Chronic Wasting Disease (CWD) **System:** Terrestrial

Kingdom	Phylum	Class	Order	Family
Virus				

Common name Chronic Wasting Disease (English)

Synonym

Similar species

Summary

Chronic Wasting Disease (CWD) is a neurological prion disease affecting cervids. Significant research and attention has been focused on CWD since its infectious agent is similar to that found in other diseases known to affect humans. However, there is no current evidence that CWD is transmissible to humans. The fatalities of cervids, however, can negatively affect cervid populations and impact humans in the form of economic loss. Many questions regarding CWD remain unanswered but the disease's impact on North American cervid populations combined with its continual geographic spread during the past decade has increased the fervour among researchers and managers to develop solutions for the biological and social challenges presented by CWD.

view this species on IUCN Red List

Species Description
Chronic Wasting Disease is a progressive, fatal disease of the nervous system, affecting cervids, both captive and free-ranging (Alberta Prion Research Institute, 2008). It is classified as a transmissible spongiform encephalopathy (TSE) or prion disease (Belay *et al*., 2004). The disease was first recognized as a clinical syndrome in mule deer at a research facility in Fort Collins, Colorado, USA in 1967. After initially being considered a disease related to captivity and associated with nutritional deficiency, toxins or stress, it was accurately classified as a TSE in 1978 (Williams & Young, 1980). When considering the entire TSE disease family, only the cervid-specific chronic wasting disease and sheep scrapie are readily transmissible to susceptible hosts through horizontal transmission of infected animals or environmental reservoirs of infectivity (Pilon *et al*., 2007). CWD is the only known spongiform encephalopathy known to naturally infect both free-ranging and captive animals. This greatly complicates efforts to monitor, control or eradicate it (Bunk, 2004). Of all prion diseases, CWD may be the most efficiently transmitted. In dense free-ranging deer populations prevalence can be as high as 40% and in captive herds it can reach 100% (Sigurdson & Aguzzi, 2007). CWD is caused by “aberrantly refolded isoforms of the prion protein, a normal cellular glycoprotein” (Williams, 2005). Prion proteins convert normal proteins in the host animal's cells resulting in concentrations of refolded isoforms. Over time, these abnormal proteins accumulate in the central nervous and lymphatic systems causing a degenerative lack of body coordination, marked changes in behaviour, emaciations, and a prolonged physical \"wasting-away\" until death (Williams *et al*., 2002). \r\n\r\n
The disease affects elk, mule deer, black-tailed deer, white-tailed deer, white-tailed deer hybrids (Forrest, 2003) and moose (Kreeger *et al*., 2006). CWD infection-specific protease-resistant prion protein accumulates in gut-associated lymphoid tissues of infected deer, which implicates alimentary shedding of the CWD agent in both feces and saliva. In elk, CWD has been detected by IHC in the myenteric plexus, the vagosympathetic trunk, the cell column of the spinal cord and endocrine glands (Salman, 2003). Because CWD infection-specific protease-resistant prion protein becomes progressively abundant in the nervous system and lymphoid tissues through the disease course, carcasses of cervids succumbing to CWD also likely to serve as foci of infection (Miller *et al*., 2004). A characteristic of all transmissible spongiform encephalopathy agents is their resistance to conventional disinfectants, high temperatures, and enzymes that normally break down proteins (USDA-APHIS, 2008). The clinical signature of CWD includes several non-diagnostic symptoms such as: weight loss, behavioural changes, excessive water consumption, salivation and urinating, together with erratic teeth grinding (Forrest, 2003). In addition, animals may show repetitive behaviours such as walking set patterns in the pen or pasture, show periods of somnolence or depression from which they are easily roused, and may carry their head and ears lowered. Affected animals continue to eat but consume reduced amounts of feed, leading to gradual loss of body condition. As the disease progresses, many affected animals display polydipsia and polyuria, increased salivation with resultant slobbering or drooling, as well as inco-ordination, posterior ataxia, fine head tremors, and a wide-based stance (Williams & Miller, 2002). \r\n
Oregon Invasive Species Council has classified Chronic Wasting Disease as one of 100 most dangerous invaders (2008). Communal use of wallows and mineral licks by elk may increase the risk of CWD transmission by sharing areas contaminated with bodily excretion potentially including CWD prions (VerCauteren *et al*., 2007a).

