities, review importing state's /province's import records over time, etc.).

- **Restrict interstate/interprovincial movement of live cervids from states, provinces, territories, or tribal lands to those animals from herds that have had annual CWD testing of the herd for at least 5 years (with a statistical confidence of 95% to find the disease at an occurrence of 1% in the translocated herd) including antemortem testing of entire captive herds and all free-ranging animals being translocated.** It must be noted that this practice provides increased risk from the identified best management practice for moving the pathogen in live animals due to 1) unknown emigration/immigration movements of free-ranging animals into and out of the herd at any point in time; and 2) captive cervid undocumented/illegal transfers, complex and frequent farm-to-farm movements of potentially infected animals, fenceline contact with infected wild animals, infection from environmental contamination; and 3) infected animals which are in the early stages of the disease will not be detected in antemortem testing.

- **Prohibit intrastate, intra-provincial, intra-territorial, and intra-tribal movement of live cervids from CWD enzootic areas.** Similar to the identified best management practice, prohibiting movements of live cervids within the jurisdictional boundaries will reduce the risk of CWD transmission and establishment of CWD through the movement of live cervids. This movement restriction will be most effective when applied directly to CWD enzootic areas/states/provinces.

Supporting Strategies and Evidence

The anthropogenic movement of live cervids is widely considered to be one of the greatest risk factors in spreading chronic wasting disease (CWD) to new areas (Williams et al. 2002; Joly et al. 2003; Travis and Miller 2003; Belay et al. 2004). Natural movements of wild cervids contribute to the spread of the disease (Miller et al. 2000; Conner and Miller 2004; Miller and Williams 2004; Miller et al. 2006; Potapov et al. 2016), and anthropogenic movements of captive and wild animals have the potential to both increase the rate at which the disease is spread and also facilitate introductions of the disease into novel geographic areas (Williams et al. 2002; Belay et al. 2004). Transfer of live animals between captive cervid facilities has been implicated in the introduction of CWD from North America to captive elk facilities in South Korea (Sohn et al. 2002; Williams et al. 2002) and has also been widely implicated in the spread of CWD among captive deer and elk facilities within North America (Williams and Young 1982; Williams et al. 2002; Williams and Miller 2002; Miller and Williams 2004; Belay et al. 2004; Kahn et al. 2004; Sigurdson and Aguzzi 2007). Despite ten years of the USDA APHIS Herd Certification Program, CWD-positive animals are still being detected among certified “low-risk” captive herds. Circumstantial evidence suggests that anthropogenic movements of CWD-infected captive cervids may also have been responsible for the introduction of CWD into naïve wild cervid populations in Canada and the United States, including populations in Saskatchewan (Miller and

Williams 2004), Nebraska (Williams et al. 2002), South Dakota (Miller and Williams 2004), and Wisconsin (Joly et al. 2003).

Guidelines and practices for movement of live cervids have been articulated for zoos and similar institutions by Travis and Miller (2003) and for captive facilities by USDA (2014). However, information gained over the last 50 years by scientists indicating an apparent 100% mortality rate among infected animals, a long incubation period for CWD leading to infected, asymptomatic animals shedding prions into the environment through the early course of the disease, a high likelihood of direct or indirect transmission of CWD from infected animals to other captive and/or wild cervids, and the possibility of long-term prion contamination of natural habitats, holding pens, and facilities occupied by CWD-positive animals (Williams et al. 2002; Travis and Miller 2003; Miller and Williams 2004; Belay et al. 2004; Mathiason et al. 2009), managers and regulators are left with making high-stakes, risk-based decisions when allowing or facilitating the movement of cervids. Additionally, given current limitations in surveillance strategies, budgets, staff capacity, and diagnostic tools, the management option providing the most effective elimination of risk for spreading or acquiring CWD from anthropogenic movements of live animals is simply not to move live cervids.

Federal and State/Province Legal Requirements

Federal legal requirements exist for interstate or interprovincial movement of live captive cervids and wildlife agencies should be familiar with the respective requirements of USDA or CFIA. Individual states and provinces may impose additional regulations on transport of live captive cervids. Transport of game meat and other products derived from captive cervids for purposes of interstate commerce are regulated by the Food and Drug Administration (in U. S.) or by individual provinces (Canada). Similarly, transport of carcasses and other parts derived from hunter-harvested wild cervids, which may contribute to the risk of spread of CWD, are regulated by appropriate state or provincial agencies. In the U. S., Violations of state laws governing transport of cervids may be prosecuted under the federal Lacey Act.

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4 - Movement of Hunter-Harvested Cervid Carcasses and Tissues[1]

<u>Best Management Practice for reducing the risk of CWD transmission and establishment of CWD via movement of hunter-harvested cervid carcasses and tissues:</u>

- **Prohibit the importation of intact cervid carcasses (e.g. carcasses with spinal column and brain tissue) from all states and provinces.** This restriction would allow cut/wrapped meat, deboned meat, cleaned skulls or skull cap with no brain material, shed antlers, hides, canine teeth, and finished taxidermy mounts to be imported from a hunter-harvested cervid. Restricting the interstate/province movement of all potentially infective neural tissue from CWD infected states and provinces, and states and provinces with unknown or no known detection of CWD, will greatly reduce the risk of moving CWD between states and provinces. An interstate/province import ban on high risk carcass parts originating from captive or shooter facilities from all states and provinces regardless of CWD status would reduce risk of importing CWD contaminated tissues into a state/province. Agencies would need to provide a program for hunters to report that their meat is from a CWD positive animal and provide directions or a means for destroying the meat or other materials from that animal.

The following list describes several additional and alternative scientifically grounded management practices for reducing or eliminating risk of disease transmission. Implementation of any of these practices will depend on a range of factors in each state, including acceptability of the proposed practice to hunters, decision-makers and the general public.

- **Allow importation of quartered carcasses with no central nervous system tissue (spinal column or brain tissue), in addition to the permitted items above.** This restriction would provide additional flexibility for hunters but would increase risk of importation of CWD from carcass part disposal issues associated with waste bone from quartered animal parts.

- **Prohibit the intrastate/intraprovincial movement of intact cervid carcasses from CWD-infected areas.** This restriction would allow only cut/wrapped meat, deboned meat, cleaned skulls or skull cap, shed antlers, hides, canine teeth, and finished taxidermy mounts to be moved outside known CWD-infected areas. Restricting the intrastate/intraprovincial movement of potentially infective neural tissue from a CWD area to a new CWD-free environment, will limit short and cumulatively more significant movements of the prion across the landscape. Agencies would need to provide a program for hunters to report when their meat is from a CWD positive animal and provide directions for destroying the meat or other materials from that animal.

[1] Adapted from MAFWA resolution supporting restriction of the importation of hunter-harvested cervid carcasses

- **Implement an import ban on all parts, including meat and antlers, from CWD-positive states/provinces/territories**. This alternative will restrict movement of all carcass parts and reduce the risk of moving prions from known CWD positive areas to uninfected environments. An interstate/province/territory import ban on carcasses including high risk carcass parts originating from captive or shooter facilities from CWD positive states and provinces would reduce risk of importing CWD contaminated tissues into a state/province/territory.

- **Prohibit importation of intact cervid carcasses from the states and provinces where CWD has been detected in captive or free-ranging cervid populations.** This restriction would allow cut/wrapped meat, deboned meat, cleaned skulls or skull cap, shed antlers, hides, canine teeth, and finished taxidermy mounts to be imported from a hunter-harvested cervid from a CWD positive state. However, with this practice, challenges exist for agencies because of the dynamic nature of CWD discoveries (both wild and domestic) involving the potential undetected movement of CWD to new areas and the non-uniform sampling effort by which states and provinces conduct surveillance. Many states currently employ this practice however, it does present more risk than a more comprehensive prohibition, leaving states with decisions on how much risk they are willing to accept. Agencies would need to provide a program for hunters to report that their meat is from a CWD positive animal and provide directions or a means for destroying the meat or other materials from that animal.

- **States, provinces, and territories without documented cases of CWD could implement a blanket import ban on harvested cervids inclusive of meat and antlers, from all areas, regardless of CWD status.** This alternative would provide the greatest reduction in the risk of importation of CWD. However, its implementation has the greatest economic and political impacts to states/provinces impact to states/provinces, along with reduced hunter opportunity by restricting or eliminating non-resident hunting. While this is an option, it would likely is considered be viewed as the least acceptable alternative, given the consequences. A blanket import ban would simplify import regulation of carcasses for agencies and enforcement purposes. However, the regulation will be unpopular with the state's hunting public who enjoy hunting in other states and particularly those hunters who hunt as nonresidents in non-CWD areas. In addition, such restrictions would significantly impact states, provinces, and territories economically, due to direct economic losses from a decrease in non-resident license sales and indirect expenditures (e.g., hotels, fuel, and groceries). An interstate/interprovincial carcass import ban on carcasses originating from captive or shooter facilities would also reduce risk for importing CWD contaminated tissues from these sources.

In addition, states and provinces should consider adopting the following regulations and policies:

- Provide educational material (online videos) for hunters on how to field-dress and debone carcasses and prepare skull caps or taxidermy mounts to ensure they are in compliance with CWD regulations.
- Require all meat be processed in the state where the animal was harvested, especially when hunting in CWD-enzootic states. Regulations may be required to ensure that local butchers do not process animals from out-of-state.
- Ensure consistent enforcement of regulations with carcass seizures and penalties for violations.
- Provide information about CWD-positive counties, state, provinces, and countries on wildlife agency websites that are updated regularly.
- Provide web resources showing how and where a hunter can have their animal tested.
- Provide a web resource that has a better user interface to display such as, Cervid carcass regulations by state - Michigan DNR where hunters can search by their destination state/province and their residence state /province to ensure they are in compliance.
  - All states, provinces, and territories should provide a notification protocol for CWD-positive animals harvested by a non-resident hunter. This would include direct notification to the state/provincial agency of a nonresident hunter and the hunter. This procedure allows for contact between the home state/provincial agency and the hunter to determine 1) if the carcass was legally imported and 2) if the carcass, parts, or game meat can be recovered for proper disposal by incineration or digestion.
- States and provinces positive for CWD should notify all non-resident hunters at time of license purchase or thereafter, that they likely are prohibited from importing carcass parts or entire carcasses to their home states and provinces. In some jurisdictions this may not be feasible.

Additional Considerations

- States and provinces that may restrict importation of carcasses or parts should consider allowing through passage of appropriately cut/wrapped meat, quarters with no part of the brain or spinal column attached, deboned meat, cleaned skulls or skull cap from CWD positive states/provinces.

- State /province/territory could consider allowing importation of whole cervid carcasses, provided the carcass is accompanied by a ‘not detected’ CWD test. This may be difficult to implement, due to the turn-around time required for CWD testing.

- Current regulations by state, Cervid carcass regulations by state - Michigan DNR

Supporting Strategies and Evidence

States, provinces, and territories should develop carcass transportation recommendations and regulations that are uniform and consistent in order to, 1) stop movement of prions across the landscape, 2) simplify carcass importation laws to reduce confusion to hunters, and 3) minimize inconsistencies with regulations from other states and provinces. CWD has been found at varied, albeit reduced levels in meat and other tissues (Angers et al. 2006, Kramm et al. 2017).

Movement of infected cervid carcasses is one of the known risks for introducing CWD prions to new areas. Individual state/provincial/territorial wildlife agencies retain authority for regulation of carcass movement from hunter-harvested North American wild cervids, both intra- and interstate or province. However, regulations vary across states, provinces, and territories, ranging from complete import bans on whole carcasses from any state or province to a ban on importation from known CWD-affected areas (either entire states or identified zones/areas within states and provinces), while others lack any carcass movement restrictions. Several states/provinces restrict the importation of high risk parts such as brain material and spinal columns.

Management strategies and management units/areas of wild cervids varies among states and provinces. Depending on the size of the state, hunting population, harvest numbers, distribution of animals challenges the ability of state/provincial/territorial wildlife agencies to comprehensively test wild cervids for CWD and is often dependent on such factors as current CWD status, agency staffing, budgets, and political influences. Without detailed and current information provided by agency websites, it may be difficult for a nonresident hunter to determine if he/she is in a CWD-affected zone and the import restrictions that apply from their home state/province/territory. The information required for a hunter to remain compliant with CWD regulations, coupled with the increased geographic distribution and prevalence of CWD across North America, requires a more consistent and precautionary approach to cervid carcass movements.

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5 - Cervid Urine Products Related to the Introduction of Prions to the Environment

Best Management Practice for reducing the risk of CWD transmission and establishment of CWD through use of natural cervid urine-based products

- **Eliminate the sale and use of natural cervid urine-based products**. Banning urine-based products is the only practice that would completely reduce the risk of importing CWD via these products. This BMP would be most effective in those states and provinces that do not have documented cases of CWD. A comprehensive ban on sales and use would be the simplest and easiest regulation for hunters to understand and agencies to enforce. It is strongly recommended that agencies reach out to hunting groups prior to any ban to explain the risks associated with natural deer urine products. The restriction will likely be opposed by captive cervid operators and producers. Many archery and firearm hunters utilize scent lures as a hunting tool where it is legal and will likely oppose any rule change.

Potential alternatives if a complete ban is not an option:

- **Permit the sales and use of synthetic scent products**. Fully synthetic scent products would be a safe alternative relative to CWD risk. However, because there is no way to differentiate synthetic products from natural urine, there would a risk of natural urine being dispensed as a synthetic. Currently, labeling of urine scents is not uniform and it may be difficult to ascertain the purity of the product. This creates challenges for users and also for enforcement of urine restrictions.

- **Permit only cervid urine products produced in-state/in-province/in-territory to reduce the risk of importing contaminated product from an unknown source**. States/provinces permitting urine production should have rigorous regulation of live cervids importation and active CWD surveillance programs.

- **Allow import of natural urine-based products from states and provinces without CWD detections.** There is currently no agency oversight of the production, bottling, distribution, or sale of urine-based products or mechanisms providing quality assurance/quality control to ensure that these products are actually CWD-free. Similarly, there are no existing mechanisms where agencies could recall CWD-contaminated products once distributed. Therefore, this alternative is higher-risk than a complete ban.

Supporting Strategies and Evidence

Prions have been detected in saliva, feces, blood, antler velvet, and urine (Angers et al. 2006, Angers et al. 2009, Haley et al. 2011, Henderson et al. 2015, Mathiason et al. 2006, Plummer et al. 2017). Infected deer may shed prions in their urine for months (or years) prior to developing clinical signs and may shed thousands of infectious doses of prion over the course of a shedding animal's life (Henderson et al. 2015).

Despite federal, state, and local laws, regulations and other measures intended to prevent the spread or reduce CWD prevalence, the disease continues to be identified in new areas, including in captive cervid facilities certified as "low risk" through the USDA Herd Certification Program (HCP) and the CFIA Voluntary Herd Certification Program (VHCP). More restrictive CWD regulations on the sales and use of potentially infected materials are needed to stop actions that could infect wild and captive cervid herds now and for future generations. Multiple states and provinces have already implemented bans on natural cervid urine products (e.g., Alaska, Arkansas, Arizona, New Mexico, Vermont, Virginia, Manitoba, Nova Scotia, Ontario, and Yukon Territory). The Northeast Association of Fish and Wildlife Agencies passed a resolution strongly encouraging all state and provincial fish and wildlife agencies to work diligently to ban the use of natural-based cervid urine products (Adopted Nov. 1, 2017 http://www.neafwa.org/uploads/2/0/9/4/20948254/deer_urine_2017.pdf).

Urine sold commercially is collected from captive cervid facilities. Extensive movement of animals between facilities, limited and delayed testing of animals, and shared equipment between breeder herds and shooting herds make captive cervids a high risk for CWD (Maddison et al. 2010). Nationally, CWD continues to be found in captive cervid facilities with 40 facilities testing positive since 2012 in 9 states. Of the CWD positive facilities, 12 were shooter facilities and 27 were breeder facilities; 18 of 27 had at least 5 years of monitoring (testing mortalities) and 15 of 27 were enrolled in the USDA HCP. Urine products are frequently batched/combined from multiple locations and distributed across the country via retail, internet, and catalog sales (Nark 2017). Urine production and sales is not regulated by any agency, nor are there any testing or marking requirements of urine products. The Archery Trade Association Deer Protection Program is modeled after the USDA HCP but has no regulatory authority to provide an adequate prevention and distribution of contaminated urine products.

CWD prions are excreted in higher concentrations in saliva and feces than in urine (Henderson et al. 2015, Plummer et al. 2017). Urine is often collected through a grate system, which allows mixing of saliva and feces with the urine prior to filtering (Spitznagel 2012). This mixing could increase the likelihood of CWD-infected urine with higher concentrations of prion entering the scent market. There is currently no rapid, cost effective test to determine if collected urine contains prions (John et al. 2013). Therefore, although the risk of CWD transmission by urine products or a single application of a urine product to a surface is relatively low compared to movement of live cervids or carcasses, regulation of this industry is lacking with no known no "safe" dose of prion; exposure to one prion may be enough to cause infection (Fryer and McLean 2011). Additionally, the repeated application of urine scents to a defined surface (same tree for instance) or in the same area over time by an archery or rifle hunter produces increased risk because the multiple applications may be increasing the loading or infective dose at the attraction site by a susceptible ungulate. The environmental persistence of the applied prions could well serve as the point source of an infection outbreak.

Prions readily bind to soil minerals where they remain infectious (Johnson et al. 2006). If cervid urine containing prions is put on the landscape by deer hunters (e.g., in a scrape or other area used by cervids), prions may bind to soil and contaminate that location for years or decades. Models have demonstrated that risk of CWD transmission from the environment increases over time as prions accumulate (Almberg et al. 2011). Repeated applications of deer urine at the same place over time could potentially build a reservoir of prions, increasing the likelihood of transmission (Mathiason et al. 2009). Plants are capable of binding prions on leaves and taking up prions into their tissues; those prions remain infectious (Pritzkow et al. 2015) although the uptake or effect in wild deer is unknown. Cervids attracted to scent location could potentially ingest prions in plants or soil and become infected.

