Consideration of Disease Risks in Translocation of Deer by Wildlife Management Agencies

A Cooperative Effort by the
Wildlife Health Committee and the Mule Deer Working Group,
Western Association of Fish and Wildlife Agencies

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Since 1922, the Western Association of Fish and Wildlife Agencies (WAFWA) has advanced conservation in western North America. Representing 23 western states and Canadian provinces, WAFWA's reach encompasses more than 40 percent of North America, including two-thirds of the United States. Drawing on the knowledge of scientists across the West, WAFWA is recognized as the expert source for information and analysis about western wildlife. WAFWA supports sound resource management and building partnerships at all levels to conserve wildlife for the use and benefit of all citizens, now and in the future.

Background

Translocation is a valuable tool for wildlife management and has been used to augment underperforming populations, to reestablish populations in areas from which a species has been previously extirpated, to manage threatened and endangered species populations, to manage wildlife conflict, and to establish species in suitable but unoccupied habitat. However, translocation of wildlife can result in the spread of disease agents or the introduction of non-native and invasive species which are hosts to disease agents (Corn and Nettles 2001, Kock et al. 2010). Wildlife management agencies with operating principles firmly rooted in science-based processes are obligated to use the best available management practices and latest information to reduce negative outcomes from management actions. This document provides information to decision makers regarding some potential disease risks of the translocation and identifies actions that may effectively reduce the risk. A full risk assessment is advised to reveal gaps or uncertainty that may result in a determination of unacceptable risk for the translocation. The International Union for the Conservation of Nature (IUCN) has additional guidelines for reintroductions and other conservation translocations that are an excellent resource for use as an assessment model (IUCN 2013). A comprehensive risk assessment usually incorporates evaluations of the source and receiving environment such as habitat, direct and indirect competition from sympatric species, wild and domestic, and potential for conflict. Wildlife managers augmenting underperforming populations should identify the cause(s) for poor performance and attempt to mitigate, especially if a previous translocation attempt has failed.

Scope

This discussion of disease risks for translocation is limited to deer species *(Odocoileus)* in the western United States and Canada. The topics reviewed are suggested initial diseases for evaluation when considering translocations, some states and provinces may have additional concerns. The scope of this document is limited to evaluating risks related to infectious agents and does not address all of the risks associated with translocating wildlife. Disease concerns are only one category in a complete risk analysis.

Objectives

To provide guidance for member agencies of the Western Association of Fish and Wildlife Agencies for the translocation of deer species in the western United States and Canada with the goals of minimizing the risk of introducing new pathogens and identifying pathogens already present, thereby avoiding negative environmental and ecological impacts to connected metapopulations. The diseases included were recommended by members of the Mule Deer Working Group and the Wildlife Health Committee because of identified concerns and it is not a comprehensive list.

Wildlife Disease Management Information

Disease agents may be bacteria, viruses, prions, or parasites (internal or external). When considering the risk of disease transmission in association with translocation events, factors to consider are: 1) the availability of antemortem testing with a high sensitivity (reliable detection of positive animals e.g. few or no false negatives) which has been validated in the species of concern; 2) the turnaround time for results from such testing; 3) resources to hold animals pending test results or to recover test-positive animals after release (depending on the epidemiology of the disease, transmission may occur before animals are removed); 4) historic appropriate health screening data for the populations including those that held in captivity in the same area; and 5) availability of effective treatments such as parasiticides or vaccinations to remove or reduce the risk of disease transmission.

In considering disease risks associated with translocation events, it is critical to first determine the disease status of source and recipient populations and the health status of the individuals to be translocated. Opportunistic or targeted post-mortems of incidental mortalities, clinically sick, and healthy animals prior to the translocation can aid in this assessment. Evaluations must consider sample size, demographics and the sensitivity of specific tests when evaluating the reliability of the assessment. If the introduction of a single diseased animal is likely to have negative consequences, then the ability to detect a truly positive animal should approach 100%. For example, deer from populations in which a disease of high consequence, such as Chronic Wasting Disease (CWD), has been detected, should not be moved to areas where the disease has not been detected. Repeated testing of populations provides additional information regarding endemic diseases and can be useful for detection of emerging diseases and diseases with low prevalence. Disease transmission risks will vary with the type of disease agent, the number, age and sex of animals to be moved, the occurrence of geographic barriers to movement, habitat conditions, the presence of natural migratory patterns of the populations, and the relative size of home ranges.