Notes
Lateral transmission is significant in the epidemiology of CWD (Kahn *et al*., 2004). Lateral transmission, compounded by animal movements, is the most important factor in spread of CWD. Indirect transmission via environmental contamination may play a role in natural dynamics and persistence of the disease and thus exacerbate the spread of the disease, and may present an obstacle to eradicating CWD from infected premises (Salman, 2003). It appears that cervids are exposed via ingestion of PrP-CWD from sources in the environment, direct contact with animals that are excreting the agent, or both. Increased population density as a consequence of keeping animals in captivity or artificial feeding of wildlife may increase the likelihood of direct and indirect transmission between individuals. Direct transmission between animals probably requires more than just transient exposure (Kahn *et al*., 2004). Infectious prions are shed through the alimentary tract via saliva or feces and potentially urine. Prions deposited in soil remain infectious and are extremely resilient, persisting up to 3 years in experimental studies and sometimes for more than 15 years in domestic situations. In addition, fecal-oral transmission is a likely mechanism of disease transmission of CWD. In fact, data shows that deer could not entirely avoid fecal consumption at supplemental feeding sites and even low-level consumption may be important if fecal material contains an infectious dose of disease agent. Consumption of fecal material, contaminated soil, and forage are potential modes of indirect disease transmission (Thompson *et al*., 2008). In the USA and Canada, the mandatory reporting of CWD is governed by a combination of national and state or provincial legislation (Kellar & Lees, 2003). Species known to be susceptible to CWD by an extreme and unnatural exposure route, i.e. intracerebral inoculation, include ferrets, raccoons, other ruminants, and squirrel monkeys (Sigurdson & Aguzzi, 2007).

Lifecycle Stages
There is no epidemiological evidence that confirms the origin of CWD. There is no evidence to support a feed-borne common source origin of CWD. However, some hypotheses of the origin include: infection of deer by a strain of scrapie that has adapted to cervid hosts, a genetic form of TSE arising in deer, with subsequent natural transmission, exposure to a currently unknown TSE, expressing the possibility, borne particularly out of infancy of study of diseases on wildlife, that there could be undetected TSE or prion disease in other species, and a spontaneous conformational change of the prion protein occurring in mule deer, with subsequent transmission to other deer and to elk. Unfortunately, none of these hypotheses provide a particularly plausible explanation of the origin of CWD (Salman, 2003). Under experimental conditions, minimum incubation was approximately fifteen months and mean time from oral infection to death was approximately twenty-three months in mule deer, and the range of onset of clinical disease in orally infected elk was approximately twelve to thirty-four months (Williams & Miller, 2002). Environmental models are distinct in representing the assumption that infectious material is durable and does not require contact with or the immediate presence of infected deer to perpetuate epidemics (Miller *et al*., 2006).

Habitat Description
Forecasting by models leads to the assumption that prevalence of CWD increases slowly over several decades. Such increases are uniform across populations and over time, it follows that CWD prevalence should be highest in areas where it has been present longest. Therefore, Wyoming and Colorado have a higher prevalence of CWD where it has been recognized for several decades (Miller *et al*., 2000).

Reproduction
It is thought that CWD is derived from sheep scrapie. On the other hand, it has been suggested that CWD is derived from the spontaneous generation of infectious prion protein. However, the disease's origin remains known (Masujin *et al*., 2007).

General Impacts
There is a significant potential for expansion of the geographic range of CWD, and once established, the disease could be maintained and transmitted through deer to deer interaction and, in some situations environmental contamination for an indefinite period of time (Grear *et al*., 2006). Exposure to CWD prions could potentially occur through consuming meat or tissues from infected animals, while processing game, or through unusual pathways such as ingesting antler velvet (Anderson *et al*., 2007). However, evidence strongly suggests a species barrier to transmission of CWD to humans (Bourne, 2004). Although findings consistently suggest that there is no connection between CWD and human TSEs, the possibility that an isolated case of human disease associated with the CWD agent has occurred or may yet occur cannot yet be excluded (MaWhinney *et al*., 2006). Several states and provinces have banned the importation of cervids in the face of growing knowledge regarding the distribution of CWD within farmed and wild herds on the continent, which could have negative effects on the economies of those who rely on the importation of cervids (Kellar & Lees, 2003). This disease has the potential to cause severe harm to deer populations and thus to disrupt ecosystems where deer occur in abundance (Miller *et al*., 2006). However, on-going research on the species barrier is indicating that there is a substantial biological barrier to transmission of CWD from deer to cattle under normal conditions (Salman, 2003).