In addition to the risks associated with the product itself, cervid urine placed by humans serves as another unnatural attractant to artificially congregate animals. In areas where CWD is present, urine may facilitate disease transmission to healthy animals, much like supplemental feeding or baiting.

State agencies that have attempted to or have implemented bans on natural urine products have experienced variable levels of negative feedback from hunters. However, some surveys suggest that hunters may be open to restrictions on the use of these products. Nationally, 82% of hunters surveyed from the National Deer Alliance have used natural urine products in the past, but despite having a history with these products, 80% still supported a ban to prevent CWD introduction (n=516, Schuler, personal communication). Synthetic urine products represent over 20% of the current market so safer alternative product is available although testing and regulation of the product and industry does not currently exist.

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6 - Import of Reproductive Tissues/Products and Gametes

Best Management Practice for the importation of reproductive tissues:

- **The importation of reproductive tissues (principally semen or embryos) should be banned in states, provinces, and territories.** To date there have been no studies investigating the possibility of transmission of CWD in cervids via transfers of reproductive tissues/products or gametes. However, such transmission pathways have been studied in other transmissible spongiform encephalopathies (TSEs), including bovine spongiform encephalopathy (BSE) in cattle and scrapie in sheep and goats (Wrathall et al. 2008), and although the incidence of such transmission events is thought to be low, embryo transfer and artificial insemination from infected animals represents potential pathways of scrapie transmission in sheep (Wrathall et al. 2008; Rubenstein et al. 2012). Based on the numerous epidemiological similarities between scrapie and CWD, it is reasonable to infer a potential risk of CWD transmission via collection, movement and use of reproductive products. States and provinces should ban the importation of reproductive tissues until further scientific data on CWD transmission is available.

- **As an alternative practice, state, provincial, and territorial wildlife agencies should do everything possible to reduce and prioritize risk if importation of reproductive tissues is considered.**

The following precautions can reduce the likelihood of CWD transmission from imported reproductive tissues (Wrathall 1997, 2000). These precautions were designed to apply specifically to those who are engaged in the direct manipulation of reproductive tissues, which in many cases will not necessarily include state agency staff. These precautions are included here for the sake of completeness and for review and consideration by agencies who may wish to consider regulating or providing guidance regarding the importation of reproductive tissues, products, and gametes into their state/province/territory.

1) **Avoid transport or importation of reproductive tissues, embryos, or gametes from high-risk areas or regions**. Materials of animal origin for use in reproductive technologies should preferably come from areas or regions that can demonstrate an absence of TSEs (Wrathall 2000). Decisions regarding the sourcing and transportation of reproductive material should consider local veterinary infrastructure, status of disease surveillance systems, statistics on TSE occurrence, and whether control policies are being effectively applied in the exporting areas or regions. The reliability of veterinary certification programs is also critical, and if the health or traceability of any materials or their donors is in any doubt, the risks must be scored accordingly (Wrathall 2000).

2) **Avoid the extraction and use of reproductive tissues, embryos, or gametes from clinically diseased animals**. Wrathall (2000) notes that reproductive technologies such as embryo or gamete harvesting are unlikely to be used on clinically affected animals, except in cases where salvage of genetic materials is desired. In such cases, there is a small but non-negligible risk of disease transmission, particularly if surgical methods of harvesting are applied. If required, the best option according to Wrathall (2000) is to follow non-surgical means of tissue or gamete collection using single-use disposable equipment which is then incinerated after use.

3) **Avoid use of high-risk tissues in reproductive technologies**. Tissues at particularly high risk for TSE transmission include the pituitary (Kidd and Gray 1988), any cells of neurological origin, including neural stem cells (Chesebro et al. 1993; Windl et al. 1999), lymphoid tissues and associated cells, and surgical catgut (McDiarmid 1996). In such cases, materials should be derived from low-risk species or from synthetic, recombinant, or plant sources (Wrathall 2000).

4) **Avoid contamination of reproductive materials at the time of collection**. Instruments for collection should be of the disposable type, and care must be taken to prevent contact with high-risk tissues, including intestines, lymphoid tissues, and placentae (Wrathall 2000).

5) **Test materials to detect presence of infectivity.** Wrathall (2000) suggests testing of representative samples of source materials as well as aliquots of the final product(s) for the presence of TSE causative agencies.

6) **Decontaminate instruments.** The guidelines proposed for instrument decontamination by Wrathall (1997; 2000) are based on guidelines which were developed by the Advisory Committee on Dangerous Pathogens (1998) for the specific context of managing transmissible spongiform encephalopathies (TSEs) in humans.

Instruments for high-risk animals known or suspected to be clinically affected with TSE should be of a single-use type and destroyed by incineration following use.

The guidelines divide instruments into three categories:

> Category 1 – Instruments for animals whose likely exposure to TSEs is zero or minimal. Conventional cleaning and sterilization procedures apply.

For clinically normal animals in regions where CWD is considered enzootic:

> Category 2 – Instruments for animals with medium to high exposure risk (i.e. possibly incubating TSE) but without clinical signs. Instruments that contact the central nervous system or eye should be incinerated. Instruments that do not contact the CNS or eye can be re-used, provided they undergo specific TSE decontamination procedures (described in more detail below). **Note that this category applies specifically to instruments used on clinically normal animals in countries or regions where the relevant TSEs are considered enzootic.**

Category 3 – Instruments for high-risk animals known or suspected to be clinically affected with TSE. Instruments should be of a single-use type and destroyed by incineration following use.

For Category 2 instruments, Wrathell (2000) recommends following at least one of three published TSE decontamination procedures:

- Chemical disinfection with sodium hypochlorite (20,000 ppm for at least one hour) (recommended by Advisory Committee on Dangerous Pathogens 1998, Centers for Disease Control and Prevention 2009).
    - Ensure surface should remain wet for entire period, then rinsed well with water. Before chemical treatment, it is strongly recommended that gross contamination of surfaces be reduced because the presence of excess organic material will reduce the strength of the chemical solutions.
    - 20,000 ppm sodium hypochlorite equals a 2% solution. Most commercial household bleach contains 5.25% sodium hypochlorite, therefore, make a 1:2.5 dilution (1 part 5.25% bleach plus 1.5 parts water) to produce a 20,000 ppm solution. This ratio can also be stated as two parts 5.25% bleach to three parts water. Working solutions should be prepared daily.
    - CAUTION: Above solutions are corrosive and require suitable personal protective equipment and proper secondary containment. These strong corrosive solutions require careful disposal in accordance with local regulations.
- Autoclaving in a porous load steam sterilizer at 134–137˚C for a single cycle of at least 18 minutes (or six cycles of three minutes each) (recommended by Advisory Committee on Dangerous Pathogens 1998).
- Immerse instruments in 1 N sodium hydroxide for one hour, clean, and autoclave at 134˚C for one hour (recommended by World Health Organization 1997).

In addition to these older protocols, it should be noted that Environ LpH has been used effectively for over a decade for TSE decontamination (Race and Raymond 2004). Hypochlorous acid (HOCl) has also shown considerable promise as an anti-prion agent in laboratory trials and is much less toxic to human workers and less damaging to equipment (Hughson et al. 2016).

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7 - Preventing Unnatural Concentrations of Cervids – Baiting and Feeding

Best Management Practice:

- **To reduce the risk of CWD transmission and establishment of CWD through unnatural concentrations of cervids, states and provinces should eliminate the baiting and feeding of all wild cervids using regulatory mechanisms such as jurisdictional bans.**

Alternative Management practices include:

- **Where a jurisdictional ban is not possible, an alternative utilized by some agencies is to allow baiting and/or feeding of cervids in portions of CWD-positive states where the disease has not yet been detected**. However, this practice may facilitate increasing the prevalence and distribution of CWD within the state due to the epidemiology of the disease, natural movements of cervids, and limitations associated with surveillance of free-ranging animals.
- **In jurisdictions with no evidence of CWD, proactive strategies to decrease baiting and feeding will minimize future disease control challenges**. These strategies may include outright bans as stated above, or aggressive education and outreach campaigns. Once baiting and feeding have been established and hunter attitudes are accepting of the practice, it may be difficult to reverse hunter attitudes even with increasing disease threat.
- **States should provide protocols for alternative methodologies to traditional baited camera surveys for hunters and landowners who wish to survey deer populations on their properties.**

Supporting Strategies and Evidence

From the perspective of control and management of infectious diseases, anything that aggregates animals will, in most circumstances, also increase the opportunity for disease transmission (Becker and Hall 2014). While natural aggregations of animals exist due to a variety of behavioral, seasonal, and resource factors, human-associated aggregations related to baiting and feeding can greatly increase the risk of disease transmission due to increased animal numbers and concentrations over extended time periods. This can lead to exposure to larger doses of infectious agents, multiple exposures, or exposures sustained over prolonged periods of time all resulting in greater probability of infection.

The provision of food items for cervids and other free-ranging wildlife by humans poses challenges on multiple levels: epidemiologic, ecologic, economic, and social (Brown and Cooper

2006; The Wildlife Society 2007). Baiting (placement of food by humans to aid hunter harvest), recreational feeding (placement of food by humans to aid in wildlife viewing for entertainment), and supplemental feeding (placement of food by humans to increase the nutrition available to wildlife) can all increase transmission of infectious diseases. This occurs by increasing both local densities of animals (and direct contacts between individuals) and environmental contamination with infectious agents (by indirect contacts with food, plants or soils) (Sorensen et al. 2014). Feeding and baiting may change social dynamics among animals and increase contacts between otherwise disparate individuals, groups, or species. Although baiting is far from risk-free, it typically occurs over a shorter period (coinciding with hunting seasons) compared to feeding operations, and may be less of a threat of disease transmission than feeding (Cosgrove et al. 2014). Evidence to date suggests that “restrictions on feeding quantity would not mitigate the potential for disease transmission” and that putative mitigating practices such as spreading feed or bait over a specified area, or restricting the kinds of food items that can be used, did not substantially reduce the potential risk for disease transmission (Palmer and Whipple 2006; Thompson et al. 2008). While proponents often claim that making bait available in areas with enzootic disease is necessary to maintain or increase hunter harvest, current evidence suggests the effect of baiting for increasing harvest is insignificant (Van Deelen et al 2003).

The argument to bait and feed wildlife is often presented by proponents for both economic and social reasons. Sales of wildlife bait and feed provides markets for surplus agricultural commodities considered unfit or unmarketable for human or livestock consumption. Although the economic value of such sales is still largely unquantified, experience in states where baiting and feeding are legal suggest it is substantial. Consequently, bans on baiting and feeding that might decrease sales are typically opposed by farmers and their advocacy organizations. Such groups often exert political pressure on decision makers responsible for wildlife management regulations, arguing bans will result in job losses and decreased economic opportunities in rural areas where hunting is a substantial source of income from tourism.

There is currently no evidence that baiting and feeding of free-ranging cervids can be conducted to mitigate increases in the opportunity for disease transmission. There is also no evidence the practice is likely to increase harvest sufficiently to overcome the negative effects of those increases by disease transmission (Rudolph et al. 2006). Any benefits of increased public support or agency credibility that might theoretically accrue from allowing hunters to use bait remain speculative, and potentially unproven. Research has shown that CWD is both contagious and self-sustaining (Miller et al. 1998; Miller and Williams 2004; Miller and Wild 2004; Miller et al. 2000). Baiting and feeding deer artificially concentrates deer, facilitating both animal-to-animal contact and exposure to potentially disease-contaminated sites (Garner 2001; Thompson et al. 2008; Mejía-Salazar et al. 2018). A consequence of increased contacts from baiting and feeding is an increased risk of transmission of infectious disease among deer (Thompson et al. 2008; Becker and Hall 2014; Ramsey et al. 2014; Sorensen et al. 2014). An international panel reviewing CWD management in Colorado emphasized that, “Regulations preventing… feeding and baiting of cervids should be continued" (Peterson et al. 2002). In preventing, managing or controlling CWD, states should consider the socio-economic consequences of prohibitions on baiting and feeding.

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Section 2: SURVEILLANCE

8 - Validated CWD Testing for Cervids

Best Management Practices using validated tests in the surveillance and monitoring of CWD includes the following:

- **For official CWD testing of cervids, use only State, Federal, and university laboratories that are part of the U. S. or Canadian National Animal Health Laboratory networks and are approved to conduct federally recognized CWD diagnostic testing (9 CFR 55.8 for U. S.).**

- **Currently available federally recognized CWD tests are immunohistochemistry (IHC), enzyme-linked immunosorbent assay (ELISA), and western blot.** All suspect positive ELISA test and western blot results should be confirmed with IHC.

- **Tissues to be tested for postmortem sampling are the medial retropharyngeal lymph nodes (MRPLN) and obex**. For white-tailed and mule deer, the MRPLN is recommended, but in other cervid species such as elk and moose, both the obex and MRPLN should be tested.

- **All cervid species should be considered potentially susceptible to CWD and tested accordingly.**

- **Antemortem testing is an active area of research and may be a useful tool for increasing surveillance in captive cervids**. If utilized by a state/provincial agency, such tests should only be used as whole-herd screening tests or for sequential testing of individual animals or certain capture/recapture scenarios. These tests should not be considered an adequate single test of individual animals.

- **States/provinces should provide expertise, samples, or resources to support research into the development and validation of new CWD diagnostic tests that may become available in the future.**

- **State /provincial agency training of personnel should include basic CWD knowledge, wet labs for hands-on instruction in sample collection, sample handling, packaging and disinfection.**

- **To limit the anthropomorphic spread of CWD, maintain sound biosecurity and carcass disposal protocols**. Limit sample collection locations of harvested animals to as close to (or within) known endemic areas as possible.

Supporting Strategies and Evidence

Susceptible Cervid Species:
Cervid species known to be susceptible to CWD include North American elk or wapiti (*Cervus canadensis*), red deer (*Cervus elaphus*), mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), sika deer (*Cervus nippon*), moose (*Alces alces*), caribou or reindeer (*Rangifer tarandus*), and their hybrids. Reeve's muntjac (*Muntiacus reevesi*) have been shown to be susceptible by oral inoculation (Nalls et al. 2013). Experimental infection trials failed to infect fallow deer (*Dama dama*) with CWD by natural transmission routes, although they are susceptible by intercerebral inoculation (Rhyan et al. 2011). For the purpose of state/provincial CWD surveillance programs, all cervid species should be considered potentially susceptible to CWD and should be monitored accordingly.

CWD Testing:
Only state/provincial, federal, and university laboratories that are part of the respective federal National Animal Health Laboratory networks in the U. S. or Canada are approved to conduct federally recognized CWD diagnostic testing. This testing authority pertains to all cervids (Canada) and captive cervids throughout the U. S., but may also be applied to free-ranging cervids in some jurisdictions. The requirement to utilize federally-approved laboratories may depend on how captive and free-ranging cervids are defined within a jurisdiction, which state agencies hold regulatory authority, and whether interstate movements are involved. However, because NAHLN certification includes requirements for quality assurance and quality control, the use of a NAHLN lab is recommended here as a BMP.

Postmortem Testing:

Species variability:
- Tissues to be tested for postmortem sampling are the medial retropharyngeal lymph nodes (MRPLN) and obex. In mule deer and white-tailed deer, the MRPLN is the preferred diagnostic sample because data indicate CWD prions are detectable in the MRPLN before the obex (Miller and Williams 2002; Keane et al. 2008). Although MRPLN is an acceptable tissue for surveillance in wild elk (Hibler et al., 2003), it has been shown that prion deposition may be more variable in some species (e.g., moose, elk, reindeer), and may initially appear in the obex. Therefore, both MRPLN and obex should be tested (Spraker et al. 2004) in clinical suspects or in other circumstances as dictated by management or research goals. In Canada, MRPLN is the preferred tissue for testing moose but obex should also be collected.

Types of Tests:
- Currently available federally recognized CWD tests for captive cervids are immunohistochemistry (IHC), enzyme-linked immunosorbent assay (ELISA), and Western blot. All suspect positive ELISA test and Western blot results should be confirmed with IHC. Use of experimental amplification tests, such as protein misfolding cyclic amplification (PMCA) and real-time quaking-induced conversion (RT-QuIC) assays may improve sensitivity (Kurt et al. 2007; Henderson et al. 2015). In addition to

using federally recognized CWD tests, agencies may consider parallel testing with promising new or emerging diagnostic tools currently under development. Once validated, available, and federally approved, these tools could be rapidly implemented.

- IHC: Considered the "gold standard" test to which all other tests are compared. IHC requires formalin-fixed tissue and typically has a 5-10 day turn-around for results depending on the capacity of the diagnostic laboratory.
- ELISA: Considered a screening test and positive test results must be confirmed by IHC. Typically, the tests have a similar sensitivity to IHC but and will occasionally produce positive results that cannot be confirmed by IHC. Some researchers have found that some ELISA positive / IHC "Not Detected" animals will test positive under both tests upon retest. ELISA tests use fresh tissue and typically have a 1-3-day turn-around for results depending on the capacity of the diagnostic laboratory.

Antemortem Testing:

Antemortem testing is an active area of research and may be a useful tool for increasing surveillance in captive cervids. For instance, these tests may be useful in screening herds or for sequential testing of individual animals or certain capture/recapture scenarios, but should **not** be considered an adequate single test of individual animals for health certification purposes. Accordingly, for free-ranging cervids, antemortem CWD testing has limited utility but may be a useful research tool or used to meet specific management needs (Wolfe et al. 2007, Monello et al. 2013).

- Biopsied tissues used for antemortem testing include tonsil, recto-anal mucosa-associated lymphoid tissue (RAMALT) and MRPLN. Of these tissues, RAMALT biopsies have been intensively investigated due to the simple biopsy procedure, minimal equipment requirements, and no requirement for anesthesia (Keane et al. 2009). However, as for most antemortem diagnostic tests, testing tissues collected by biopsy will <u>not</u> identify all CWD infected cervids (Wolfe et al. 2007, Keane et al. 2009, Monello et al. 2013, Thomsen et al. 2012).
    - Immunohistochemistry of biopsies is still considered the gold standard test for antemortem testing, although USDA and CFIA does not consider antemortem testing an official test. It is highly recommended that IHC be used for tissue biopsies so that the number of diagnostic follicles can be determined.
        - As stated previously, use of experimental amplification tests, such as RT-QuIC assays may improve sensitivity (Henderson et al. 2015, Manne et al. 2017) and once validated and approved, may be available in the future.
    - The number of lymphoid follicles in RAMALT appears to decrease with age and results can be affected by repeated sampling, so having an adequate number of follicles for a valid test (e.g., $n \geq 5$ for deer and ≥ 10 for elk) may be a limiting factor (Wolfe et al. 2007, Keane et al. 2009, Spraker et al. 2009a).
    - Rectal biopsy samples are less likely to identify animals in early stages of CWD (Wolfe et al. 2007, Keane et al. 2009, Monello et al. 2013).