Wildlife and livestock frequently interact on rangelands throughout much of the public and private land in western North America. This interaction occurs in a wide range of settings, from remote grazing allotments, farm and ranch yards, water sources, and at livestock feedlots. These situations represent another potential risk for disease transmission to and from wildlife.

Selected Infectious Agents and Diseases of Concern

Bovine Virus Diarrhea. Bovine Virus Diarrhea virus (BVDV) is a pestivirus which causes a serious disease syndrome in cattle. Evidence of the virus has been found in a number of North American cervids by virus isolation and exposure to the virus has also been documented with serosurveillance (Wolff et al. 2016). In cattle, the virus causes gastrointestinal and respiratory disease, abortion, and immunosuppression through lymphoid depletion. Infection of pregnant females during the first trimester produces a persistently infected (PI) offspring. Persistently infected individuals have been identified in groups of free-ranging white-tailed and mule deer, and captive mountain goats. Persistently infected animals are efficient, life-long shedders of the virus and create a long-term source of infection for the rest of the population. Reproductive losses have been documented in experimentally infected white-tailed deer, but the potential for population level effects is unknown. Serology and antigen capture enzyme-linked immunosorbent assay (ELISA) appear to be sensitive tests for detecting potential carriers (Wolf et al. 2016). The relative risk associated with translocating an infected individual, whether transiently infected or a PI animal, is unknown as is the potential population-level impact.

Bovine Tuberculosis. *Mycobacterium bovis* has been found in deer (and elk) in areas of Alberta, the Northwest Territories (NWT) and Manitoba, Canada, white-tailed deer in New York, Michigan, Minnesota, and Nebraska, and mule deer in Montana (Rhyan et al. 1995). The disease was transmitted to deer from domestic livestock originally (cattle) and is now considered endemic at low levels in deer in several counties in some of those states. The occurrence in Canadian deer is low with wood bison (Alberta and the NWT) and elk (Manitoba) serving as reservoirs. Tuberculosis has also been found in carnivores (wolves, coyotes, and a fox) and omnivores (black bears, and raccoons) in some of those areas, but it is uncertain whether or not these species could act as a source of transmission to deer. The United States is considered free of Bovine Tuberculosis (BTB) in cattle by the U. S. Department of Agriculture, therefore the likelihood of the disease occurring

in deer in other areas of the country is considered to be very low without movement of infected wildlife or cattle. However BTB is present in livestock in Mexico and may be present in deer in Mexico. Two known foci of BTB in Canada are in northern Alberta/Northwest Territories and Manitoba in wood bison and elk, and in deer, respectively. Recent management of elk and deer exposed to BTB in Manitoba has shown that agencies can take aggressive steps to manage this disease. The cervid tuberculosis dual path platform (TB DPP) test is the current official test in the United States for elk and white-tailed deer and is considered by USDA-APHIS to be sufficiently sensitive and specific for regulatory purposes. Additional BTB diagnostic tests are being researched. Infected individuals may not exhibit signs of disease. The risk of introducing BTB through the translocation of infected individuals is significant.

Cervid Adenovirus. Large mortality events have occurred in black-tailed and mule deer in Oregon and California and in mule deer in Southeast Alberta. Smaller mortality events have been observed in Wyoming, often in association with backyard feeding and congregation of deer. Signs of infection are a systemic vasculitis with marked pulmonary edema, hemorrhagic enteropathy, and necrotizing stomatitis, pharyngitis, and glossitis. Transmission appears to be by direct contact and possibly body fluids. Little has been published on the epidemiology of the disease or the occurrence of carriers, however a limited serosurvey of elk in SW British Columbia showed seroprevalence following the outbreak in deer in Alberta, suggesting that species other than deer may be involved. Outbreaks appear to be sporadic, but when they occur the number of deaths can be high. Serum neutralization and ELISA have been used to test for exposure to the virus and appear to have acceptable levels of sensitivity and specificity but these tests are rarely available. Immunohistochemistry of tonsillar biopsies could be an effective test for infection but is not routinely available. The risk of introducing cervid adenovirus through the translocation of infected individuals is unknown as is the potential population level impact.