Management Info
Preventative measures: Regulatory agencies in locations without CWD should plan to prevent its introduction through cervid and cervid part movement restrictions, restrictions on baiting and feeding, risk assessments, population management, and information dissemination (USDA-APHIS, 2008). In particular fawns/calves should never be moved in or out of enzootic and newly infected areas to prevent potential spread. Where possible potentially infected fawns and calves should be euthanized, particularly as most live animal tests for CWD may not be effective in young animals. Carcass disposal in enzootic and newly infected areas should focus on reducing surface contamination by deep burial at approved sites or small numbers can be incinerated (Pybus & Hwang, 2008).\r\n
Management Techniques to Eliminate, Contain, or Control CWD: Outbreak surveillance establishes the prevalence, incidence, and distribution of the disease, and allows the evaluation of management actions. Population reduction is a technique that encompasses the depopulation of farmed cervids, or of free-ranging cervids in limited geographical areas. Targeted removal can reduce a specific subset of an affected population (USDA-APHIS, 2008). Surveillance testing and removal can be used to remove CWD affected animals from a population, but this approach may only be appropriate in limited situations. Therapeutics and vaccines could be a future option, but these tools are not currently available. Restrictions on feeding or baiting of free-ranging cervids where appropriate, and regulations for the farmed cervid industry are examples of management tools that may be used to control CWD. The manipulation of environmental factors could limit animal use of areas and potential exposure. These tools are most useful in dealing with environmental contamination. Lastly, agricultural and wildlife agencies should provide scientifically based recommendations for limiting animal movements to prevent the spread of CWD (USDA-APHIS, 2008). Long persistence times or high excretion rates of infectious agent will make it more difficult to reduce or eradicate CWD as compared to the case of direct transmission. Better understanding of agent excretion and persistence are thus needed in order to make realistic assessments of the viability of specific CWD control strategies (Miller *et al*., 2006). \r\n
Integrated Management: In Canada and the USA, financial incentives have been added in the form of compensation for animals slaughtered in national eradication efforts for CWD (Kellar & Lees, 2003). Banning supplemental feeding practices to reduce risks of disease transmission, especially in areas with infectious disease outbreaks, is warranted (Thompson *et al*., 2008). \r\n
Biological: Studies suggest that tonsillar biopsy is a valid method for detecting CWD in live deer during incubation stage, and may be used as an ante-mortem and pre-clinical diagnosis and as an adjunct management tool (Salman, 2003). Current research into rectal biopsies may produce an effective method of ante-mortem CWD diagnosis in elk (UDSA, 2008). A CWD-susceptible cell line has also been developed, which is derived from cervid brain fibroblasts, and has been used to screen inhibitors of CWD infection. This is the first CWD specific assay introduced for screening compounds that inhibit CWD propagation (Sigurdson & Aguzzi, 2007).\r\n
For more information on response to CWD in at risk, newly infected and enzootic areas please see the Chronic Wasting Disease Workshop document (Pybus & Hwang, 2008).

Principal source:

Compiler: National Biological Information Infrastructure (NBII) & IUCN/SSC Invasive Species Specialist Group (ISSG)

Review: Chronic Wasting Disease (CWD) Alliance

Pubblication date: 2010-05-15

ALIEN RANGE

[3] CANADA
[17] UNITED STATES
[1] KOREA, REPUBLIC OF

BIBLIOGRAPHY

78 references found for **Chronic Wasting Disease (CWD)**

Managment information

Alberta Prion Research Institute., 2008. Chronic Wasting Disease: Regulation and Impact Workshop Report February 28, 2008. PrioNet Canada

Summary: Available from: http://www.prioninstitute.ca/forms/08-03%20CWD%20Report%20for%20web.pdf [Accessed 10 September 2008]

Belay E. D, Maddox R. A, Williams E. S, Miller M. W, Gambetti P, Schonberger L. B. 2004. Chronic wasting disease and potential transmission to humans. Emerging Infectious Diseases • www.cdc.gov/eid • Vol. 10, No. 6, June 2004

Summary: Available from: http://www.cdc.gov/ncidod/eid/vol10no6/pdfs/03-1082.pdf [Accessed 10 September 2008]

Biosecurity New Zealand., undated. Pests & Diaseses: Chronic Wasting Disease

Summary: Available from: http://www.biosecurity.govt.nz/pest-and-disease-response/pests-and-diseases-watchlist/chronic-wasting-disease [Accessed 10 September 2008]

Blanchong, Julie A.; Joly, Damien O.; Samuel, Michael D.; Langenberg, Julia A.; Rolley, Robert E.; Sausen, Janet F., 2006. White-tailed deer harvest from the chronic wasting disease eradication zone in south-central Wisconsin. Wildlife Society Bulletin. 34(3). OCT 2006. 725-731.