    - The *PRNP* genotype of deer and elk can impact antemortem diagnostic test sensitivity; therefore, the genotype should be determined concurrently when utilizing biopsies. For instance, test sensitivity is greatest in 96GG white-tailed deer and 132MM elk (Wolfe et al. 2007, Monello et al. 2013; Thomsen et al. 2012). Additional research is needed to better understand CWD progression through susceptible species of different genotypes and how this impacts diagnostic testing.
- Research groups are actively examining non-biopsy sample types, such as blood (Kramm et al. 2017), but agencies should seek guidance from state and federal veterinary diagnostic laboratories and the USDA or CFIA before adopting new test methods.

Sampling Protocols:
Sampling procedures and target tissue samples will vary depending on the species and circumstances. For postmortem testing, detailed sample collection procedures for obex and MRPLN in cervids are available through numerous state/provincial wildlife agency websites. Procedures for antemortem collection of tonsil and RAMALT in cervids have been described (Wolfe et al. 2002 and 2007, Keane et al. 2009, Spraker et al. 2009b; Geremia et al. 2015).

Training Personnel:
State/provincial agency training of personnel should include basic CWD knowledge, wet labs for hands-on instruction in sample collection, sample handling, packaging and disinfection. Collection videos and PowerPoint-type demos are available through numerous state wildlife agencies. Some jurisdictions have Certified/Authorized CWD Collector programs administered by their animal health agencies.

Training Websites:
Kansas State Veterinary Diagnostic Lab
https://youtu.be/XdK6HWokfPQ?list=PLNjV05pK4JEWNg10K9yal6tdKSZc-87Je

Wyoming Game and Fish Department
https://youtu.be/-jpvxatk0gw

Oklahoma Department of Agriculture
https://www.youtube.com/watch?v=1XgNy1BfiH8

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https://www.youtube.com/watch?v=Owpv30ulOvk

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9 - Surveillance Strategies in CWD-Negative States and Provinces or Populations

<u>Best Management Practice for conducting surveillance in a CWD-negative state, province, or population</u>

In states, provinces, and territories not known to have CWD, implement a weighted, statewide/province-wide/territory-wide risk-based surveillance strategy appropriate to the population. Walsh et al. (2012) compiled all pertinent resources at the time into a single document to guide resource agencies in the development and implementation of a weighted, risk-based surveillance strategy. This guidance document and other resources defined below should be reviewed and considered when developing a state or provincial surveillance strategy:

- Assessing relative risks and mapping spatial risks specific to a state/province or population can direct sampling effort both across and within sampling units. Surveillance strategies that leverage spatial risk factors may include:
    - Enhanced surveillance along state/provincial borders near known cases of CWD in free-ranging or captive cervids.
    - More intensive sampling in free-ranging animals around captive cervid facilities and taxidermy studios that may not be disposing of wastes appropriately.
    - Enhanced surveillance in areas where carcasses are known to be dumped because of the potential for inclusion of out-of-state /province animal remains or infected vehicle-killed remains to seed the environment if contaminated.
    - Additional risk factors may be adopted as appropriate for individual states, provinces, areas, or populations. For example, states with a large population of citizens that hunt out-of-state in CWD enzootic areas should assess the relative risk of importing CWD in hunter-harvested carcasses or tissues.
    - An example of a weighted, risk-based surveillance plan is available for New York: http://www.dec.ny.gov/docs/wildlife_pdf/cwdsurplan13web.pdf
- Weighted or focused sampling based on appropriate demographic risk factors may increase the likelihood of detecting CWD at a low prevalence (Walsh 2012). Samples should be collected preferentially based on the highest risk factors. For example:
    - Whenever possible, collect and test (descending weights/relative risk):
        - All clinical suspects

        - All captive/farm cervids dying of any cause, including known and unknown causes
        - Vehicle-killed or any other non-hunting related mortality (e.g. predation) of cervids > 2 years of age. As an example, focusing on vehicle-killed adults collected along major migration routes (if present) may increase efficiency.
    - Planned surveillance activities around cervid harvest:
        - Adult male deer (>2 years) hunter harvest
        - Adults (>2 years) in general

- Any surveillance strategy developed should be adaptive and integrated with a response and management plan.
    - New research or additional resources may require alteration of CWD surveillance plans.
    - Consider rapid implementation or co-implementation of new or emerging diagnostic tools as they are made available and approved.

- Other considerations:
    - Agencies are advised to work closely with an internal or external epidemiologist to determine the best approach for surveillance for CWD.
    - If surveillance cannot use a weighted or statistically valid sampling strategy, states and provinces should establish a minimum sample size over the broadest possible region.
    - Sampling efficiency can be increased by working with taxidermists, meat processors, landowners, and hunting associations.
        - Trained taxidermists have high success rates in collecting appropriate samples (e.g., retropharyngeal lymph nodes) and providing correct data to state/provincial agencies.
        - Payments, benefits, or other incentives provided to CWD sample collection cooperators may increase efficiency and data quality for sampling.
    - Development of regional surveillance plans may reduce burdens on individual states and provinces and increase confidence in neighboring states’ and provinces’ surveillance.
    - Consider regulatory actions to reduce or eliminate important risk factors when applicable (see appendix).

- Captive cervids should be included in any surveillance strategy, both as a risk factor for free-ranging cervid populations and as priority surveillance samples. All captive cervids should be sampled for CWD testing at time of death and surveillance of captive cervids should be considered an adjunct surveillance strategy.
- Collaboration with state/provincial/territorial food and agriculture agencies and other animal health agencies (animal control, veterinary medical boards, etc.) provides additional resources and is critical to successful surveillance and information sharing.
- Outreach and education to staff, other government agencies, hunters, and other public may be necessary to help overcome apathy or negative inertia for active surveillance.

The appendix to this chapter includes a sample chronic wasting disease risk assessment to facilitate the identification of important risk factors to analyze in developing surveillance strategies for CWD.

Supporting Strategies and Evidence

Active surveillance for chronic wasting disease should be a priority for all wildlife agencies. Recent detections in free-ranging ungulates in Norway (Benestad et al. 2016), range expansion in North America, and the challenge of effective control make CWD a significant concern to many wildlife managers. Once the disease is present, environmental contamination can play a large role in the spread and maintenance of the disease (Almberg et al. 2011); neither environmental decontamination nor eradication once the disease is established in a population are feasible at this time. These limitations combined with the recent and very preliminary research reports from Canada suggesting that *Cynomolgus* macaques may be susceptible to CWD (Czub et al. 2017), remind us that there is still much we do not understand about CWD and provide an important warning that caution should be employed.

For any state or provincial CWD management program to be effective, a robust and adaptable surveillance strategy must be in place to detect CWD as early as possible, when prevalence rates are low and seeding of the environment is minimal (Gross and Miller 2000, Joly et al. 2009, Walsh 2012). “Targeted” sampling of clinical suspects alone is unlikely to detect CWD at levels low enough for management strategies to be successful because disease prevalence is likely >1% once these animals are seen on the landscape (Miller et al. 2000). Similarly, testing only hunter-harvested cervids may not detect CWD until after it has been in a population for an extended time. Ideally, agencies will develop a state/province, area, population, or herd-specific active surveillance strategy that increases the likelihood of detecting CWD at the lowest prevalence possible given available resources. These strategies should be adaptive and incorporate known spatial and demographic risk factors into sampling efforts (Walsh and Miller 2010, Walsh 2012). Cooperation with agricultural agencies responsible for captive cervids is critical for timely information sharing and coordinated outbreak response.

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APPENDIX: **Chronic Wasting Disease Risk Assessment**

What data are available? Use this checklist to help guide your state's/province assessment of risks related to CWD.

- State/province-wide cervid population/density estimates, including demographic data
- Previous CWD sampling data (sex, age, date, location, season of take)
    - Ability to collect and test roadkill?
    - Ability to collect and test clinical suspects?
    - Ability to collect and test hunter harvested samples?
- Do you have deer and elk check stations? If so, where? Are samples collected at these locations?
- What samples are collected (obex, retropharyngeal lymph nodes, tonsils)? Who collects them? Are they trained?
- What is your preferred level of confidence (95% or 99%) to detect a given level of prevalence (5%, 1%, or 0.1%)?
- Financially, what range of sampling can you afford annually (2000–5000 of each susceptible species tested)?
- Known carcass dump sites?

Additional data: Taxidermists and Meat Processors:

- Physical location
- Verification of current operation. Date when staff visited this location
- On-site interview:
    - Number of cervids processed annually
    - Number of cervids coming in from out-of-state/province
    - Disposal method (landfill/dumpster, pit, compost, left on property, unknown, other). Are there regulations on disposal methods?
    - Live captive/farm cervids on premises (including wild deer rehabilitation). Are there regulations prohibiting ownership of live cervids by these businesses?

Captive/Farm Cervid Facilities:

- Physical location
- Herd status (CWD Certified or other). What are criteria for lowered designations?
- Species kept (white-tailed deer, elk, red deer, sika deer, etc.)
- Verification of current operation. If out-of-business, year known?
- Previous escapes at this location? Successful in recovering escapes?
- Imported cervids from out-of-state/province and if so, which states/provinces?
- What are the testing requirements to move deer intra-state/province?
- Past compliance issues
- Detailed on-site questions:
    - Disposal method for carcasses (buried, left in place, pit, burned, unknown)
    - Fence quality (low, medium, high)
    - Other businesses or activities involving cervids (taxidermy, rehabilitation, commercial transport, meat processing)
    - Primary business model: urine collection, shooting operation, breeding facility, antler velvet
    - Routine veterinary care

Neighboring States/Provinces/Territories:

- Levels of surveillance (number of samples collected, strategy?)
- Estimates of how many hunters go out-of-state/province?

Section 3: MANAGEMENT

10 - Development of a CWD Management Plan

Best Management Practices for development of contents included in a CWD Management Plan

A CWD Management Plan is a valuable tool for organizing information about CWD response options within a particular state, province, or territory. The basic elements of a management plan should include:

Background Information

- Provide introductory and background material on the susceptible herds and cervid populations in your state/province/territory. Include:
  - Information regarding management authority and legal issues
  - Existing management tools and evidence for their efficacy
- Identify specific, measurable, attainable, relevant, and time-bound objectives of the CWD management plan
- Provide a summary of state/provincial history/status regarding CWD
- List state/provincial/ agency regulations already in place regarding CWD
- Explain how the management plan was created and who participated in development

Additional background material could include discussions of:

- Biology, distribution of cervids and predicted population impacts related to CWD
- Existing management tools and evidence for their efficacy
- CWD and human health
- History of CWD surveillance and planning in your state/province
- Alternative livestock operations or captive cervid facilities in your state/province
- Baiting and feeding issues
- Scents and lures
- Carcass transport
- Rehabilitation/translocation
- Carcass disposal

Communication

- Identify objectives for your messages during surveillance, pre-detection, and response to detection
- Identify the target audience or audiences
- Develop speaking points for pre- and post-detection
- Identify communication methods to be used, staff member leading each effort, and timeline for final products
- Develop a phone tree that lists contact information and order for contacting those who need to be notified in the event of detection in a new area. Consider wildlife management agency personnel, state/provincial veterinarian or other agriculture/livestock officials, state/provincial public health officials, and others.
- Provide a set of frequently asked questions and answers on your website
- Develop an example press release

Surveillance

- Surveillance plan for areas where the disease has not yet been detected should prioritize samples according to risk and allow for statistically rigorous inferences to be made from the data.
- Sampling of symptomatic hunter-harvested, and vehicle-killed animals may provide a readily accessible and publicly acceptable avenue for surveillance. Note that testing of vehicle-killed animals during certain times of the year (i.e. shortly after fawning) or during periods of migration may result in a significant amount of low-risk samples and may not be an efficient surveillance strategy in some areas.
- Educating and then partnering with taxidermists and/or meat processors should be considered.
- Cervids exhibiting clinical signs of CWD symptomatic animals should be removed and tested. The likelihood of detecting CWD in an animal that appears sick is much greater than sampling asymptomatic or healthy-appearing animals.
- Weighted surveillance strategies (i.e., targeting segments of the population that are more likely to be infected with CWD; Walsh 2012) may be considered to improve efficiency in surveillance
- All samples must be georeferenced
- List estimated personnel/equipment needs and budget

Agencies are advised to work closely with an internal or external epidemiologist to determine the best approach for surveillance of CWD and to monitor CWD endemic populations as described in the following section.

CWD Management-Response to initial detection in an area

- Initiate a central coordinating group / body or other, similar Incident Command System

Defining CWD prevalence and distribution within the Initial Response Area:

- Define an Initial Response Area
- Define initial sampling scheme
    - Special buck/bull management hunting, sharpshooter removal, etc.
    - Evaluate results of sampling
    - Determine CWD prevalence and distribution within the Initial Response Area
        - If needed, consider additional sampling efforts (e.g. special hunts, or monitoring during another general hunting season) from hunter-harvested animals to obtain rigorous estimates of prevalence and distribution at appropriate scales
- Define a Transport Restriction Zone
- Determine CWD prevalence and distribution within the Initial Response Area
- Define potential conflicts and complications
- Consider immediate actions (e.g. implementing rule changes) to control CWD spread since success is more likely early in an outbreak
- Use prepared phone tree within communication plan to ensure all appropriate officials and stakeholders are notified
- Set up a public information campaign using previously drafted communication plan.
- Consider drafting additional regulations (e.g., recreational feeding/baiting ban, carcass movement restrictions)

Long-term Monitoring and Management

Some options for management are detailed in Western Association of Fish and Wildlife Agencies (WAFWA) Recommendations for Adaptive Management of Chronic Wasting Disease in the West (2017).

- Long-term management strategies and goals should be based on prevalence and distribution of CWD
- Develop a monitoring strategy to detect spatial spread of CWD and change in prevalence over time
- Specific herd management plans must be adaptive, and tailored to the circumstances of a population/area
- Develop a monitoring program to evaluate management efficacy
- Continue information and outreach program

Captive Cervids

- Improve participation in national/state/provincial/territorial CWD herd certification programs (USDA farmed cervid program website - CWD) and compliance with USDA CWD Program Standards (USDA CWD program standards document) . Canadian Food Inspection Agency (CFIA) CWD program information can be found at (http://www.inspection.gc.ca/animals/terrestrial-animals/diseases/reportable/cwd/herd-certification/eng/1330187841589/1330187970925)
- Develop more comprehensive state/provincial CWD herd certification programs
- Important planning considerations should include:
    - Fencing design to prevent contact between captive and wild cervids (e.g., double fence, minimum 8 foot fence height for deer and 10 foot fence height for elk)
    - Sampling strategy to sample all susceptible animals based on age (>1 year of age)
    - Mandatory, 100% disease surveillance on private shooting facilities
    - Slaughter surveillance, including the disposal of entrails, etc.
    - Sample collection and submission procedures of certified herds by a USDA or CFIA accredited veterinarian
    - Protocols for response plans if CWD is detected in a facility, including mandatory requirements for depopulation, quarantine, and decontamination
    - Mandatory whole-herd diagnostic testing (when a reliable live animal test becomes available)
    - DNA comparison for verification of animal identity
    - Regular inspections by state/provincial/territorial and/or federal agencies and requirements for complete electronic herd inventories
    - In-state/province/territory animal movements tracking by permit
    - Electronic information logging and tracking system for all animals born or acquired to facilitate trace-forward or backward if needed
    - Permanent double-marking animal identification
    - Regular and frequent reporting intervals for sharing testing results
    - Herd owner enrollment and advancement
    - Changes to certification status following additions of animals or genetic material (germplasm) to a herd
    - Clear statement of conditions which will result in loss of certification status
    - Changes to certification status following relocation of a herd
    - Consequences associated with cancellation of participation in the HCP
    - Quarantine and decontamination protocols
- In states and provinces where wildlife management agencies do not have authority over captive cervids, it is critical that the agency maintains strong collaboration with agencies that have jurisdiction. There must be a mutual understanding on management of captive cervid facilities, ingress/egress problems, disease testing, and other issues that warrant

cooperation. Consider including officials with authority over captive cervids during plan development, and during response to CWD detection in free-ranging wildlife. Cooperation with state agriculture and marketing officials is also important in states where the state fish and wildlife agency has sole management authority for captive cervids.

Supporting Strategies and Evidence

As CWD continues to be detected across North America, the benefit to wildlife management agencies of developing CWD management plans has become clear. In many cases, disease is already well-established by the time it's detected, so a prompt but methodical response is appropriate and critical when considering the effects on the resource, the state or provincial economy, and potential concerns raised by public health agencies. A well-developed and clearly defined plan will facilitate allocation of available resources in a manner most likely to meet defined objectives, allow a prompt response, and improve public perception when agencies are faced with management decisions in CWD affected areas.

A CWD management plan must be developed using the best available science. Plan developers should call upon the knowledge of colleagues in other agencies and universities with experience in CWD management. Scientists and researchers with expertise in prion disease can .contribute to the scientific aspects of development of a CWD management plan. Although much is still unknown about CWD management, there is a vast amount of pertinent literature that should be reviewed. A comprehensive list of peer-reviewed, published articles in included below to assist agencies in the development of CWD management plans.

Surveillance (looking for new foci or infections) and monitoring efforts (tracking trends, ideally in response to management) should be designed to allow for statistically rigorous inferences to be made from the data (e.g. Samuel et al. 2003, Walsh 2012). Appropriate selection of the sampling unit, or target population, is critical. For example, collection of a representative number of samples scattered over a large state/province is much less sensitive to disease detection than that same number of samples collected on a herd management unit or county basis. Selection of an overly large sampling unit can lead to misinterpretation of the area as being "CWD-free" when in fact adequate sampling was not conducted to detect disease.