Chronic Wasting Disease. The potential spread of CWD to new areas is perhaps the greatest concern for managers of deer populations because the low prevalence and prolonged latent period makes identification of positive areas difficult. The prion agent is infective in the environment for years and infection may occur through contact with a contaminated environment or an infected animal. Infected animals can shed the prion before the onset of clinical signs, sometimes for months (Mathiason et al. 2009). The tests for the presence of the prion in tissues of harvested animals are specific and sensitive (Spraker et al. 2002, Hibler et al. 2003). However, testing of live animals remains problematic due to the difficulty in obtaining diagnostic samples and the potential for false negative results early in the disease course. Several researchers have investigated the accuracy of two live animal tests; tonsil biopsy and rectal biopsy (Wolfe et al. 2007, Geremia et al. 2015, Keane et al. 2009, Thomsen et al. 2012). The sensitivity of these tests (portion of positives detected) has ranged from 63% to 80% in deer herds with a relatively high level of CWD prevalence (up to 67%). The detection of prions in tonsillar and rectal samples from infected animals is influenced by the quality of the sample, species, PRNP codon allele of the deer, and number of days post-exposure (Thomsen et al. 2012). Some infected animals will not test positive for more than 23 months post-exposure, but may excrete prions 7 to 11 months before developing clinical signs (Mathiason et al. 2009, Tamgüney et al. 2009). It is possible that an infected test-negative animal could be contagious for several months before succumbing to the disease and could represent a risk for disease introduction if it were to be translocated to a CWD negative area. Many states and provinces have tested for the presence of CWD in deer populations using samples from hunter-harvested deer, moose and elk at a level such that the disease would be detected if it was present in 1% or more of the animals and have identified CWD endemic and presumptive CWD free regions. The risk of introducing CWD with the translocation of a positive animal is significant for positive source populations, with a potentially significant impact to the herd into which it is moved. Therefore, accumulating a multi-year testing history on potential source populations is important and deer from CWD endemic areas should not be moved to areas where it has not been detected.

Contagious Ecthyma. Contagious ecthyma or Orf virus is a parapox virus that causes contagious ecthyma. The disease is more common in sheep and goat species, but has occasionally been found in deer and other ungulates. Usually the infection is easily identified by observation of numerous crusts and scabs on the affected animal, especially around the nose and mouth. The occurrence of inapparent carriers is not known. However, the virus is very hardy and can survive in crusts in the environment for several months or years. The disease can result in mortality in musk ox, mountain goats, and

bighorn lambs, but is probably not a significant concern for the translocation of deer. Serologic testing for detection of exposed individuals by complement fixation, agar gel immunodiffusion and ELISA is available (sensitivity and specificity for wildlife species is unknown). The risk of unknowingly translocating an infected individual is low as is the impact to deer herds, but multi-year herd testing history of potential source populations is advised due to the environmental hardiness of this virus.

Orbiviral diseases. Bluetongue (BTV) and Epizootic Hemorrhagic Disease (EHD) viruses are transmitted by *Culicoides* midges rather than direct contact between infected animals. The occurrence and persistence of disease is dependent upon the geographic range of this vector. The epizootiology of EHD, and probably BTV has two distinct geographic patterns: a stable enzootic cycle in which there is a relatively high prevalence rate but a low occurrence of clinical signs in the southeast US and a one of sporadic epizootics with high mortality and morbidity in northern US and very southwestern part of Canada. In addition, some deer populations have been shown to have an increased genetic susceptibility to the disease. Translocation of susceptible deer into an endemic area may result in failure of the translocation. Serologic testing of exposed animals is available.