Bollinger, Trent, Peter Caley, Evelyn Merrill, Fracois Messier, Michael W. Miller, Michael D. Samuel, Emmanuel Vanopdenbosch., 2004. Expert Scientific Panel on Chronic Wasting Disease. Wildlife Damage Management, Internet Center for Canadian Cooperative Wildlife Health Centre: Newsletters & Publications University of Nebraska - Lincoln Year 2004

Summary: Available from: http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1018&context=icwdmccwhcnews [Accessed 10 September 2008]

Bourne, Debra., 2004. Chronic Wasting Disease Review. October 2004 / For SEAC / Page 1 of 66

Summary: Available from: http://www.seac.gov.uk/papers/cwdiseaseannex1.pdf [Accessed 10 September 2008]

Canadian Cooperative Wildlife Health Centre., 2005. Canada•s National Chronic Wasting Disease Control Strategy. Wildlife Damage Management, Internet Center for Canadian Cooperative Wildlife Health Centre: Newsletters & Publications. University of Nebraska - Lincoln Year 2005. Prepared for the Federal-Provincial/Territorial Resource Ministers Council by the Technical Working Group assembled under the Inter-Agency Oversight Committee (IOC) for Chronic Wasting Disease. Published on Behalf of the IOC by Saskatchewan Environment 3211 Albert St. Regina, SK, S4S 5W6

Summary: Available from: http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1017&context=icwdmccwhcnews [Accessed 10 September 2008]

Centers for Disease Control and Prevention (CDC), 2007. Chronic Wasting Disease (CWD)

Summary: Available from: http://www.cdc.gov/ncidod/dvrd/cwd/index.htm [Accessed 10 September 2008]

Chang, Binggong; Cheng, Xin; Yin, Shaoman; Pan, Tao; Zhang, Hongtao; Wong, Poki; Kang, Shin-Chung; Xiao, Fan; Yan, Huimin; Li, Chaoyang; Wolfe, Lisa L.; Miller, Michael W.; Wisniewski, Thomas; Greene, Mark I.; Sy, Man-Sun., 2007. Test for detection of disease-associated prion aggregate in the blood of infected but asymptomatic animals. Clinical & Vaccine Immunology. 14(1). JAN 2007. 36-43.

de Motes, C. Maluquer; Cano, M. J.; Torres, J. M.; Pumarola, M.; Girones, R., 2008. Detection and survival of prion agents in aquatic environments. Water Research. 42(10-11). MAY 2008. 2465-2472.

Drake, John M., 2005. Risk analysis for invasive species and emerging infectious diseases: Concepts and applications. American Midland Naturalist. 153(1). January 2005. 4-19.

Forrest, R.A., 2002. Chronic Wasting Disease: A Review and working hypothesis, the Agent and its Transmission PART I: A Logical Causative Agent. The CWD Foundation

Summary: Available from: http://www.stopcwd.org/library/cwd_paper.pdf [Accessed 10 April 2009]

Forrest, R.A., 2003. Chronic Wasting Disease: A working hypothesis, the Agent and its Transmission PART IIa: Novel Vectors

Summary: Available from: http://www.stopcwd.org/library/cwd_paper2.pdf [Accessed 10 September 2008]

Grear, Daniel A.; Samuel, Michael D.; Langenberg, Julie A.; Keane, Delwyn., 2006. Demographic patterns and harvest vulnerability of chronic wasting disease infected white-tailed deer in Wisconsin. Journal of Wildlife Management. 70(2). 2006. 546-553.

Gross, John E.; Miller, Michael W., 2001. Chronic wasting disease in mule deer: Disease dynamics and control. Journal of Wildlife Management. 65(2). April, 2001. 205-215.

Joly, Damien O., Christine A. Ribic, Julie A. Langenberg, Kerry Beheler, Carl A. Batha, Brian J. Dhuey, Robert E. Rolley, Gerald Bartelt, Timothy R. Van Deelen, and Michael D. Samuel., 2003. Dispatch: Chronic Wasting Disease in Free-Ranging Wisconsin White-Tailed Deer. Emerging Infectious Diseases • Vol. 9, No. 5, May 2003

Summary: Available from: http://www.cdc.gov/ncidod/EID/vol9no5/pdfs/02-0721.pdf [Accessed 10 September 2008]

Joly, Damien O.; Samuel, Michael D.; Langenberg, Julia A.; Blanchong, Julie A.; Batha, Carl A.; Rolley, Robert E.; Keane, Delwyn P.; Ribic, Christine A., 2006. Spatial epidemiology of chronic wasting disease in Wisconsin white-tailed deer. Journal of Wildlife Diseases. 42(3). JUL 2006. 578-588.

Kahn, Sarah; Caroline Dub•; Lynn Bates, & Aru Balachandran., 2004. Chronic wasting disease in Canada: Part 1. Can Vet J. 2004 May; 45(5): 397•404.