Stakeholders have important input in the development of a successful CWD plan. Stakeholder support is critical to execution of surveillance and management actions and including representatives of relevant stakeholder groups during development of CWD plans will maintain transparency and ensure that points of contention are identified and addressed. Because herds or populations affected by CWD often span jurisdictional boundaries (state /provincial, federal, tribal, international boundaries), open collaboration among such jurisdictions will further the implementation success of a CWD management plan.

And finally, communication is always a key part of any successful plan that involves an adaptive management strategy. It is critical that the wildlife management agency has a consistent and accurate message, and that the message effectively reaches constituents. Detailing communication strategies within the management plan will ensure that important details and constituents are not overlooked. In some cases, a communications plan between stakeholders will be developed separately to insure accurate information flow is unified and talking points to the public and media contains critical information delivered appropriately through either a single source or planned release.

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11 - Managing CWD Prevalence

<u>Best Management Practices for managing CWD prevalence in infected populations should include the following:</u>

- **Agencies are advised to work closely with an internal or external epidemiologist to determine the best approach to monitoring CWD endemic populations.**

- **Utilize harvest or other removal mechanisms to manage prevalence by: 1) targeting the portion of the population most likely to have CWD, 2) targeting animals in known CWD hotspots, 3) targeting timing of removal to most effectively remove infected animals, and 4) reduce cervid density in CWD positive areas with high density populations.** Efforts to suppress CWD should focus on strategies that exploit or complement current management activities, for example, modeling and some field observations suggest that harvest could be used to control CWD.

- **Reduce environmental contamination by reducing artificial cervid concentration sites.** Management to reduce or eliminate repeated visitation by cervids at concentration points to reduce localized environmental contamination and transmission.

- **Utilize a coordinated, adaptive management approach to provide for strategic application and evaluation of experimental CWD suppression strategies whereby the data gathered from these efforts would then be used to develop improved strategies.**

- **Develop and implement regulations to minimize the possibility of spreading CWD by controlling the transportation of carcasses and potentially infective carcass parts between hunt areas and across state boundaries.** Through regulation, ensure the head and all portions of the spinal column are either left at the site of the kill or disposed of in an approved manner.

Supporting Strategies and Evidence

Note: The subject matter review and recommendations in this chapter were excerpted from the Western Association of Fish and Wildlife Agencies' "Recommendations on Adaptive Management of Chronic Wasting Disease in the West"(2017)https://www.wafwa.org/Documents%20and%20Settings/37/Site%20Documents/Co mmittees/Wildlife%20Health/docs/CWDAdaptiveManagementRecommendations_WAFWAfinal_approved010618.pdf

As chronic wasting disease (CWD) continues to spread throughout free-ranging populations in North America and elsewhere, viable management strategies are needed. Once CWD has become established in a population (often well before it is detected), its eradication is not currently considered feasible. Regardless, opportunities remain for responsible management agencies to stabilize or suppress CWD outbreaks and thereby minimize impacts and potentially irreparable harm. Typical disease control tools such as vaccines, safe and practical agents to eliminate prions from the environment, and effective curative therapies remain unavailable for CWD. Consequently, to date, most of the attempts to manage CWD have focused on reducing population densities and eliminating areas of CWD foci through a combination of hunter harvest and agency culling (Blanchong et al. 2006, Conner et al. 2007, Pybus 2012, Mateus-Pinilla et al. 2013, Manjerovac et al. 2014). Many of these programs were prematurely terminated due to lack of early, measurable successes, high personnel/agency costs, and lack of public support. Unfortunately, the early termination of these programs precluded a more robust evaluation of the potential efficacy of longer-term management. This situation highlights the need for management strategies that include realistic goals that can be applied for extended time periods, and have sufficient public and stakeholder acceptance. Because eradication is not feasible in areas with established infections, management for CWD control will require a sustained, long-term commitment by wildlife managers and the public.

Harvest Management

Future efforts toward CWD suppression should focus on strategies that exploit or complement current management activities. For example, modeling and some field observations suggest that harvest could be used to control CWD (Wild et al. 2011, Jennelle et al. 2014, Geremia et al. 2015, Potapov et al. 2016, Al-Arydah et al. 2016). Male deer appear to have a higher likelihood of CWD infection than females (Miller et al. 2000, Grear et al. 2006, DeVivo et al. 2017). Focusing harvest of sufficient intensity on the segment of the population most likely to be infected could help reduce disease prevalence and subsequent transmission (e.g., Potapov et al. 2016). Exploiting potential biases in removal of infected animals via harvest (e.g., Conner et al. 2000) also could be used to enhance the efficacy of harvest as a control strategy (Wild et al. 2011). For example, targeting mature male deer via increased harvest pressure during or after the breeding season may selectively remove a higher proportion of infected individuals than harvest in early autumn (Conner et al. 2000). Such strategies would allow agencies to modify existing harvest management approaches to emphasize CWD suppression and thus should be relatively sustainable in the long-term with minimal additional personnel time or cost. Alternatively, multiple CWD management programs have targeted winter culling around known CWD infected animals because of spatial clustering of the disease on the landscape (e.g., Connor et al. 2007, Pybus 2012, Mateus-Pinilla et al. 2013). Data from these management attempts suggest effectiveness in limiting CWD (Pybus 2012, Mateus-Pinilla et al. 2013, Geremia et al. 2015).

Due to the poor success in implementing long-term agency culling programs (e.g., Conner et al. 2007, Pybus 2012), an alternative approach might be to use hunting seasons targeting specific winter ranges or disease foci.

Management of Environmental Contamination

Environmental accumulation of prions can contribute to transmission of CWD and may be a significant driver in population response (Almberg et al. 2011). Areas that promote artificial cervid “hotspots” such as salt/mineral licks and artificial feed sources (e.g., bait piles, backyard feeders, stored forage, grain bins) may serve as sources of prion concentration and transmission (Miller et al. 2004, Thompson et al. 2008, Lavelle et al. 2014, Mejía-Salazar et al. 2017). Risks associated with intentional winter feeding of cervids, either annually or episodically, also should be considered as these activities may exacerbate CWD transmission. Management to reduce or eliminate repeated visitation to spatial concentration points should reduce localized environmental contamination and transmission. Depending on jurisdiction, this approach could require undertaking regulatory and on-the-ground actions. This strategy likely would require significant start-up investments; however, once implemented it could be maintained in the long term at a lower cost.

Adaptive Management

Despite significant advances in our understanding of CWD over the past 40 years, there is still little published information on effective management (Miller and Fischer 2016, Uehlinger et al. 2016). While some of the aforementioned strategies have been modeled, field data on efficacy are limited or lacking. Nevertheless, wildlife managers are tasked with managing for healthy, sustainable free-ranging populations even in the absence of definitive CWD control strategies. It follows that a coordinated, adaptive management approach would provide a path forward for CWD management. Adaptive management would allow for strategic application and evaluation of experimental CWD suppression strategies whereby the data gathered would then be used to develop improved strategies. This approach is not to be confused with simple trial and error; rather it is a systematic, hypothesis-based and scientific approach to applied management (Walters 1986, Walters and Holling 1990, Williams 2009). Results are used not only in evaluating the hypothesis, but also to gather new data directing future management. Agencies looking to use an adaptive management approach must be prepared to invest resources into public involvement, communications, data collection, experimental design, and evaluation. Fully evaluating any individual management strategy would require multiple applications under a variety of intensities and field conditions. As a result, this would be most efficient under a collaborative approach with multiple jurisdictions working together to apply and evaluate management strategies. Each individual agency can elect to apply as many or as few strategies or replicates as appropriate in their jurisdiction, while still gathering valuable data to contribute to broader understanding of CWD control strategies. Due to significant regional differences in habitat, susceptible species, and behavior, we believe such collaboration should be focused at a regional level.

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12 - Monitoring of CWD Enzootic Populations

<u>Best Management Practices to monitor CWD enzootic populations include the following:</u>

- **Define biologically relevant spatial units for data collection and evaluation.**
- **Determine meaningful sample sizes for interpretation.**
- **Identify surveillance goals to help guide sampling strategies over time.**
- **Work within existing management frameworks to maximize opportunities for sample collection and minimize additional time and cost to the agency**.

Supporting Strategies and Evidence

Once chronic wasting disease (CWD) is detected in an area, surveillance goals designed to detect disease may shift to monitoring disease prevalence, bringing increased complexity in methods and analyses (Walsh et al, 2012). Any long-term CWD monitoring program must take into account the underlying management infrastructure of the agency as well as ultimate surveillance goals. Maintaining a CWD monitoring program over many decades can be challenging as agency focus and level of agency/public concern may shift over time. Effective monitoring can be conducted in multiple ways and should work within existing management frameworks to maximize opportunities for sample collection and minimize additional time and financial cost to the agency. Overall data goals must be considered and areas for monitoring will likely need to be prioritized to meet long-term needs.

It is important to consider broader questions related to goals of the agency monitoring program to help guide decisions on approach. Questions such as how the data will be used, what spatial scale to collect samples/analyze data, what sample sizes are needed, and what disease metrics will be measured are critical in guiding sampling strategies. In order to effectively utilize monitoring programs, agencies must take the time to identify biologically relevant spatial units and appropriate sample sizes to collect useful information. At a minimum, agencies should aim to estimate prevalence with statistically valid sample sizes in affected herd units at least every 5 years.

Monitoring for spatial and temporal changes in disease patterns can be particularly valuable when linked with research to understand the epidemiology of CWD. In these situations, monitoring programs must be closely linked with the objectives of the research program being conducted. Monitoring is also an important component of agency programs that are being conducted to manage CWD. Monitoring changes in disease patterns and impacts of disease on target populations provides the primary source of information to assess the effect of management programs and is a crucial component of monitoring target population response to adaptive management approaches for CWD.

Primary Monitoring Methods

Live Animal Testing

Live animal sampling efforts are often conducted through research projects with directed questions to allow for more precise information on disease dynamics at a local scale. This generally represents more intensive monitoring strategies requiring significant resources and logistical considerations. This often involves live animal capture and sampling operations. The primary benefit of these intensive projects at a local scale is the finer resolution of data and more precise estimates of disease dynamics; however, the high cost in both time and resources of these types of programs generally lead to smaller-scale monitoring that may not always apply uniformly to a larger population. Live animal testing currently requires invasive procedures and extensive animal handling that are not efficient for large-scale surveillance efforts. Furthermore, limitations in accuracy of live animal diagnostics tests during early infection must be considered with any live animal testing program. Populations without any active harvest represent significant challenges for disease monitoring and live animal sampling may be the primary method available for monitoring disease in those areas.

Hunter Harvest

Hunter harvest sampling represents the most common approach to CWD monitoring by agencies. This allows for the most efficient use of existing resources and management frameworks. Although “targeted” or vehicle-killed surveillance may be beneficial for detection, they are likely of less value for disease monitoring in an infected population. Random sampling via hunter harvested animals is likely the most efficient passive sampling method for estimating prevalence or incidence in CWD enzootic populations (Samuel 2003). However, many areas may consider a combination of hunter harvested sampling as well as targeted and vehicle-killed surveillance to achieve disease monitoring in infected populations while also surveying for spread and new disease foci.

Disease Monitoring Goals

CWD monitoring of infected populations typically has one or more of the following 3 goals:

1) Assess the spatial distribution and/or estimate prevalence
2) Monitor changes in CWD over time or evaluate responses to management actions
3) Evaluate CWD as it relates to research projects

Monitoring Considerations

A variety of methods and sample designs are available for CWD monitoring. Each has positive and negative aspects; the program you design should meet the goals and resources for your situation. Your options will depend on management, monitoring goals, and resources required. Thus cost and resources may be a major factor in determining extent and type of monitoring strategy. The challenge is to decide which strategy will make the best use of that resource, given a specific goal.

Though elk, moose, mule deer, and white-tailed deer may occupy the same general area, data on CWD are best tracked separately for each species or target population, rather than considering all cervids as one target population. Existing information demonstrates that rates of infection vary among cervid species, possibly due to genetic susceptibility, different rates of disease transmission, and/or differing social behaviors. However, transmission of CWD is likely to occur among sympatric cervid populations. Finally, it is crucial to consider the size of the region and number of animals in relationship to the surveillance objectives for detecting CWD. Chronic wasting disease is not evenly distributed across the landscape and more likely is represented by clusters of diseased animals within the greater population (Miller and Conner 2005). Monitoring should occur at biologically relevant spatial scales in view of the highly clustered distribution of CWD in wild cervids (Ricci 2017).

Sampling Strategies

1) Annual Sampling: - Perhaps the simplest concept is annual surveillance across an entire jurisdiction or regionally within the CWD enzootic area. While this strategy may be compelling, achieving long-term and effective surveillance with annual sampling in an enzootic area is difficult. Even with surveillance across an entire jurisdiction, consideration must be given to biologically relevant spatial scales. So if statewide surveillance is conducted, data must be still be collected at the level of a population or analysis unit to allow for interpretation. This approach to sampling is unlikely to consistently provide appropriate sample sizes to allow for interpretation at biologically relevant spatial scales, though it may be effective if the annual sampling is focused on a relatively small enzootic area. Regional surveillance should include a buffer zone outside of the known CWD enzootic area to monitor spread. While this approach has the benefit of consistent application and expectations for hunters and agency personnel, over time hunter, landowner, and agency fatigue will likely hinder the ability to consistently meet sample goals.

2) Intermittent Sampling: – This option would allow for intermittent or pulse surveillance every 2-5 years. This would provide long-term monitoring of CWD in populations, but may not require sampling every year. For this strategy to be successful, achieving adequate sample sizes in the single year of sampling would be essential. Adequate license numbers and bag limits and compulsory sample submission can be used to ensure that target sample sizes are acquired in a single year's effort.

3) Rotating Sampling: – In jurisdictions with a large CWD enzootic area, rotating surveillance with focus on a portion of the enzootic area and buffer zone, or simply a portion of the entire jurisdiction each year may allow for better monitoring of CWD over time with fewer resources than annual jurisdiction-wide surveillance. As above, adequate license numbers and bag limits and compulsory sample submission can be used to ensure that target sample sizes are acquired in a single year's effort.

4) Focused Sampling: – In jurisdictions with a large CWD enzootic area, some agencies may consider choosing selected index populations for focused monitoring over time. This would be most effective in combination with another strategy. For example, an agency could consider intermittent jurisdiction-wide surveillance every 3 years, but conduct annual focused surveillance in selected populations of interest (e.g. where management actions are being applied, or where population impacts are suspected).

5) Culling: – Culling is often used as a disease control strategy but it may also be used for monitoring, particularly in areas without hunter harvest. Disease monitoring through culling operations must account for method of removal and determine whether animals were targeted or randomly removed. For the purposes of baseline monitoring, higher levels of statistical inference are possible when it can be shown that animals are randomly removed, however, sampling of targeted removals may also provide valuable data, particularly when monitoring a targeted removal project over time. Targeted culling may be particularly beneficial for agencies looking to conduct an initial assessment of chronic wasting disease after a new detection.

6) Opportunistic: – In areas with a long history of CWD and minimal resources or agency interest, opportunistic surveillance may be the only option. While this method may not provide the same levels of statistical inference as more structured sampling approaches, it can still provide useful data for general monitoring, particularly when data are pooled over multiple years. Ideally, CWD surveillance data would be pooled for no more than three years to minimize error associated with changes in prevalence over time. If appropriate sample sizes are achieved by this method of opportunistic sampling, reasonable interpretation of data may be considered. If data are severely limited, agencies could consider pooling up to five years of data to help identify areas for more robust evaluation. Agencies must interpret data with extreme caution when data are pooled over more than three years, but limited data may still help to identify areas for future focus of minimal sampling resources. In addition, the presence of opportunistic sampling programs may help to garner support for expanded work.

Metrics for Monitoring Disease Trends

A variety of metrics exist for measuring disease trends in populations. Each metric has its own strengths and weaknesses and agencies must consider the ultimate goals of their monitoring program to determine which metric is most appropriate. In general, prevalence, incidence, and force of infection are the metrics most relevant to measure CWD infection intensity within a population over time. With all the metrics outlined, one must consider the potential for sampling bias. While hunter-harvested sampling may the most accessible and cost-effective method, there may still be some amount of bias (Conner et al. 2000). Similarly, live animal sampling may also introduce significant bias through unintentional selection of infected animals through capture. Just as infected animals may be more susceptible to hunter harvest, they may also be more susceptible to capture.

Prevalence

Prevalence is defined as the proportion of test-positive animals within a reference population sampled over a specified period of time. Prevalence is the easiest metric that can be used to track changes in CWD over time. This is a readily understood concept by agency personnel and the public and allows for effective communication of disease information. However, given the long course of CWD infection, prevalence also is the least sensitive or slowest to respond to changes in disease dynamics. While it is possible to look at prevalence trends over time, it may take multiple years or sampling cycles to truly determine changes in prevalence. Relying solely on prevalence estimates to track changes in disease over time is acceptable; however, effective communication and education on the length of time needed to measure changes are necessary. Agencies using prevalence as a primary disease tracking metric must be careful to not prematurely interpret prevalence data.

Considering the age and sex of the animals used for prevalence calculation is warranted. Prevalence should be tracked separately for males and females. Additionally, evaluating prevalence by age, may provide some additional information and tracking. Looking at changes in CWD infected fawn or yearling prevalence in populations with high CWD prevalence may provide useful tracking information. In some cases, this could be used as a crude measurement of incidence (see below).

Incidence

Incidence is defined as the number of new cases of disease in a population over a defined period of time. This metric provides the best information to track changes in rates of disease transmission, but it requires repeated live capture and sampling of individually marked animals, thus increasing costs and logistical complexities. This may be most useful for disease monitoring associated with research or in populations without active harvest where live animal sampling may be the only option.

CWD infected yearling or fawn prevalence in some cases could be used as a crude measurement of incidence. Because yearlings and fawns have been alive for less than 2 years, infected animals were likely infected within that time period (Walsh et al. 2012). This metric would be most effective in areas with a high CWD prevalence.