Summary: Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=548623 [Accessed 10 September 2008]

Kellar, J. A.; Lees, V. W., 2003. Risk management of the transmissible spongiform encephalopathies in North America. Revue Scientifique et Technique Office International des Epizooties. 22(1). April 2003. 201-225

Masujin, Kentaro; Shimada, Kimi; Kimura, Kumiko M.; Imamura, Morikazu; Yoshida, Ayumu; Iwamaru, Yoshifumi; Mohri, Shirou; Yokoyama, Takashi., 2007. Applicability of current bovine spongiform encephalopathy (BSE) diagnostic procedures for chronic wasting disease (CWD). Microbiology & Immunology. 51(10). 2007. 1039-1043.

Mathiason, Candace K. Jenny G. Powers, Sallie J. Dahmes, David A. Osborn, Karl V. Miller, Robert J. Warren, Gary L. Mason, Sheila A. Hays, Jeanette Hayes-Klug, Davis M. Seelig, Margaret A. Wild, Lisa L. Wolfe, Terry R. Spraker, Michael W. Miller, Christina J. Sigurdson, Glenn C. Telling, Edward A. Hoover. 2006. Reports: Infectious Prions in the Saliva and Blood of Deer with Chronic Wasting Disease Science 6 October 2006: Vol. 314. no. 5796, pp. 133 - 136 DOI: 10.1126/science.1132661

MaWhinney, Samantha; W. John Pape; Jeri E. Forster, C. Alan Anderson, Patrick Bosque, and Michael W. Miller., 2006. Human Prion Disease and Relative Risk Associated with Chronic Wasting Disease.Emerging Infectious Diseases • www.cdc.gov/eid • Vol. 12, No. 10, October 2006