Force of Infection

Force of infection is the probability, over a short period of time, that an uninfected animal contracts an infection. This metric requires collection of detailed sex and age-specific prevalence data, but is more sensitive to changes in transmission rates than prevalence. Tracking trends in force of infection over time may allow for earlier evaluation of changes in transmission dynamics. This may be particularly useful when evaluating effects of management.

Sample Size

Any effective CWD monitoring program must consider sample size. State or provincial agency biometricians should be consulted to help identify appropriate sample sizes to achieve desired monitoring goals. Agencies should identify directed goals for monitoring to help with sample size calculations. Ask: Is the objective to achieve a coarse estimate of prevalence or to detect changes or trends over time? What level of statistical rigor are you looking for? What is the magnitude of change necessary to detect with confidence? All of these are important questions to consider when determining monitoring goals. Detecting small changes in CWD prevalence (<5%) with any confidence may require very high sample sizes. The Western Association of Fish and Wildlife Agencies 2017 Recommendations for Adaptive Management of Chronic Wasting Disease in the West provides a helpful example of simple sample size calculations for detecting various changes in prevalence over time. In many cases, identifying appropriate sample sizes will help to direct decisions on the most effective approach to surveillance in an area. If sample sizes for good prevalence estimates can be achieved in a single harvest season, then annual surveillance or intermittent surveillance may be effective. In some areas, lower cervid density or low harvest may require multiple years of surveillance to achieve reasonable sample sizes. When multiple years of surveillance are used to estimate prevalence, consideration of changes in prevalence over time must be included. Ideally, sampling should be conducted over no more than three years to minimize error associated with changes in prevalence over time. While sampling over multiple years is not ideal, the slow spread and rate of increase in prevalence associated with CWD allow for reasonable estimates over multi-year sampling efforts. As a general rule of thumb, sample sizes less than 100 samples over a three year period are likely unreliable for estimating prevalence in a given population.

Selection of Sampling Units or Scale

To obtain meaningful and statistically relevant samples from monitoring efforts, it is essential that a biologically relevant spatial scale is defined. This may equal a population unit, or possibly subdivisions of a population unit if biologically relevant subgroups can be identified. Due to the uneven distribution of CWD on the landscape and spatial clustering of disease that has been observed, spatial scale is an essential consideration regardless of the sampling strategy employed.

Note: Portions of the subject matter review and recommendations in this chapter were excerpted from the 2017 Western Association of Fish and Wildlife Agencies document and Walsh et al. 2012 document cited below.

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13 - Rehabilitation of Deer and other Cervids

<u>Best Management Practice to reduce the risk of CWD transmission and establishment of CWD involving wildlife rehabilitation:</u>

- **Prohibit cervid rehabilitation activities in designated CWD management zones or in other geographic areas or within jurisdictional boundaries where CWD has been detected in wild or captive cervid populations.**

Alternative Management practices include:

- **In states, provinces or geographic areas where CWD is suspected but not yet reported, restrict rehabilitation activities to facilities that observe all recommended biosecurity protocols for the safe handling, disposal, and decontamination of prions and prion-infected tissues, materials, and equipment.**

- **An alternative practice that adds additional risk for states, provinces, or geographic areas is to allow cervid rehabilitation where CWD is suspected but not yet reported in wild cervids, or where detections have been reported in captive but not wild cervid herds.** Facilities must observe all recommended biosecurity protocols for the safe handling, carcass disposal, and decontamination of prions and prion-infected tissues, materials, and equipment.

    - State agencies can increase oversight of wild deer rehabilitation by taking an active role in management and regulation of cervid rehabilitation facilities. States should identify which rehabilitators take in deer, use electronic reporting systems to track deer rehabilitation, and provide rehabilitators with specific measures to reduce or prevent disease at their facilities. Rehabilitation facilities should be inspected by state agency staff on a regular basis and, at a minimum, meet basic standards outlined by the International Wildlife Rehabilitation Council. Rehabilitators should be required to provide carcasses or samples from deceased cervids for diagnostic testing and report any cervids presented to them or reported by the public exhibiting clinical signs consistent with CWD (uncoordinated gait or stumbling, drooling, head tilt, emaciation). Deer rehabilitators must dispose of carcasses in an approved manner as per state laws and in CWD positive states carcass disposal should follow guidelines set forth in chapter 16 *Carcass Disposal*. Rehabilitators should be encouraged to keep adult deer separate from fawns at rehabilitation facilities. Fawns should not be overwintered except for those fawns that require continued rehabilitative care. Deer rehabilitators must maintain accurate records for all deer that are handled under the authority of their Wildlife Rehabilitator License including all deer transferred to another rehabilitator, euthanized, died or released to the wild.

Supporting Strategies and Evidence

Wildlife rehabilitation attempts to “provide professional care to sick, injured, and orphaned wild animals so ultimately they can be returned to their natural habitat” (National Wildlife Rehabilitators Association 2018). Such efforts often focus on “abandoned” or “picked up” fawns which would otherwise be euthanized or left in the field to die of natural causes such as starvation or predation (Beringer et al. 2004; Williams and Gregonis 2015). Some programs also attempt to foster new-born orphaned fawns with free-ranging doe-fawn groups. Rehabilitated orphaned fawns are often held 3–4 months prior to release in the late summer-early fall (Williams and Gregonis 2015).

Data from New York State (see Figure) indicate that wild deer (primarily fawns) are often moved long distances to a wildlife rehabilitator who will rehabilitate fawns. In some cases, the long distance transport of an “abandoned fawn” is facilitated by a misguided but well-meaning attempt by a private citizen to bring the fawn to a rehabilitator. In other cases, a fawn is brought to a rehabilitator who accepts the animal from the public, and then transfers the fawn to another rehabilitator who specializes in deer rehabilitation.

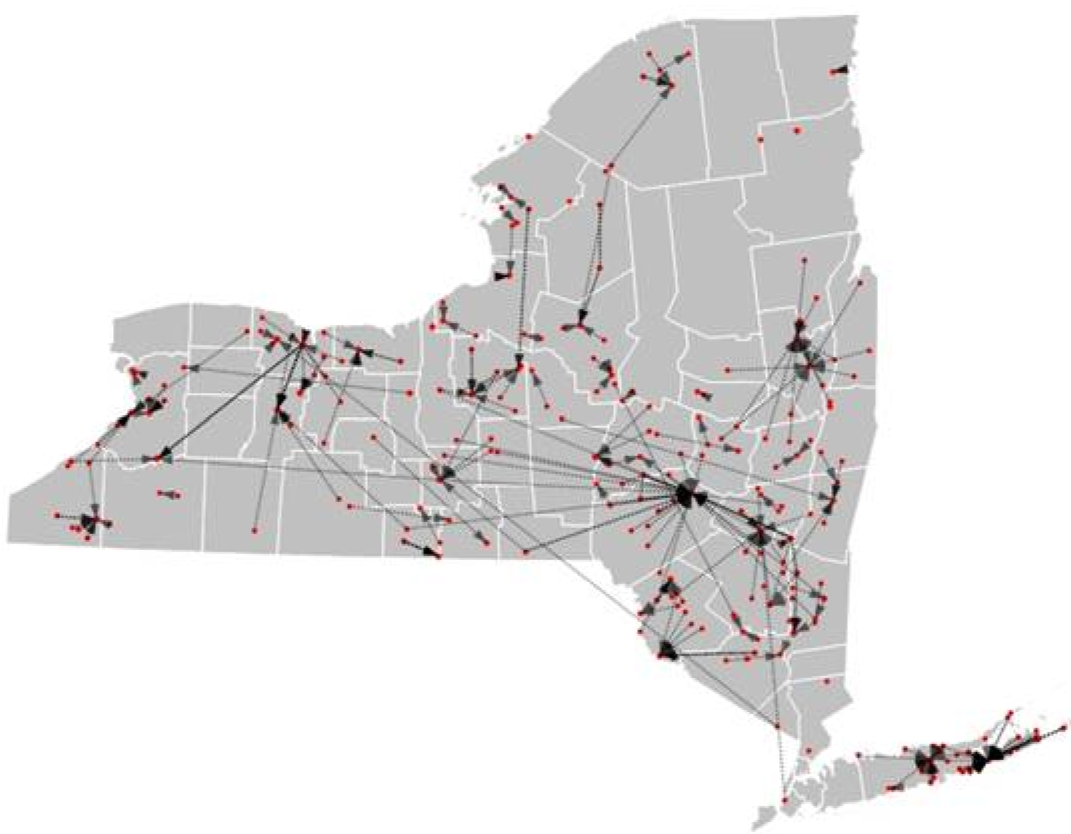

Figure: Movement patterns for white-tailed deer taken in by licensed wildlife rehabilitators in New York State in 2012. Most deer released were young-of-the-year (fawns). Several deer were moved more than 40 miles to a rehabilitation facility. Release locations for deer were not available.

Although state fish and wildlife agencies have the authority to certify and license wildlife rehabilitators (National Wildlife Rehabilitators Association 2018), the facilities used by these rehabilitators vary greatly in complexity and sophistication, ranging from private in-home facilities to large, non-profit centers treating thousands of animals every year (Porter 1996; Schwarz 2010). Staff capabilities also vary from fairly rudimentary care and employee knowledge to highly trained staff and full-time veterinary care (Schwarz 2010).

Concerns about the ability of private rehabilitators to effectively contain and manage infectious wildlife diseases were raised over 20 years ago by Porter (1996). In particular, private rehabilitation facilities may lack effective control or containment structures and equipment as well as associated training and biosecurity procedures for minimizing disease transmission risk to other captive animals, wild animals, or humans (Porter 1996). Agency oversight of wildlife rehabilitators is generally not at a level that would certify or approve a facility for biosecurity or disease containment. Although there has been discussion of CWD and other prion diseases in the recent wildlife rehabilitation literature (e.g. Schwarz 2010), it is clear from the information presented in other chapters of this document that CWD and other prion diseases represent unique challenges for facilities of all sizes and types (rehabilitation, research, captive/farming, etc.) in terms of the uncontrolled environmental persistence of the infectious agent, the strict requirements for disposal of contaminated materials, and the difficulty of decontamination of exposed surfaces and equipment. Travis and Miller (2003) provide detailed guidance for handling, disposal, and decontamination procedures for zoos and other captive animal facilities that house CWD-susceptible animals. These procedures have been modified by USDA APHIS (2014) and contributors in this volume to conform to best available science and practices.

Vertical transmission of CWD from female deer to fawns has been documented experimentally in muntjac deer (*Muntiacus reevesi*; Nalls et al. 2013) and mule deer fawns showed rapid development of CWD when infected orally (Sigurdson et al. 1999). A large-scale survey of CWD prevalence in wild white-tail deer fawns in Wisconsin resulted in multiple detections (Chronic Wasting Disease Alliance 2003), indicating that either vertical and/or horizontal transmission of CWD to fawns is occurring in wild populations of this species. Removal of fawns from the wild in areas where CWD is known or likely to occur therefore creates a very real risk of prion contamination at rehabilitation facilities and indirect transmission to fawns, with attendant concerns about appropriate procedures for disposal and decontamination, while the release of infected (but asymptomatic) fawns has the potential to spread CWD to novel areas or populations. Due to the period required from first infection to observable prion in lymphatic tissue, there currently is no live animal test that could identify an infected fawn prior to release unless the animal was held an extended period of time. The currently-available antemortem tests are probably not viable tools for determining CWD status of rehabbed fawns because of the low test sensitivity and expense of testing due to the required anesthesia and surgery. Although available antemortem tests can be used in screening herds, these tests should not be considered an adequate single test of individual animals for health certification purposes (see Chapter 8 – Validated CWD Testing for Wild Cervids).

In New York State, a ban on deer rehabilitation was implemented as part of the emergency regulations imposed in a 16 km-diameter CWD containment zone established in 2005 following multiple CWD detections in Oneida County (Evans et al. 2014). Managers determined that significant risks exist to wildlife health when CWD-infected animals are housed in facilities which do not provide adequate biosecurity measures for animals with prion diseases. It was recommended that deer rehabilitation be prohibited in CWD management zones and other management areas where CWD has been detected in wild cervid populations. States and provinces permitting rehabilitation activities where CWD is suspected but not yet detected in wild cervids, or where CWD has been confirmed in isolated and contained captive settings but not wild cervid populations, should closely follow the biosecurity procedures described by Travis and Miller (2003), as updated by USDA APHIS (2014) and the contributions in this volume.

A statewide ban on deer rehabilitation has been implemented more recently in response to CWD detections in the state of Arkansas (Jennifer Ballard, Arkansas Game and Fish Commission, pers. comm.). Prior to establishing this rule, a limited number of individuals in Arkansas accepted injured or "orphaned" deer for the purpose of rehabilitation. This practice was known to involve the movement of deer across county lines, from the county of origin to the county in which the licensed rehabilitator was located. With knowledge that deer from multiple counties are often housed in the same facility and moved across multiple counties with the potential to share pathogens, rehabilitation was considered a risk for the spread of CWD. In addition, rehabilitation is not an effective tool for enhancing white-tailed deer populations as survival of rehabilitated deer is extremely low.

The map above illustrates the value of implementing reporting requirements and data management systems that can be used to track wild deer in rehabilitative care. New York State's CWD Risk Minimization Plan specifically recommends that individual wild deer brought to rehabilitation be accurately recorded and tracked while in rehabilitative care in a manner that allows state agencies to perform trace-outs if CWD is confirmed in a wild deer that has been in the wildlife rehabilitation system.

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14 - Carcass Disposal

Best Management Practices for reducing the risk of CWD transmission and establishment of CWD through appropriate carcass disposal include the following:

- **Incineration of carcasses in an Environmental Protection Agency-approved conventional incinerator, air curtain incinerator, or cement kiln**. After incineration, ashes should be buried in an active, licensed landfill at a depth that meets local and state/provincial/territorial regulations to prevent scavenging or contamination of groundwater. Animal carcasses can be disposed of by incineration with a minimum secondary temperature of 1000°C (1832°F) (Taylor and Woodgate 2003). Incineration may not be a culturally acceptable practice for disposal by certain Indigenous groups.

- **High-pressure alkaline hydrolysis of carcasses followed by burial of the treated material in an active, licensed landfill at a depth that meets local and state/provincial/territorial regulations.** Alkaline hydrolysis using a pressurized vessel that exposes the carcass or tissues to 1 N NaOH or KOH heated to 150°C for a minimum of 3 hours (Taylor and Woodgate 2003, Richmond et al. 2003).

- **Composting.** Composting of livestock carcasses is an efficient method of disposal with proper management. While composting of carcasses does not reliably inactivate all prions, research does indicate that it can significantly reduce prion infectivity (Xu, 2013, 2014). Further research into optimizing methods of composting to inactivate prions is warranted, although basic precautions such as controlling run-off during the composting process and insuring that the composted material is not spread on the landscape would appear to be warranted. In areas where large volumes of carcasses must be disposed of, consideration of composting followed by a secondary disposal method such as incineration, landfill, or alkaline hydrolysis may provide a more viable method to reduce large carcass volume to allow for more efficient use of other disposal methods. This option would still require considerable time and attention to assure composting methods are managed appropriately.

- **Centralized sites/methods for disposal of CWD-positive or high risk carcasses**. Several states have established disposal sites for carcasses potentially contaminated with CWD. The agreement between the Utah Division of Wildlife Resources and the Utah Environmental Protection agency (available on request) is an excellent example of interagency cooperation on disposal. Each state or province should investigate the possibility of similar agreements and centralized disposal sites and methods (IAFWA, 2006).

- **Approved Landfill.** Properly licensed and operated landfills offer one of the most economically feasible options for disposal of carcasses and parts, particularly in high volumes. While disposal via landfill may not eliminate infectious prion, carcass parts disposed of in a landfill would be inaccessible to cervids and may functionally contain the CWD prion (Jacobson et al., 2009). It is important that carcasses are properly covered after disposal in a landfill to prevent scavenging.

Supporting Strategies and Evidence

Destruction or inactivation of prions is difficult and few treatments have been documented as completely successful. In addition, there are currently no quality assurance or quality control methods to ensure successful prion inactivation. For that reason, we have provided a list of processes above reported to reduce the amount or activity of the infectious prion material.

Jurisdictions need to consider many factors related to carcass disposal. In areas with limited or no detection of CWD, multiple carcass disposal options may be considered. In regions with significant widespread CWD, jurisdictions must consider more factors than simple disposal of known positive carcasses. Consideration must be made of the high volume of vehicle-killed animals as well as hunter harvested carcasses or parts. Due to the high volume of carcasses that may need disposal in a jurisdiction, further investigation of appropriate disposal mechanisms is warranted. As many landfills begin to close or discontinue accepting carcasses, options for efficient disposal may become limited. Lack of access to landfills for disposal of large numbers of vehicle-killed animals or access for individual hunters for disposal may lead to inappropriate disposal of carcasses onto the landscape and facilitate disease transmission.

With all recommended methods, carcasses must be carefully transported between the collection location and treatment or burial sites to prevent the spread of potentially contaminated and infectious materials. Precautions should be taken to prevent ashes, blood, tissues, or feces from leaking from transport vehicles.

APHIS recommends first testing individual animals for prion protein by IHC or other official test and delaying disposal until test results are obtained. Subsequently, disposal options involving incineration, alkaline hydrolysis, or rendering with burial of the treated materials can be used for the positive animals, and simple carcass burial in a landfill or onsite may be used for the negative animals. This works well for animals being tested, but considering the large volume of harvested and road-killed animals that are never tested and may be disposed by hunters, assuring that viable options are available for disposal at minimal cost will be essential.

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15 - Recommended Decontamination and Disinfection Methods for Equipment

<u>Best Management Practices / Guidelines for Disinfection of Materials exposed to Prions in field, laboratory and necropsy settings</u>:

A. Field Settings

Use for field sampling procedures. Can also be shared with hunters:

<u>Non-porous, surfaces (plastic or metal tables) and instruments used for collection of field samples (knives, forceps, scissors, jaw spreaders, saws)</u>

- Current recommendations are to use a 2%, (20,000 ppm) solution of bleach as a disinfectant solution. **See notes for preparation of Sodium hypochlorite (bleach) solution in section C. and section D. for product information.**
- Instruments should be cleaned of organic material prior to disinfection using a detergent with activity against prions such as Tergazyme™ and wiped with paper towel or rinsed with water (dispose of paper towels by incineration or in approved landfill) prior to disinfection.
- Disinfection requires 10 minutes of contact time with the 2% bleach solution. <u>Disposable materials (e.g. plastic gloves, boot covers plastic aprons, Tyvek suits)</u>
- Use disposable materials to prevent soiling of clothing. Dispose of these outer materials by bagging and incineration or in an approved landfill

<u>Non-disposable porous material (clothing, rubber aprons, rubber boots)</u>

- Clean off organic material with an enzymatic detergent such as Tergazyme ™.
- If the material can handle it, then wipe down with 20,000 ppm bleach
  - Avoid using leather gloves or boots as they are difficult to clean without being damaged. Wear boot covers
- Dedicate clothing /PPE to be used only in known enzootic areas. Do not transfer from the area unless it is stored in a container which is impermeable (heavy plastic tote) and labelled as prion infected.
  - When back from the field, all materials that are non-disposable should be re-cleaned and sterilized using the methods described below for use in the laboratory.

Personal Protection

- Bleach irritates mucous membranes, the skin and the respiratory system. It also reacts readily with other chemicals.
- Ensure the area is well ventilated when diluting or using bleach.

- Protective gear - gloves, lab coat, coveralls or apron, and eye protection are recommended.

Laboratory or Necropsy Room

Disposable Materials

- Bag and incinerate or put in an approved landfill.

Autoclave methods for non-disposable, heat tolerant materials (e.g. metal and glass instruments, laboratory surfaces, clothing and non-disposable PPE)

Clean using an enzymatic detergent with activity against prions such as Tergazyme™

Follow with disinfection with one of the following three methods below.

- Autoclave at 134° C for 18 minutes in a porous load sterilizer
- Autoclave at 132° C for 1 hour in a gravity displacement sterilizer
- Immerse in 20,000 ppm bleach (preferred) or 1 N caustic lye (alternative) at ambient temperature for 1 hour; rinse in water and subject to routine sterilization.
    - Additional acceptable methods for sterilization can be found in Rutala et al, 2010 and WHO, 2000.
- ***State Veterinary Diagnostic laboratories, Veterinary schools or local animal clinics usually have autoclaves.***

Chemical methods for non-porous surfaces and heat sensitive instruments

Clean using an enzymatic detergent with activity against prions such as Tergazyme™

Follow with disinfection with one of the following three methods below.

Flood with 2N NaOH (caustic lye) or undiluted bleach; let stand for 1 hour; make sure surfaces remain wet; mop up and rinse with water.

Where surfaces cannot tolerate caustic lye or bleach:

- thorough cleaning with detergent will remove or dilute remaining infectivity
- additional benefit from autoclave at 121°C for 15 minutes
- material should not be considered prion free
- Environ LpH se Phenolic disinfectant (Steris Life Sciences; EPA Reg. No. 1043–118) may be used on washable, hard, non-porous surfaces (such as floors, tables, equipment, and counters), or non-disposable instruments, or sharps, and sharp containers. This product is currently being used under FIFRA Section 18

exemptions in some states. Users should consult with the state/provincial environmental protection officer prior to use.

Sensitive or difficult to clean equipment (cameras, oscillating [Stryker saw]) or work surfaces

- ***Protect covering with plastic (plastic bag) or plastic backed absorbent material (puppy pad). This Protective material must then be properly handled, and either incinerated or sent to an approved landfill.***

C. Notes about Chemicals and Preparing Working Solutions, Personal Safety and Autoclaves

Preparation of stock solutions

Sodium hypochlorite (bleach)

- Comes in concentration of 5.25–8.25%. (CLOROX ® bleach is a 6% Sodium hypochlorite solution or 60,000 ppm).
- To make a 20,000 ppm (2%) solution, dilute 5.25 % bleach 1:1.5, bleach : water – for these purposes a 1:1 dilution is fine with a resultant concentration of 25,000 ppm bleach.
- Factors that degrade the disinfecting power of bleach
    - Time (check expiration date on bottles)
    - temperatures above and below 50–70 °F
    - direct sunlight (use opaque bottles)
    - water, especially hot water
    - organic materials (blood, body bits, manure, dirt)
  - ***Make fresh bleach solution daily with cold water***
- Some brands of bleach Austin's Elite Professional® and Austin A-1 Bleach ®do not require rinsing after disinfection.

Sodium hydroxide (NaOH, soda or caustic lye)

- 1NaOH is a solution of 40 g NaOH in 1 liter of water.
- Factors that degrade 1N NAOH
    - Absorbs CO_2 from the air which decreases its disinfecting properties.
    - 10 N NaOH solutions do not absorb CO_2 and do not degrade
- 1N NaOH working solutions should be prepared fresh daily for each use either from solid NaOH pellets, or by dilution of 10 N NaOH stock solution (1 part 10 N NaOH plus 9 parts water).

Cautions regarding hazardous material

PERSONAL SAFETY

Bleach and caustic lye are corrosive and require suitable personal protective equipment and proper secondary containment. These strong corrosive solutions require careful disposal in accordance with local regulations.

Sodium hypochlorite (bleach)
Solutions continuously off gas chlorine and so must be kept tightly sealed and away from light. The amount of chlorine released during inactivation may be sufficient to create a potential respiratory hazard unless the process is carried out in a well-ventilated or isolated location.

Sodium hydroxide (Caustic lye)
Caustic but relatively slow acting at room temperature, and can be removed from skin or clothing by thorough rinsing with water. Hot lye is aggressively caustic, and should not be handled until cool.

Equipment Safety

Sodium hypochlorite (bleach)

Non-corrosive to glass or aluminum
If bleach is used to clean or soak an instrument, completely rinse from the surfaces before autoclaving.

Sodium hydroxide (Caustic Lye)

Generally does not corrode stainless steel. Some Stainless steel can be damaged (including some used for surgical instruments). Test a sample or consult with the manufacturer before decontaminating a large number of instruments.
Corrosive to glass and aluminum

Autoclaves

Gravity displacement autoclaves

Air is displaced by steam through a port in the bottom of the chamber. Gravity displacement autoclaves are designed for general decontamination and sterilization of solutions and instruments.

Porous load autoclaves

Air is exhausted by vacuum and replaced by steam. Porous load autoclaves are optimized for sterilization of clean instruments, gowns, drapes, toweling, and other dry materials required for surgery. They are not suitable for liquid sterilization.

D. Products Mentioned in Text

1) Tergazyme ™ enzyme detergent with prion killing activity
Alconox, Inc., 30 Glenn Street, Suite 309, White Plains, NY 10603 USA, Phone: 914-948-4040
www.alconox.com
https://alconox.com/resources/standarddocuments/tb/techbull_tergazyme.pdf
https://www.alconox.com/lp/healthcare/healthcare-cleaning-prion.asp?gclid=CNPkz5L1-boCFYtQOgody3kAOA

2) Bleach (Sodium hypochlorite)
Some brands of bleach Austin's Elite Professional® and Austin A-1 Bleach ®do not contain trace amounts of mercury and are safer for the waste water stream. These are 5.25%.

3) Environ LpH phenolic disinfectant
STERIS Corporation, 5960 Heisley Road, Mentor, OH 44060-1834, USA, 800-444-9009
www.sterislifesciences.com
https://www.sterislifesciences.com/Products/Surface-Disinfectants/Pharmaceutical-Disinfectants/Environ-LpH-se-Phenolic-Disinfectant

4) Soda or Caustic lye (Sodium hydroxide)
10 N NAOH solutions can be purchased from:
VWR (https://us.vwr.com/store/)
Sodium hydroxide 10 N in aqueous solution, Reagent Grade
https://us.vwr.com/store/catalog/product.jsp?catalog_number=97064-782
or Fischer Scientific
https://www.fishersci.com/shop/products/sodium-hydroxide-solution-10n-certified-fisher-chemical-3/p-214277#?keyword=sodium+hydroxide+solution
Pellets can also be purchased from Fischer Scientific
https://www.fishersci.com/us/en/catalog/search/products?keyword=sodium+hydroxide+%28pellets%2Fcertified+acs%29+fisher+chemical&nav=&typeAheadCat=mostPopular

Supporting Strategies and Evidence

Prion Resistance

The ability of the CWD prion to be transmitted horizontally and the length of time prions remain infectious in the environment may perpetuate epizootics (Johnson et al. 2006). Experimental research has found that prions can bind to soil, remain infectious, and upon exposure to certain soil types (e.g., high percentage clay and pH >6.6) may even have enhanced persistence and infectivity (Johnson et al. 2007). While prions in live cervids and their excretions, carcasses, and contaminated environments pose the greatest concentration of prions, lab-based research has demonstrated that grass and plants can bind prions from exposure on the surface and uptake prion from contaminated soil. Hamsters that were fed the prion-contaminated plant samples developed prion disease (Pritzkow et al. 2015). The prion has also been detected in water that has undergone a simulated treatment process (Hinckley et al. 2008) and within environmental water samples from enzootic areas (Nichols et al. 2009) when tested using highly sensitive assays. Although the length of time that the prions can remain infective in the environment is unknown, it is likely years. One study found that animals that were grazed on a pasture where infected animals had been absent for two years were able to become infected and develop disease (Miller et al. 2004). Due to the stability of prions in the environment, the potential role of scavengers in facilitating transmission of prion to new areas has been discussed and investigated. Infective prions can be passed through the digestive tract of coyotes (Nichols et al. 2015) and crows (Fischer et al. 2013); however, the reduction in infective load after passage through the digestive tract, as observed in other species (Jeffrey et al. 2006), was not evaluated. While it has been suggested that crows could therefore play a role in translocating infectious prion to disease free areas, reduction in the overall pool of environmental infectivity through local dispersal and dilution could reduce the risk of transmission (Wild et al. 2011). A recent experimental study was able to infect swine through direct injections of CWD prion into the brain (intracerebrally) and by feeding CWD-positive material to pigs (Moore et al. 2017). Although the amount of detectable prion in the infected pigs appeared to be low, the authors indicate that "it may be possible for swine to serve as a reservoir for prion disease under natural conditions." This raises concerns regarding the potential for feral swine in enzootic areas to play a role in transmission of the disease to new areas.

Methods of disinfection/decontamination

Inactivation of Prions: Prions are resistant to conventional inactivation procedures including irradiation, boiling, dry heat, enzymes, and chemicals (formalin, betapropiolactone, alcohols). The safest and most unambiguous method for ensuring that there is no risk of residual infectivity on contaminated instruments and other materials is to discard and destroy them by incineration (Taylor and Woodgate 2003). Current recommendations for inactivation of prions on non-disposable materials are based on the use of Bleach (sodium hypochlorite, NaClO), soda or caustic lye (sodium hydroxide, NAOH) and the moist heat of autoclaving with the combination of heat and chemical being most effective (Rutala and Weber, 2010, Taylor and Woodgate 2003, WHO, 2000, and Hughson et al. 2016).

How equipment is handled prior to decontamination and disinfection may also affect the amount of prion destroyed. Dried prion-containing material was found to be more resistant to disinfection and certain disinfectants (e.g., glutaraldehyde, formaldehyde or ethanol) can fix or dehydrate the proteins thus causing them to be more difficult to inactivate. Recommendations are to keep instruments moist or damp prior to the decontamination and disinfection by immersing them in water or a detergent with activity against prions or wrapping them in a wet cloth (Rutala and Weber, 2010, WHO 2000)

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Section 4: SUPPORTING ACTIVITIES

16 – Internal and Public Communications

Agencies use many different outlets and forms of communication to share information about CWD within the agency and with externally with hunters, stakeholders, community and other agency decision-makers, and the general public. Although this chapter focuses primarily on web and online communications, we recommend the development of an integrated communications strategy that incorporates multiple media sources (print, radio, television) as well as public meetings and other outreach activities. Agencies may also wish to develop a CWD Communications Plan which articulates strategies and approaches for public, internal, and partner communications.

Best Management Practices for Internal Communications

Internal communications are critical for CWD management and agencies should consider developing an internal CWD communications plan which should clearly identify the following:

- Authority and responsibility related to CWD surveillance and management operations.
- An internal communications structure to facilitate communication related to CWD between agency administrators and field-level employees.
- Cohesive CWD talking points and messaging.
- How and where staff can access up-to-date information on CWD testing results in their state, surveillance and management actions, and current "hot topics."

Best Management Practices for Online Communication with the Public

An agency CWD website could include (but not be limited to) the following information:

- General information about CWD:
  - History
  - Species affected
  - Pathogenesis
  - Clinical signs
  - Distribution across the state/province, country, world
- Public health concerns:
  - CDC recommendations
  - Risk for livestock, domestic species
- Recommendations for hunters:
      - Hunt planning information (where applicable), including guidance for out-of-state hunters
      - Location (units, counties) of CWD sampling areas (mandatory, voluntary)
      - Check station locations, if applicable
      - Options for submitting samples for CWD testing outside of sampling areas

        - Relevant contact information, e.g. regional offices
    - Hunting in CWD-positive areas:
        - Specific guidance for out-of-state hunters
        - Recognizing clinical signs and appropriate responses
        - Personal Protective Equipment
    - Post hunt processing:
        - ✓ Field dressing
        - ✓ Deboning or removal of spine and head for transport
        - ✓ Preparing for taxidermy
        - ✓ Disposal of parts
        - ✓ Movement of carcasses/parts across state lines for nonresident hunters
    - Movement of carcasses/parts/disposal recommendations
    - Reporting requirements
    - Use of natural deer urine products
    - Issues with feeding/baiting
- Current CWD surveillance and response activities
    - Background on how surveillance is being conducted
        - Maps of CWD locations and prevalence
            - Include species, hunt area/unit, county, or other relevant units
            - Known data on infection rates and disease distribution
        - Testing over time; include positives/negatives
    - Identify locations where samples are collected (taxidermists, deer processors, drop-off or check stations)
    - CWD response and management activities
    - CWD research projects, if applicable
- Public reporting of sick or diseased animals:
    - Provide multiple methods for the public to report: Online forms, social media monitoring
    - Provide relevant addresses and phone numbers
    - Provide information urging people not to approach or contact sick animals without appropriate PPE, to reduce risks of contamination
    - Provide guidance and circumstances for shooting a sick animal and for testing and disposal of the carcass
    - Consider providing links to licensed wildlife rehabilitators for reporting purposes only (we do not recommend rehabilitating deer in areas where CWD is enzootic) [please refer to chapter 15 on rehabilitation]
- Reiterate relevant regulations, including:
- Carcass movement regulations
- Wildlife feeding/baiting
- Wildlife rehabilitation (deer fawn and elk/moose calf)
- Reporting requirements
- Use of urine scent lures and other biological attractants
- CWD test result reporting
    - Provide for partners and hunters to submit samples and check test results

        - Use a unique identifying sample number that is meaningful to diagnostic laboratory or state/provincial agency
        - Mark by specific locations using standardized coordinate systems (e.g. UTM (Universal Transverse Mercator) or latitude/longitude)
- Educational materials
    - Fact sheets
        - Should be printable
        - Include information on transmission, species affected, distribution, etc.
        - Can be customized for specific groups (e.g. taxidermists, meat processors, wildlife rehabilitators, hunters, public)
    - Frequently asked questions (FAQs)
    - Other relevant websites
        - CWD Alliance: http://cwd-info.org/
        - Links to current research, especially significant review papers and findings relevant to CWD management in the state/province/territory
        - Other states and provinces

Supporting Strategies and Evidence

An effective communication strategy should increase the public's understanding of, support for, and participation in CWD surveillance and response programs, as well as provide the regulatory agency with a platform to distribute new information. A website can serve as an effective tool for this purpose and include the ability to provide up-to-date background information on CWD, current CWD status and distribution in the state/province and the country, current surveillance programs, relevant regulations, resources for hunters to get their animal tested, and provide timely CWD test results. The website could also be a portal for the public to ask questions, voice concerns, and communicate CWD test results. In rural or remote areas, electronic communication may not be the best method of communication with the target audience and alternative methods of communication (e.g. written documents, public meetings) should be considered.

Examples of CWD web pages:

State of Michigan: http://mi.gov/cwd

Pennsylvania Game Commission: http://www.pgc.pa.gov/Wildlife/Wildlife-RelatedDiseases/Pages/ChronicWastingDisease.aspx

Wyoming Game and Fish Department: https://wgfd.wyo.gov/Wildlife-in-Wyoming/More-Wildlife/Wildlife-Disease/Chronic-Wasting-Disease

Colorado Parks and Wildlife: http://cpw.state.co.us/cwd

New York State Department of Environmental Conservation: http://www.dec.ny.gov/animals/7191.html

Alberta Environment and Parks: http://aep.alberta.ca/fish-wildlife/wildlife-diseases/chronic-wasting-disease/

17 – Human Dimensions

<u>Best Management Practices involving human dimensions in implementing a CWD program include the following:</u>

- **Conduct social science surveys to inform management decisions.** Many states and provinces are placing an increased emphasis on social science surveys. These surveys should be statistically robust and address knowledge, attitudes, perceptions, and support for CWD management programs. This is particularly important in areas with new infections where there is little to no state or provincial-specific information. Surveys should also explore hunter attitudes related to CWD including effort and success rates, and willingness to accept regulatory changes to manage CWD. Similar information should be collected from landowners, who are critical to a successful CWD management program. Landowner beliefs about CWD are generally lacking because the majority of the survey interest if focused on agency's primary constituency, its hunters. These surveys should also explore the potential economic and sociocultural effects of CWD using accepted social science methods.