Miller, Michael W., Elizabeth S. Williams, Craig W. McCarty, Terry R. Spraker, Terry J. Kreeger, Catherine T. Larsen, and E. Tom Thorne., 2000. Epizootiology of Chronic Wasting Disease in Free Ranging Cervids in Colorado and Wyoming. Journal of Wildlife Diseases, 36(4), 2000, pp. 676–690
Summary: Available from: http://www.jwildlifedis.org.ezproxy.auckland.ac.nz/cgi/reprint/36/4/676 [Accessed 10 September 2008]
Miller, Michael W.; Hobbs, N. Thompson; Tavener, Simon J., 2006. Dynamics of prion disease transmission in mule deer. Ecological Applications. 16(6). DEC 2006. 2208-2214.
Miller, Michael W., Margaret, A. Wild, Elizabeth S. Williams., 2000. Epidemiology of Chronic Wasting Disease in Captive Rocky Mountain Elk. Journal of Wildlife Diseases 34(3) 1998. 532-536
Minnesota Department of Health., 2007. Chronic Wasting Disease (CWD)
Summary: Available from: http://www.health.state.mn.us/divs/idepc/diseases/cwd/index.html [Accessed 10 September 2008]
Minnesota Department of Health., undated. Fact Sheet/Brochure: Chronic Wasting Disease. Information on Chronic Wasting Disease (CWD) for deer hunters, meat processors and consumers.
Summary: Available from: http://www.health.state.mn.us/divs/idepc/diseases/cwd/cwd.pdf [Accessed 10 September 2008]
North Dakota Department of Health, September-October 2004. Epidemiology Report. Transmissible Spongiform Encephalopathies
Summary: Available from: http://www.health.state.nd.us/Disease/Documents/EpiReport/09-10-04.pdf [Accessed 10 September 2008]
Oregon Invasive Species Council., 2008. 100 most dangerous invaders
Summary: Available from: http://www.oregon.gov/OISC/list_100_worst.shtml [Accessed 10 September 2008]
Oyer, Anne M.; Mathews, Nancy E.; Skuldt, Lesa H., 2007. Long-distance movement of a white-tailed deer away from a chronic wasting disease area. Journal of Wildlife Management. 71(5). JUL 2007. 1635-1638.
Pilon, John; Loiacono, Christina; Okeson, Danelle; Lund, Sharon; Vercauteren, Kurt; Rhyan, Jack; Miller, Lowell., 2007. Anti-prion activity generated by a novel vaccine formulation. Neuroscience Letters. 429(2-3). DEC 18 2007. 161-164.
Pybus, M. & Hwang, Y.T. 2008. Chronic Wasting Disease Workshop. Alberta Sustainable Resource Development, Fish and Wildlife Division & Saskatchewan Ministry of Environment, Fish and Wildlife Branch.
Summary: Available from: http://142.229.230.68/BioDiversityStewardship/WildlifeDiseases/documents/CWD_workshop_Dec_4_FINAL.pdf
Salman, Mo D., 2003. Chronic Wasting Disease in Deer and Elk: Scientific Facts and Findings. Review. J. Vet. Med. Sci. 65(7): 761-768, 2003
Summary: Available from: http://www.cwd-info.org/pdf/CWD%20Review%20Article%20-%20Salman%202003.pdf [Accessed 10 September 2008]
Schauber, Eric M.; Woolf, Alan., 2003. Chronic wasting disease in deer and elk: A critique of current models and their application. Wildlife Society Bulletin. 31(3). Fall 2003. 610-616.
Sigurdson, C. J.; Mathiason, C. K.; Perrott, M. R.; Eliason, G. A.; Spraker, T. R.; Glatzel, M.; Manco, G.; Bartz, J. C.; Miller, M. W.; Hoover, E. A., 2008. Experimental chronic wasting disease (CWD) in the ferret. Journal of Comparative Pathology. 138(4). MAY 2008. 189-196.
Sohn, Hyun-Joo; Jae-Hoon Kim; Kang-Seuk Choi; Jin-Ju Nah; Yi-Seok Joo; Young-Hwa Jean; Soo-Whan Ahn; Ok-Kyung Kim; Dae-Yong Kim; And Aru Balachandran., 2002. A Case of Chronic Wasting Disease in an Elk Imported to Korea from Canada. Note Pathology
Summary: Available from: http://www.jstage.jst.go.jp/article/jvms/64/9/855/_pdf [Accessed 10 September 2008]
Spraker, T. R.; Miller, M. W.; Williams, E. S.; Getzy, D. M.; Adrian, W. J.; Schooveld, G. G.; Spowart, R. A.; O Rourke, K. I.; Miller, J. M.; Merz, P. A., 1997. Spongiform encephalopathy in free-ranging mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*) and Rocky Mountain elk (*Cervus elaphus nelsoni*) in Northcentral Colorado. Journal of Wildlife Diseases. 33(1). 1997. 1-6.
Stafford, Nicole T.; Needham, Mark D.; Vaske, Jerry J; Petchenik, Jordan., 2007. Hunter and nonhunter beliefs about chronic wasting disease in Wisconsin. Journal of Wildlife Management. 71(5). JUL 2007. 1739-1744
Texas Department of State Health Services., 2005. Chronic Wasting Disease.
Summary: Available from: http://www.dshs.state.tx.us/idcu/disease/chronic_wasting_disease/CWD.pdf [Accessed 10 September 2008]
Thompson, Abbey K.; Samuel, Michael D.; Van Deelen, Timothy R., 2008. Alternative feeding strategies and potential disease transmission in Wisconsin white-tailed deer. Journal of Wildlife Management. 72(2). FEB 2008. 416-421.
Travis, Dominic; Miller, Michele., 2003. A short review of transmissible spongiform encephalopathies, and guidelines for managing risks associated with chronic wasting disease in captive cervids in zoos. Journal of Zoo & Wildlife Medicine. 34(2). June 2003. 125-133.
USDA-APHIS., 2006. Evaluation and Management of Chronic Wasting Disease Transmission. Wildlife Services Seeking Solutions Through Research
Summary: Available from: http://www.aphis.usda.gov/wildlife_damage/nwrc/downloads/082-CWD.pdf [Accessed 10 September 2008]
USDA-APHIS., 2008. Animal Health Chronic Wasting Disease
Summary: Available from: http://www.aphis.usda.gov/animal_health/animal_diseases/cwd/ [Accessed 10 September 2008]
USGS National Wildlife Health Center., 2008. Chronic Wasting Disease (CWD)
Summary: Available from: http://www.nwhc.usgs.gov/disease_information/chronic_wasting_disease/index.jsp [Accessed 10 September 2008]
VerCauteren, Kurt C., 2004. Evaluation and Management of Chronic Wasting Disease Transmission. Wildlife Damage Management, Internet Center for USDA National Wildlife Research Center - Staff Publications University of Nebraska - Lincoln
Summary: Available from: http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1126&context=icwdm_usdanwrc [Accessed 10 September 2008]
Vercauteren, Kurt C.; Lavelle, Michael J.; Seward, Nathan W.; Fischer, Justin W.; Phillips, Gregory E., 2007b. Fence-line contact between wild and farmed cervids in colorado: Potential for disease transmission. Journal of Wildlife Management. 71(5). JUL 2007. 1594-1602.
Vercauteren, Kurt C; Lavelle, Michael J; Seward, Nathan W; Fischer, Justin W; Phillips, Gregory E., 2007c. Fence-line contact between wild and farmed white-tailed deer in Michigan: Potential for disease transmission. Journal of Wildlife Management. 71(5). JUL 2007. 1603-1606.
VerCauteren, Kurt C., Patrick W. Burke, Gregory W. Phillips, Justin W. Fischer, Nathan W. Seward, Bruce A. Wunder, Michael J. Lavelle., 2007a. Elk Use of Wallows and Potential Chronic Wasting Disease Transmission. Wildlife Damage Management, Internet Center for USDA National Wildlife Research Center - Staff Publications University of Nebraska - Lincoln
Summary: Available from: http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1772&context=icwdm_usdanwrc [Accessed 10 September 2008]

Virginia Invasive Species Council. 2005. Virginia Invasive Species Management Plan. Virginia Department of Conservation and Recreation Division of Natural Heritage. Richmond. 84 p.
Summary: Available from: http://www.sarpaquatic.org/Virginia_Invasive_Species_Mgt_Plan.pdf [Accessed 10 September 2008]
Williams, Elizabeth S.; Kreeger, Terry J.; Kahn, Richard H.; Thorne, E. Tom., 2002. Chronic wasting disease of deer and elk: A review with recommendations for management. Journal of Wildlife Management. 66(3). July, 2002. 551-563.
Williams, Elizabeth S., Michael W. Miller, E. Tom Thorne., undated. Chronic Wasting Disease: Implications & Challenges for Wildlife Managers.
Summary: Available from: http://www.cwd-info.org/pdf/CWDPresentationatNAWNRC.pdf [Accessed 10 September 2008]
Williams, E. S., 2005. Review Article. Chronic Wasting Disease. Vet Pathol 42:530–549 (2005)
Summary: Available from: http://www.vetpathology.org/cgi/reprint/42/5/530 [Accessed 10 September 2008]
Wolfe, Lisa L.; Miller, Michael W.; Williams, Elizabeth S., 2004. Feasibility of test-and-cull for managing chronic wasting disease in urban mule deer. Wildlife Society Bulletin. 32(2). Summer 2004. 500-505.