- **Develop a comprehensive external and internal communication plan.** Develop a communication plan (perhaps as a subset of a larger CWD response plan) that provides the public with timely and accurate information about CWD in their state/province. Communication strategies should aim to improve public understanding of CWD and engage the hunters and non-hunters in managing the disease. Elements of a communications plan should:

    a. Contain key messages about CWD

    b. Include and use the best available science, preferably from the host state /province/territory

    c. Frequently be updated

    d. Ensure openness, honesty, and transparency

    e. Use social media (e.g., Facebook, Twitter) to convey information to the widest range of age and cultural segments of the population

- **Increase stakeholder engagement and outreach to the communities, hunters and private landowners.** Agencies should foster community partnerships and work collaboratively to find support for CWD management. It is important that all affected groups be engaged in CWD management process. Outreach should be informed by research (both biological and social) about CWD and its risks, and how the public feels about methods for management of the disease. Outreach to private landowners should explain the work of state fish and wildlife agencies and the importance of CWD control efforts. Brochures, fact sheets, and maps for public distribution can be an important tool.

- **Maintain a topically relevant and accurate website.** State/provincial/territorial agency websites are often out-of-date and/or not updated frequently enough. Managers should strive to keep their website updated. The New York State Department of Environmental Conservation is an example of a well-maintained website, https://www.dec.ny.gov/animals/7191.html. Also see chapter 4 of this report.

Supporting Strategies and Evidence

The wildlife management environment functionally has three components – wildlife, habitats, and humans. It can broadly be stated that everything that does not directly involve wild animals or their habitats is about humans (Decker et al. 2012). The human component of the management environment falls within the field of study known as human dimensions, which can be defined as the application of the social sciences to natural resources management issues. Human dimensions research attempts to describe and understand human thought and behavior toward fish and wildlife management with a goal to improve management.

Human dimensions research is essential for understanding the potential impacts of CWD (Decker et al. 2006). While there is a growing body of literature devoted to understanding stakeholder perceptions, attitudes, and beliefs about CWD, the amount of published information is limited when compared with disease ecology studies. Most of those studies have been conducted in areas with longer-term CWD infections (e.g., Alberta, Colorado, Wyoming, Illinois, South Dakota, and Wisconsin). Research has also shown that hunters are concerned about CWD-related risk (Gigliotti 2004, Miller 2004). States, provinces, and territories should be concerned about the potential impacts of CWD in their cervids, as the disease may cause declines in hunter numbers (Vaske et al. 2004). Needham et al. (2004) postulated that upwards of two-thirds of hunters would quit participation in hunting if CWD was transmissible to humans. While research to date has not empirically demonstrated a human health risk, preliminary experimental studies suggest that risk cannot be completely ruled out. In fact, the U. S. and Canadian Centers for Disease Control and Prevention recommend testing of all cervids taken in areas known to have the disease, and to not consume meat from CWD-positive animals (see, CDC - CWD guidelines). This perception of risk has the potential to also impact trust in the wildlife agency, the agency's ability to effectively manage the disease (e.g., lack of support from hunters and landowners), and negatively impact local economies (Vaske and Lyon 2011). A top-down, authoritative solution that does not include stakeholders and social science research may ultimately harm and nullify a comprehensive response (Heberlein 2004, Holsman et al. 2010).

As an example, in 2002, when CWD was first discovered in Wisconsin, firearm deer license sales decreased 11%, which resulted in economic losses between $53 million and $79 million (Bishop 2004). Although hunter numbers rebounded slightly, most did not come back. Today, Wisconsin has eight percent fewer deer license sales than before CWD was discovered in Wisconsin deer. In addition, when public support for management actions is lacking and social/political factors influence decision-making, wildlife agencies run the risk of losing management momentum and their ability to slow disease spread. Indeed, Wisconsin DNR was compelled to take a ‘passive’ approach (Kroll et al. 2012, page 56) and has since seen prevalence substantially increase, especially in males (Jennelle et al. 2014). Without a thorough investment in human dimension research and planning, agencies will be poorly positioned to effectively respond to the challenges CWD brings.

“In any moment of decision, the best thing you can do is the right thing, the next best thing is the wrong thing, and the worst thing you can do is nothing.”

- Theodore Roosevelt

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18 - Economic Impacts of Chronic Wasting Disease

<u>**Best Management Practices for mitigating economic impacts include:**</u>

- **Support human dimensions, economics, and social science research that evaluates the impact of CWD prevalence on hunting practices and hunting-related expenditures.**

- **Support research into the economics of reducing the risk of CWD introduction into states and cost evaluations of early management responses.**

- **Identify means of comparing accounting costs across states for budget planning for surveillance and possible management tools.**

- **Seek additional federal and state/province revenue streams outside of license sales for CWD-related expenditures accrued by state fish and wildlife agencies (e.g. doe tag sales in CWD enzootic zones which directly support CWD management).**

Supporting Strategies and Evidence

Although state and provincial fish and wildlife agencies support and contribute to citizen recreation in many ways, the majority of funding for most fish and wildlife agencies is derived from license sales or, in Canada, general government revenues. This funding supports the broader mission of the state fish and wildlife agencies, beyond just the management of single fish or wildlife species. From creating accessible wildlife areas to habitat improvement, and supporting hunter education programs to everyday office expenditures, license sales often form the backbone of many agency budgets. The sale of licenses for mule deer, white-tailed deer, and elk hunting accounts for the highest proportion of these funding dollars in many states. U.S. expenditures directly related to deer hunting account for nearly half of all hunting related expenditures and are estimated to range from about $12 to $18 billion dollars per year since 2001 (U.S. Fish & Wildlife Service 2011; U.S. Fish & Wildlife Service 2017). Across all economic sectors, the total annual economic contribution of deer hunting to the U.S. economy has approached $40 billion, contributing as much as $5.5 billion per year in state and federal tax revenue (Southwick Associates 2012). Comparable economic benefits are generated in Canada (Federal et al. 2014) and are at substantial risk as CWD continues to increase and spread in enzootic areas.

The effect of CWD on agency budgets and expenditures can be both direct and indirect. Direct effects include additional strains on budgets and staff time as states increase capacity for surveillance, monitoring, and management actions to combat CWD. While studies of the direct economic impacts of CWD to agencies are limited, early work in Wisconsin, as an example, suggests that CWD can reduce financial resources available to the agency while also substantially increasing budget expenditures. Following the finding of CWD in Wisconsin, an initial 10% reduction in hunting license sales was attributed to that finding (Vaske et al. 2004). Since 2002, Wisconsin has spent just over $48 million dollars for disease monitoring and to reduce the spread and prevalence of CWD. Some funding was provided through the U.S. Department of Agriculture's (USDA) CWD program, which no longer available to states. As CWD prevalence has increased within Wisconsin and funding was reduced, alternative funding measures were implemented including earmarking sales of doe tags purchased in CWD-affected counties for the agency's CWD budget. The direct and indirect impacts of CWD on wildlife agency resources and the broader impacts on state, provincial, and federal economies can be significant and difficult to offset.

Direct Impacts:

1. **Increased expenditure on CWD surveillance, monitoring, and hunter service testing**. Increased agency expenditures on CWD include direct testing as well as increases in staff time, travel, planning, logistical support, and communications. Identifying efficiencies in all aspects of CWD management is an important strategy for achieving management goals. In particular, efficiencies in sample collection and submission are important to reach sampling goals. Many wildlife agencies have implemented tools such as weighted surveillance to maximize detection ability when sample submissions are reduced due to reduced funding.
2. **Cost of additional management tools.** Whether hiring specialists to concentrate testing or reduce populations in CWD-affected areas or managing additional hunting opportunities, design and implementation of different management tools create additional expenditures for a program.
3. **Reduced license sale revenue.**
    a. **Hunter reduction:** As prevalence and distribution of CWD rises and approaches 50% within a local population of wild cervids, research indicates that approximately 42% of residents and 54% of non-residents would stop hunting deer or elk there (Needham et al. 2004). The loss of revenue from these license sales impacts all agency management activities, in addition to those related to CWD.
    b. **Population reduction:** With increasing infection rates, affected herds may decrease and not be able to sustain historical harvest rates (DeVivo et al. 2017, Edmunds et al. 2016)
4. **Diversion of funds from other agency programs.** In some instances, agencies may need to readjust budgets to provide more funds to CWD programs. This can directly impact other agency efforts.

Indirect Impacts:

1. **Limit an agency's ability to manage a game species.** Deer and other species are managed to maintain healthy populations at numbers sufficient to provide a harvest of a percentage of that population. Reduction in license sales or hunter harvest can directly impact the ability of the state to manage these populations at levels which are acceptable and sustainable from biological and societal perspectives.

2. **Decrease support for wildlife agencies.** Restrictions and changes to traditional hunting practices can lead to loss of public support for fish and wildlife agencies. Long-term persistence of CWD in infected deer populations and the long-term viability of CWD prions in the environment pose additional challenges.

3. **Constrain cultural traditions and the social and economic stability of communities dependent on hunting.** As an example, in Wisconsin, hunter losses were estimated to amount to between $53 million and $79 million in 2002 and $45 million to $72 million in 2003 (Bishop 2004). While loss to the Wisconsin economy was estimated to be approximately $5 million during that time frame, Bishop (2004) believed that losses in some rural areas may have been substantial, but data were not available to estimate these losses and may have been an outlier in comparison to other state's initial findings. Subsistence hunting is also difficult to quantify, but of significant importance to food security for rural and indigenous communities. The economic value of subsistence harvest from one herd of barren-ground caribou (Beverly and Qamanirjuaq Caribou Management Board 2008) in Northern Canada is estimated at over $14 million. In some instances it is difficult to measure the additional spiritual, aesthetic, and social values of wildlife. Sociocultural practices related to hunting are incredibly important in many rural and Indigenous communities with existing challenges to overall physical and mental health. Any required shifts of those practices or loss of opportunities to hunt a species will have larger and long-standing impacts.

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19 - Optimizing the Contribution of Research to CWD Management

Significant advances have occurred in recent decades that expand our knowledge of prion diseases, specifically detection, transmission, and biology. Despite these advances, our attempts to identify effective management strategies remain elusive (Uehlinger et al. 2016). These knowledge gaps limit our ability to clearly foresee the biological, social, and political impacts of chronic wasting disease (CWD), and to take the most appropriate steps to mitigate negative consequences of the disease on conservation, animal, and potentially human health. Therefore, best management practices for agencies responding to CWD include consideration of opportunities to incorporate research into their work. Only through addressing knowledge gaps will efficacy and efficiency of management actions improve and risks of CWD be reduced in the future.

Research activities range from opportunistic collection of data to design of rigorous landscape scale evaluations of management interventions. At minimum, communication with CWD experts, researchers, and biometricians prior to initiating surveillance is recommended to identify important and opportunistic contributions that could be gained with minimal added cost or workload. For example, managers could collect data on sex, age, and harvest location of cervids sampled for surveillance, collect tissue samples for genetic analysis, develop and evaluate new diagnostic tests, or archive specimens for future needs. Similarly, with appropriate planning and communication, captive cervids can potentially serve as a ready source of data and samples to support CWD research needs.

Communication and collaboration across jurisdictional boundaries can be used to magnify the impact of data collection to a broader spatial and temporal scale. Such an approach has been proposed through a disease management venture to enhance understanding of bighorn sheep respiratory disease etiology and ecology. Likewise, a multistate research approach was used to investigate the emergence of snake fungal disease in multiple eastern and Midwestern states. The intent and premise is that coordination to implement standardized protocols for treatment application and data collection over multiple small scale evaluations are likely to provide more insight than could be gained from differing data collection methods and numerous varying treatments. Collaboration to identify paired treatment and control sites for application of cervid density management is an example of how this could be applied as a best management practice for CWD. Wood et al. (2017) reiterate the importance of using adaptive management and outline an approach for experimental application and evaluation of prospective CWD management strategies in the west. Agencies considering management intervention are encouraged to review these recommendations. The development of controlled study designs to evaluate management strategies also was identified as the greatest priority or need for southeastern states represented at a 2017 CWD Research Workshop hosted in Arkansas. A 2017 research coordination meeting with several states in the upper Midwest has helped provide consistency between projects. Similar recommendations for a regional approach to research and management would be beneficial.

Collaboration can also be used to compare data over a broad geographic area to identify trends that may not otherwise be apparent. For example, a recent genetic analysis of elk from multiple locations in the Western U.S. identified selection of more resistant PRNP genotypes where CWD has occurred for a longer period (Monello et al, 2017). Publishing peer-reviewed research as well as sharing data are critical means of collaboration and exemplify best management practices. In addition to building our foundational knowledge, describing current conditions and trends, and documenting impacts, these shared data are useful in constructing and testing predictive models.

Despite the high cost and complexity, well designed studies that test experimental manipulations and disease dynamics over long time frames and wide spatial scales will be critical to informing effective management practices in the future. For example, Before-After-Control-Impact (BACI) design studies provide a rigorous evaluation of experimental manipulations. The BACI design uses matched control and treatment populations, collects required information prior to applying a treatment, and then monitors each population after the treatment application. Use of BACI design in CWD research has been limited to date (e.g., Conner et al. 2007) and none have been conducted over a sufficient time scale for complete evaluation. Best management practices dictate that commitment to resources are maintained for several years (i.e., *at minimum* 5 years) to fully evaluate effects of management interventions (WAFWA 2018); however, this can be challenging considering the prolonged disease course and extended epidemic curve associated with CWD.

In addition to biological research, research to understand the human dimensions (HD) of CWD (e.g., stakeholder attitudes, beliefs, and values) is critical to developing best management practices. Understanding the human component can have dramatic effects on the success, failure, and future of CWD management. Understanding how stakeholders' attitudes, social norms, and behavioral intent inform support for management actions is critical for programmatic success. For example, how stakeholders perceive the long-term positive benefits of CWD management including what management actions are, and are not, supported and, thereby, indicate which are most likely to succeed in their implementation may significantly influence hunter participation and tolerance of deer and elk population reduction strategies. In addition to characterizing current stakeholder perspectives, HD research can help identify the underlying values and informational sources that shape those perspectives. This can assist in developing informational messaging that reaches the public more efficiently, informs them more adequately, and, where necessary, begins the process of increasing support for science-based management approaches that have low initial acceptance. Conducting analytical assessments and retrospective analyses of HD experiences can serve as lessons learned (Vaske 2010). Just as evaluating the outcome of disease management efforts facilitates adaptive management, recurrent evaluation of stakeholder perspectives and communication strategies allows these efforts to be similarly responsive.

Management agencies, as well as producers of captive cervids, are well-poised to support critical research to close knowledge gaps and move toward successful management of CWD. Best management practices for CWD include incorporating research whenever possible and using available resources in the most effective manner. The *Plan for Assisting States, Federal Agencies, and Tribes in Managing Chronic Wasting Disease in Wild and Captive Cervids* (2002) identified four areas for CWD research focus. While a number of the knowledge gaps have been filled since the report was released, the topical areas remain relevant. A revision of those research goals and tasks could be considered when planning management and allocating resources. **These priority areas include:**

1. Prion detection and diagnostics.

Recent advances:

Research has led to significant advances in diagnostic testing (e.g., enzyme-linked immunosorbent assay (ELISA)), prion detection in some substrates (e.g., protein misfolding cyclic amplification (PMCA), Real-Time Quaking-Induced Conversion (RT-QuIC)), and antemortem diagnostics (tonsil and recto-anal mucosa–associated lymphoid tissues (RAMALT) biopsy).

Next steps:

Additional advances in CWD detection will likely follow on the coat-tails of other prion diseases. Of particular need are more sensitive tests for live animals, including a rapid throughput test for surveillance and to facilitate test-and-cull management, and the ability to reliably detect prions in environmental samples, such as soil, water, and urine.

2. Disease biology and pathogenesis.

Recent advances:

Research has led to significant advances in understanding routes of prion shedding, transmission, species susceptibility, and genetic contributions to susceptibility.

Next steps:

Apply these advances to continue modeling and understanding disease ecology, such as sources of new loci of infection and impacts of genetic resistance and selection. Filling knowledge gaps about strains of CWD and species barriers, particularly for humans, remain important needs. Identification of the relative contributions of the various disease transmission pathways towards the overall spread of CWD in wild and captive cervid populations has been identified as a research priority under legislation introduced by Representative Abraham (R-LA) in the U. S. House of Representatives in June, 2018 (H. R. 6272). Developing prophylactic or treatment measures are needed, but realistically the development of such measures appears unlikely in the near term.

3. Management and Ecology of the Disease and the Host.

Recent advances:

Short term studies have been performed to fill some knowledge gaps on the role of cervid ecology on CWD transmission, identify the role of soil and plants in prion availability, and model disease dynamics and predict management effectiveness.

Next steps:

Significant needs remain in this area, particularly long-term, broad scale multi-jurisdictional studies to evaluate the effectiveness of management treatments such as density reduction and targeted removals. Identification of techniques to reduce infectious load in the environment would be beneficial for captive, and potentially, free-ranging cervids. A greater understanding is needed of the role of plant uptake (and other environmental sources) for CWD transmission, prion translocation, and exposure of humans, livestock, and other wildlife species to prions.

4. Human dimensions.

Recent advances:

Place-based inquiry on perceptions of CWD and impact on hunting and risk evaluations have been conducted on a limited scale.

Next steps:

Significant knowledge gaps remain that will influence managers' ability to successfully address CWD, particularly public attitudes on the need for management and acceptance of proposed management actions. Additional needs include understanding differences in attitudes and beliefs in different geographic locations, understanding concern about risk to human health, public acceptance of risk from CWD, including human assisted movement of cervids, and evaluating communication preferences between geographic regions, stakeholder groups, and other demographics.

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20 - CWD and Cervid Regulations in North America

<u>Best Management Practices for reducing the risk of CWD transmission and establishment of CWD through regulations and regulatory strategies</u>

<u>State, provincial, and territorial wildlife agencies should:</u>

- **Assume sole authority for management (versus joint authority) of CWD in confined herds and privately-owned cervid herds if possible.** When litigation arises it is helpful to be able to present consistent statements of jurisdiction over time, whether through regulation or supplemented with the opinion of the state attorney general.

- **Work closely with neighboring jurisdictions to coordinate and, where possible, harmonize management and regulatory responses to CWD;**

- **Review and evaluate their wildlife disease regulations and authorities on a regular, ongoing basis, in order to ensure sufficient management flexibility and regulatory authority to manage CWD in wild and/or captive cervid populations.** Also review statutes pertaining to civil liability for damages caused to captive cervids, which may contain language designating or implying that captive cervids are domestic animals.