General information

Aguzzi, Adriano; Heikenwalder, Mathias; Miele, Gino., 2004. Progress and problems in the biology, diagnostics, and therapeutics of prion diseases. Journal of Clinical Investigation. 114(2). July 2004. 153-160.
Anderson, C. Alan; Bosque, Patrick; Filley, Christopher M.; Arciniegas, David B.; Kleinschmidt-DeMasters, B. K.; Pape, W. John; Tyler, Kenneth L., 2007. Colorado surveillance program for chronic wasting disease transmission to humans - Lessons from 2 highly suspicious but negative cases. Archives of Neurology. 64(3). MAR 2007. 439-441.
Baeten, Laurie A.; Powers, Barbara E.; Jewell, Jean E.; Spraker, Terry R.; Miller, Michael W., 2007. A natural case of chronic wasting disease in a free-ranging moose (*Alces alces shirasi*). Journal of Wildlife Diseases. 43(2). APR 2007. 309-314.
Binghamton University., 2005, November 22. First Ever Study To Investigate Impact Of Chronic Wasting Disease On Humans. ScienceDaily.
Summary: Available from: http://www.sciencedaily.com/releases/2005/11/051122183641.htm [Accessed 10 September 2008]
Bollinger, T., Caley, P., Merrill, E., Messier, F., Miller, M.W., Samuel, M.D. & Vanopdenbosch, E. 2004. Chronic wasting disease in Canadian wildlife: an expert opinion on the epidemiology and risks to wild deer. Canadian Cooperative Wildlife Health Centre, Western College of Veterinary Medicine, University of Saskatchewan.
Bunk S., 2004. Chronic Wasting Disease–Prion Disease in the Wild. PLoS Biol 2(4): e121 doi:10.1371/journal.pbio.0020121
Harrington, Robert D.; Baszler, Timothy V.; O Rourke, Katherine I.; Schneider, David A.; Spraker, Terry R.; Liggitt, H. Denny; Knowles, Donald P., 2008. A species barrier limits transmission of chronic wasting disease to mink (*Mustela vison*). Journal of General Virology. 89(Part 4). APR 2008. 1086-1096.
Jacques, Christopher N.; Jenks, Jonathan A.; Jenny, Allen L.; Griffin, Steven L., 2003. Prevalence of chronic wasting disease and bovine tuberculosis in free-ranging deer and elk in South Dakota. Journal of Wildlife Diseases. 39(1). January 2003. 29-34.
Kim, Tae-Yung; Shon, Hyun-Joo; Joo, Yi-Seok; Mun, Un-Kyong; Kang, Kyung-Sun; Lee, Yong-Soon., 2005. Additional cases of chronic wasting disease in imported deer in Korea. Journal of Veterinary Medical Science. 67(8). AUG 2005. 753-759.
Summary: Available from: http://www.cwd.cc/Additional%20Cases%20of%20CWD%20in%20Imported%20Deer%20in%20Korea.pdf [Accessed 10 September 2008]
Kreeger, T., Montgomery, D.L., Jewell, J.E., Schulz, W. & Williams, E.S. 2006. Oral transmission of chronic wasting disease in captive Shira's moose. Journal of Wildlife Diseases 42: 640–645.
Miller, Michael W.; Williams, Elizabeth S.; Hobbs, N. Thompson; Wolfe, Lisa L., 2004. Environmental sources of prion transmission in mule deer. Emerging Infectious Diseases. 10(6). June 2004. 1003-1006.
Missouri Departments of Agriculture. 2010a. Chronic Wasting Disease Found in Captive Deer.
Summary: Available from: http://mda.mo.gov/news/2010/Chronic_Wasting_Disease_Found_in_Captive_Deer [Accessed 14 May, 2010]
Missouri Departments of Agriculture. 2010b. Chronic Wasting Disease Found in Captive Deer.
Summary: Available from: http://mda.mo.gov/news/2010/CWD_Test_Results_Negative_in_White_Tailed_Deer_on_Property_in_Linn_County [Accessed 14 May, 2010]
Montana Fish, Wildlife and Parks. 2009. Montana: Chronic Wasting Disease not found in 2009.
Summary: Available from: http://fwp.mt.gov/hunting/chronicwd.html [Accessed 14 May, 2010]
North Dakota Fish and Game Department. 2010. CWD Found in Southwestern North Dakota Deer.
Summary: Available from: http://www.gf.nd.gov/hunting/cwd-q-and-a.html [Accessed 14 May, 2010]
Patrick, B. 2008. Michigan s First Case of Chronic Wasting Disease Detected at Kent County Deer Breeding Facility.
Summary: Available from: http://www.michigan.gov/mda/0,1607,7-125--198869--,00.html [Accessed 14 May, 2010]
Sigurdson, Christina J; Aguzzi, Adriano., 2007. Chronic wasting disease. Biochimica et Biophysica Acta. 1772(6). JUN 2007. 610-618.
The Grand Rapids Press. 2008. Michigan : Tests of More Than 1,000 Deer Find No More Cases of Chronic Wasting Disease.
Summary: Available from: http://www.mlive.com/news/grand-rapids/index.ssf/2008/10/tests_of_more_than_1000_deer_f/3625/comments-newest.html [Accessed 14 May, 2010]
Virginia Department of Game and Inland Fisheries (VDGIF). 2010. Chronic Wasting Disease Found in White-tailed Deer in Virginia.
Summary: Available from: http://www.dgif.virginia.gov/news/release.asp?id=246 [Accessed 14 May, 2010]
Williams, Elizabeth S. & Ian K. Barker., 2001. Infectious Diseases of Wild Mammals (Third Edition) Published Online: 25 Feb 2008 Editor(s): Elizabeth S. Williams, Ian K. Barker. Print ISBN: 9780813825564 Online ISBN: 9780470344880 Copyright © 2001 Iowa State University Press
Williams E. S and S Young. 1980. Chronic wasting disease of captive mule deer: a spongiform encephalopathy. Journal of Wildlife Diseases, 16(1), 1980, pp. 89-98
Williams, E.S & M.W. Miller., 2002. Cachexie chronique des cerfs et des wapitis en Am–rique du Nord. Rev.sci. tech. Off. Int. Epiz., 2002, 21 (2), 305-316
Summary: Available from: French version: http://www.oie.int/fr/publicat/RT/2102/f_R2126.htm [Accessed 10 September 2008]
Williams, E.S & M.W. Miller., 2002. Caquexia cr–nica en ciervos y wapit–es de Am–rica del Norte. Rev.sci. tech. Off. Int. Epiz., 2002, 21 (2), 305-316
Summary: Available from: Spanish version: http://www.oie.int/esp/publicat/RT/2102/e_R2126.htm [Accessed 10 September 2008]

Williams, E.S & M.W. Miller., 2002. Chronic Wasting Disease in deer and elk in North America. Rev.sci. tech. Off. Int. Epiz., 2002, 21 (2), 305-316
Summary: Available from: English version: http://www.oie.int/eng/publicat/rt/2102/E.S.%20WILLIAM%20and%20Miller.pdf [Accessed 10 September 2008]
Williams, E.S. & Young, S. 1980. Chronic wasting disease of captive mule deer: a spongiform encephalopathy. Journal of Wildlife Diseases 16, 89-98