- **Enact regulations to**:
    - Promote testing of harvested animals in CWD-enzootic areas;
    - Mandate CWD testing for all cervids that die in private ownership/management or within a confined cervid operation;
    - Ensure consistent enforcement of intrastate and interstate movement prohibitions, including seizures and penalties; and

  Prohibit:
    - Feeding/baiting of cervids
    - Live importation of cervids into the state/province/territory except to regulated and licensed facilities
    - Importation of intact cervid carcasses and cervid parts known to contain significant amounts of prions into the state/province/territory
    - Movement of intact cervid carcasses and cervid parts known to contain significant amounts of prions from a CWD-enzootic area within a state/province/territory

Supporting Strategies and Evidence

CWD regulations vary widely between state, provincial, and territorial jurisdictions. While oversight of confined and privately-owned cervids falls solely on the agricultural or wildlife agencies in a few states and provinces, both agencies jointly manage privately-owned or confined cervids in the majority of states and provinces. Many states and provinces have restrictions prohibiting the importation of live cervids from another state or province where CWD is enzootic. However, some states ban importation (or ownership) of all live cervids. Even with the ever present and increasing threat of CWD, a few states and provinces have no ban or restriction in place, and allow free movement of live cervids across borders.

In states and provinces where privately-owned cervids are legal, regulatory language requires some level of postmortem CWD testing. These requirements and levels of enforcement vary greatly for each state and province. All states and provinces perform some level of CWD testing of wild cervids, again to varying degrees. Through this testing more than half of the states and three Canadian provinces have detected CWD in either privately-owned or wild cervids.

Baiting (for hunting) and feeding of wild cervids continues in many states and provinces. More states ban or restrict baiting rather than feeding, even though feeding extends the temporal scale that animals are congregating at unnatural food sites. Increased attention is being placed on the movement of cervid parts and carcasses across jurisdictional boundaries. Movement of potentially infected parts and carcasses increases the chance of CWD being introduced into new areas and more states, provinces, and territories are taking steps to reduce or ban these movements. Sound and consistent regulations and practices across all states, provinces, and territories would reduce confusion among stakeholders, especially those hunting in jurisdictions other than where they reside; reduce inadvertently moving CWD into new areas; and reduce the likelihood of disease transmission in areas where it currently exists.

Reference

The Chronic Wasting Disease Alliance maintains a current, up-to-date list of state and provincial regulations related to CWD. Link to clickable map or table of regulations by state, province, and territory: http://cwd-info.org/wp-content/uploads/2018/06/CWDRegstableState-Province_Spring18.pdf

21 – Relevant Case Law

Cases discussing regulatory authority over, categorization of, and ownership interests in captive cervids

Hill v. Missouri Department of Conservation, No. SC 96739 (Mo. Sup. Ct. 2018):

The Missouri Conservation Commission proposed new regulations of the captive cervid industry in an effort to eradicate CWD. These regulations banned the importation of cervids, and imposed stricter fencing, recordkeeping, and veterinary inspection requirements. Captive cervid owners/managers sued the Commission in state court to prevent the regulations from going into effect. The trial court ruled in favor of the cervid owners/managers. The state's appeal was then transferred to the Missouri Supreme Court.

The Commission argued that its authority under Article IV, §40(a) of the state constitution extends to captive cervids as "game" and "wildlife resources of the state." Cervid owners argued that the term "wildlife" does not include captive cervids, as it refers to animals that are both (1) "wild by nature" and (2) untamed and undomesticated. They further argued that "game" is a subset of that definition of "wildlife."

The Missouri Supreme Court rejected the cervid owners/managers' argument, finding that the terms "wildlife" and "game" include all animals wild by nature, regardless of whether they are domesticated. The cervid owners/managers' reading would define the Commission's authority on an "unworkable animal-by-animal basis" as against a "rational species-by-species basis." The text of article IV, §40(a) does not suggest the application of such an "animal-by-animal basis," and neither do historical interpretations of the text.

Cervid owners/managers also argued that privately owned cervids are not "resources of the state." The court rejected this argument as well, finding that "resources of the state" simply refers to wildlife within the state's geographical borders. Therefore, the Commission has the authority to regulate captive cervids as "game" and "wildlife resources of the state."

The Commission finally argued that the trial court erred in its determination that the proposed regulations violated the right to farm under Article I, §35 of the state constitution. This provision guarantees "the right of farmers and ranchers to engage in farming and ranching practices." Cervid owners/managers failed to show that they were engaged in such practices. Nothing in that provision suggested any intent to limit the Commission's regulatory authority for game and wildlife or for the captive cervid industry.

The Missouri Supreme Court reversed in favor of the Commission.

> **But see** **Oak Creek Whitetail Ranch, L.L.C. v. Lange**, 326 S.W.3d 549 (Mo. Ct. App. 2010) (holding that a dog owner was liable for monetary damages when his dog killed 21 breeder deer; the deer were domestic animals per Mo. Rev. Stat. § 273.020 because they "[l]iv[ed] in or near the habitation of man; domesticated; tame; as, domestic animals");
>
> **and**
>
> **Autumn Antlers Trophy Whitetail Lodge v. Armstrong,** 2014 WL 10252003 (Minn. Dist. Ct. Aug. 18, 2014) (construing Minn. Stat. § 347.01—which makes dog owners liable for killing or wounding domestic animals—to potentially cover captive cervids as under the jurisdiction of the state department of agriculture, rather than its department of natural resources); 2015 WL 4945799 (June 24, 2015) (finding in favor of the deer facility and awarding damages).

U.S. v. Wainwright, 89 F.Supp. 3d 950 (S.D. Ohio 2015):

The federal government charged defendant Wainwright with several Lacey Act and Ohio criminal violations including operation of captive white-tailed deer hunting preserves without a license and interstate trafficking of white-tailed deer. Defendant moved to dismiss the charges.

The court held that white-tailed deer born and raised in captivity were "wild animals" within the meaning of the Lacey Act, 16 U.S.C. §§ 3371(a), 3372(a), which makes it a crime to import, export, transport, sell, receive, acquire, or purchase any fish or wildlife in violation of state law regardless of whether they are captive or free-ranging. The Ohio statutes at issue prohibit operation of a "wild animal hunting preserve" without a license, and define such preserves to include land where captive deer are released and hunted. Ohio Rev. Code §§ 1531.01, 1533.721.

The court also held that the Lacey Act's definition of "wild animal" was clear enough to provide defendant with fair warning that the Act covered white-tailed deer. § 3371(a) ("defining wildlife as "any wild animal, whether alive or dead, including without limitation any wild mammal…whether or not bred, hatched, or born in captivity, and includes any part, product, egg, or offspring thereof"). The court construed the Lacey Act to require consideration of whether a species, not a specimen, is wild (similar to the inquiry the Missouri Supreme Court would make in Hill three years later).

The district court ruled for the federal government.

> **<u>See also</u> <u>U.S. v. Condict</u>,** No. CR-05-004-SPS, 2006 WL 1793235, at *3 (E.D. Ok. June 27, 2006) (also holding that wildlife under the Lacey Act includes farm-raised domesticated deer).

<u>Peterson v. Smith</u>, 03-17-00703-CV (Tex. Ct. App., 3d Dist.) [appeal pending]:

A deer-breeding facility sued for a declaration of ownership in breeder deer for which they possessed Texas breeding permits, and also sought to overturn comprehensive rules promulgated by the Texas Parks & Wildlife Department (TPWD) requiring breeder deer to undergo CWD testing in line with existing procedures for free-ranging deer.

Under Article XVI, § 59(a) of the Texas Constitution (the Conservation Amendment), natural resources are held as a "public right" to be preserved by legislation. The legislature accordingly proclaimed that "[a]ll wild animals…inside the borders of [the] state are the property of the people of this state." Tex. Parks & Wild. Code § 1.101(4) (defining "wild" as "normally liv[ing] in a state of nature and…not ordinarily domesticated"). Restriction of wild animals' movement does not affect their status as public property. § 1.103.

The district court rejected the breeders' claims on the bases of sovereign immunity, lack of redressable injury or deprivation of due process concerning his ability to transfer deer, and authority in TPWD to regulate their captive deer as publicly-owned wildlife under the Texas Constitution and Code.

The court ruled in favor of the Department.

> **<u>See also</u> <u>Anderton v. TPWD</u>,** 605 F. App'x 339, 348 (5th Cir. 2015) (per curiam) (holding that Texas deer breeders "cannot claim a constitutionally protected property interest in [their herd of breeder deer]").

<u>Indiana Department of Natural Resources v. Whitetail Bluff, LLC</u>, 25 N.E.3d 218 (Ind. Ct. App. 2015):

After being advised by the Indiana Department of Natural Resources (IDNR) that state law did not prohibit operating an enclosed white-tailed deer hunting facility, plaintiff established such a facility and populated it with captive deer. Soon, IDNR notified the facility that the presence of captive deer resulted in its land no longer being eligible for forest classification and plaintiff owing back taxes. Captive deer operations in Indiana were also subject to regulation by the State's Board of Animal Health (BOAH), which required tagging of animals for its CWD certification program.

> Indiana's Attorney General issued an opinion finding that IDNR's and BOAH's jurisdiction over captive deer was ambiguous, and soon the General Assembly passed legislation authorizing deer farming as an agricultural practice while precluding the hunting of "cervidae livestock". IDNR issued an emergency rule stating that obtaining a game breeder's license did not allow the hunting of animals maintained under that license—including fenced-in hunting. Plaintiff sued to overturn the rule and contested IDNR's jurisdiction over captive deer.
>
> The Court construed Indiana Code § 14-22-1-1 ("All wild animals, except those that are…legally owned or being held in captivity under a license or permit as required by this article; or…otherwise excepted in this article; are the property of the people of Indiana…The department shall protect and properly manage the fish and wildlife resources of Indiana") to confer no authority on IDNR to protect and manage wild animals that are legally owned or held in captivity under a license or permit. This reading comported with case law construing a prior version of § 14-22-1-1 in favor of the facility and BOAH.
>
> The Court also held that high-fence hunting is not prohibited under § 14-22-20.5-2. The court considered the ethics of high-fence hunting and the hazards of CWD but ultimately took negative notice of IDNR's change in position.

The court of appeals ruled against the Department.

22 - CWD and Public Health

Best Management Practices related to public health and CWD include the following:

- **Wear protective gloves, wash hands, and disinfect field equipment**. Anyone handling cervids (deer, elk, etc.) or cervid carcasses should take precautions to avoid exposure to disease agents with known (e.g. leptospirosis) or unknown (e.g. CWD) risk to humans. Recommendations from the Centers for Disease Control and Prevention (CDC) and state/provincial wildlife health agencies include wearing gloves, washing hands and instruments, disinfecting field equipment (see chapter in this volume on disinfection), and minimizing the handling of nervous tissue (brain and spinal cord).

- **Avoid sawing through the bone and cutting through the brain and spinal cord**. In CWD enzootic areas, to reduce exposure to CWD prions avoid sawing through the bone and cutting through the brain and spinal cord. Meat processors should process deer individually and clean and disinfect equipment between animals. States should consider developing regulations for meat processors who handle deer from out-of-state or from CWD enzootic zones.

- **Do not consume meat from animals that appear sick or are found dead of unknown causes.** The CDC and many wildlife agencies recommend that meat should not be consumed from animals that appear sick or are found dead of unknown causes. These animals should be reported to the respective state, provincial, or territorial wildlife agency. Tissues and organs with the potential for higher concentrations of CWD, including brain, spinal cord, spleen, tonsils, and lymph nodes, should be avoided and not consumed.

- **Do not consume meat or other tissues from CWD-positive animals.** The CDC recommends that cervids, especially from CWD-positive regions, be tested for CWD prior to consumption and that hunters and others should avoid consuming meat or other tissues from positive animals. However, it should be noted that assays used for prion detection are surveillance tools and do not constitute a food safety test. Meat/muscle tissue is not tested for CWD due to the low level of prion detectable in this tissue. Further, some animals in the early stages of infection may test negative due to the low level of prions present. To qualify this CDC recommendation it should be stated that transmission of CWD to humans through consumption of game meat has not been documented and no human has ever been diagnosed with CWD prion-related disease.

Supporting Strategies and Evidence

The popularity of hunting of cervids in North America and subsequent consumption of venison raises concerns regarding the possibility of transmission of chronic wasting disease (CWD) to humans. Some transmissible spongiform encephalopathies of animals, such as bovine spongiform encephalopathy (BSE), have been shown to be transmissible to humans (Aguzzi and Heikenwalder 2006); however, others, such as scrapie, do not appear to readily cross the species barrier. To date, the natural host range for CWD appears to be limited to cervids, and there have been no documented cases of CWD in humans. Nevertheless, preliminary unpublished results from one experimental study suggest a potential risk to humans, and the CDC currently recommends hunters test their harvested animals for CWD prior to consumption and that meat or other tissues from CWD-positive animals should not be consumed. These recommendations have not changed following publication of experimental studies that were unable to demonstrate transmission of CWD to macaques (Race et al. 2018).

Humans are susceptible to several prion diseases including Creutzfeldt-Jakob Disease (CJD), variant CJD (caused by the classical bovine spongiform encephalopathy [BSE] agent), fatal familial insomnia, kuru, and Gerstmann-Sträusler-Scheinker disease. Of these only kuru and BSE are known to be transmissible, and BSE is the only animal prion disease known with certainty to be infectious to humans. Other animal prion diseases, including scrapie in sheep and goats, have not been shown to be transmissible to humans despite centuries of exposure, although certain lines of experimental investigation suggest a low but non-zero zoonotic potential for classical scrapie strains

Chronic wasting disease causes natural disease in members of the Cervidae family and has been detected in free-ranging Rocky Mountain elk, mule deer, white-tailed deer, moose, and reindeer (Miller and Fischer 2016). Species from captive commercial collections in North America have included elk, mule deer, sika deer, and white-tailed deer (U. S. Geological Survey 2016). Cattle that have been co-grazed with CWD-infected cervids have not developed disease (Sigurdson 2008; Williams et al. 2018), and other, non-cervid species have not been found to develop disease except in controlled experiments.

Experimental studies have further elucidated the potential host range and expanded our knowledge regarding both molecular and physical barriers to transmission. Studies using intracerebral (directly into the brain) inoculation of CWD evaluate molecular barriers and demonstrate whether the normal prion protein of the host species is capable of misfolding to the abnormal CWD prion protein shape. Amino acid sequence of the host prion protein, most importantly the presence of asparagine at position 170 in humans (Kurt et al. 2009), is an important determinant of whether misfolding occurs when exposed to the CWD prion (reviewed by Kurt and Sigurdson 2016). These studies indicated that a wide range of species are theoretically susceptible to CWD infection although susceptibility does not necessarily follow taxonomic lines. While many species, including raccoons, macaques, and some rodents, appear resistant to infection by intracerebral inoculation, exposure via this route has resulted in CWD infection in other rodents, fallow deer, mustelids, felids, non-human primates and ruminants, although with variable attack rates (Kurt and Sigurdson 2016).

Despite the development of infection following intracerebral inoculation, most species appear to have physical barriers that so far prevent infection following natural exposure. Experimental natural or oral exposure to CWD did not result in infection in fallow deer (Rhyan et al. 2011), mustelids, felids, non-cervid ruminants (Kurt and Sigurdson 2016; Williams et al. 2018), and macaques in two related studies (Race et al. 2009; 2018). Experimental infections simulating natural exposure have resulted in disease in several cervid species including elk (Hamir et al. 2006a), muntjac (Napier et al. 2009), reindeer (Mitchell et al. 2012), and red deer (Balachandran et al. 2010). Infection following oral exposure in non-cervids has been demonstrated only in swine (Moore et al., 2017), squirrel monkeys (Marsh et al. 2005), and macaque monkeys (S. Czub, personal communication).

Successful infection of primates via intracerebral inoculation and oral exposure, although inconsistent, raises concerns for the potential for human infection. Squirrel monkeys have become infected following intracerebral inoculation, and there is evidence squirrel monkeys fed CWD-positive material have developed disease (Marsh et al. 2005). Although Race et al. (2009; 2018) saw no evidence of transmission to cynomolgus macaques, preliminary results from another study indicated cynomolgus macaques fed CWD-positive meat were capable of developing disease that is clinically similar to prion disease (S. Czub, personal communication). This research has not passed peer-review or been published to date.

Chronic wasting disease is increasing in prevalence and geographic range. Therefore, the potential for human infection may be increasing as infective contact rates increase (Belay et al. 2004). The CWD prion has been found in venison (skeletal muscle) of CWD-infected deer (Angers et al. 2006), including those that are not yet showing clinical signs (Daus et al. 2011). However, a small number of studies have investigated humans known to consume CWD-positive meat and were unable to establish any links to human disease (Mawhinney et al. 2006, Anderson et al., 2007). Some molecular studies suggest that the human prion protein is refractory to misfolding when exposed to the CWD prion while others show varying degrees of susceptibility (Waddell et al. 2017). Nevertheless, prion diseases can have extremely long incubation periods and surveillance in humans is limited, and thus the possibility for CWD to cause disease in humans cannot be ruled out. Experimental studies using transgenic mice suggest that CWD disease properties may change after multiple passages through different animals (Telling 2011). Human disease risk may depend on the strain and emerging strains may have increased infection risk to humans (Barria et al. 2011, Daus and Beekes 2012, Herbst et al. 2017). A recent systematic review of information on the potential transmissibility of CWD to humans had the following conclusion:

> "Future discovery of CWD transmission to humans cannot be entirely ruled out on the basis of current studies, particularly in light of possibly decades-long incubation periods for CWD prions in humans. It would be prudent to continue CWD research and epidemiologic surveillance, exercise caution when handling potentially contaminated material and explore CWD management opportunities." (Waddell et al 2017)

The potential impacts on public health in the more holistic sense (e.g. mental health and social well-being) of detection of CWD in wild cervids should not be ignored and should be explored further. Hunting of wild cervids is of high importance in terms of subsistence harvesting, particularly in rural and Indigenous communities, with high sociocultural importance to the health and wellbeing of members of those communities.

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