Miscellaneous bacterial diseases. While many additional infectious diseases have not been associated with epizootics, many are contagious including keratoconjunctivitis (Pinkeye), leptospirosis, and Johne's disease *(Mycobacterium avium paratuberculosis)*. The recent epizootic of treponeme-associated hoof disease in Washington elk is an example of how serious unexpected and unanticipated diseases can emerge in wild populations. It is possible for translocation to precipitate such an event or increase the negative impact of a disease emergence (Clegg et al. 2015). See the WAFWA Mule Deer Working Group Factsheet #11 on diseases and parasites for more information (WAFWA-MDWG 2015). Managers should carefully review recent literature for the species and the occurrence of emerging diseases and unusual mortality events should be fully investigated in areas which are being considered as sources or recipients of translocated animals.

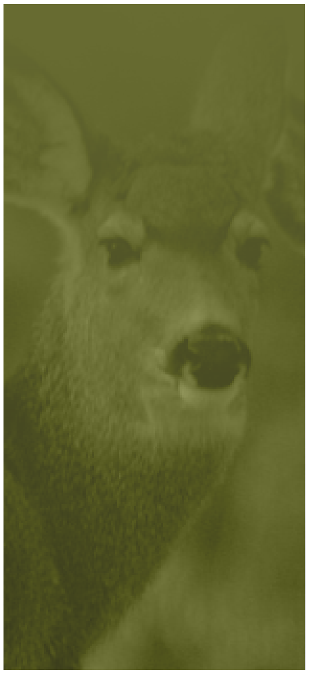
Exotic lice. Three species of exotic lice have been identified in black-tailed and mule deer populations, *Bovicola tibialis*, *Linognathus africanus*, and *Damalinia forficula*. Infestations have led to hair loss, declining body condition and mortality, particularly in young deer in the winter in several areas of California and the Pacific Northwest, including British Columbia (Idaho Department of Fish and Game 2016, Roug et al. 2016). Population declines have been observed in areas where the lice are present. Treatment with a topical pyrethrin or avermectin parasiticide or similar product may be effective at reducing the lice on individual animals. Products with an extended duration of action such as anti-parasitic ear tags may further reduce the intensity of infestation. The risk of translocating an infested animal and introducing the disease to a naïve population is significant however the risk may be reduced by treatment.

Carotid worm. As the definitive hosts, mule deer and black-tailed deer are generally unaffected by *Elaeophora schneiderii*. In other ungulates (elk, white-tailed deer, moose, domestic livestock) infection can cause blindness, difficulty eating and swallowing, horn and antler deformities, and death through interruption of blood flow to critical tissues and subsequent necrosis. The vector, a tabanid fly, is widespread and the disease has been reported throughout the western United States. Carotid worm could be a concern for the introduction of mule deer into areas with white-tailed deer, elk or moose and such translocations are not advised. Neither antemortem diagnosis nor treatment of deer has been investigated to any extent and its range is poorly defined.

Echinococcus. *Echinococcus granulosus* and *E. multilocularis* are two taenid parasites found in North America that include an ungulate host for an immature larval form (hydatid) and a carnivore, frequently a canid, host of the adult stage within the intestinal tract. Some genotypes are primarily associated with the sylvatic wolf-wild ungulate cycle and others are associated with the dog-domestic sheep cycle. These parasites do not appear to significantly impact host populations. The larval (hydatid) stage of the parasite can cause infections in people but the incidence rates in North America are relatively low. Diagnosis in affected ungulates is difficult but hydatids are usually apparent in lung or liver at postmortem. Polymerase chain reaction methods can identify the genotype of the parasites in feces or tissues. The population level risk of moving an infected deer is low but it could result in the introduction of the parasite to a new region.

Giant liver fluke. *Fascioloides magna* is a parasite of domestic livestock and wildlife of North America and Europe. Flukes rarely cause disease in elk, white-tailed deer, and caribou but have been identified in mortality events of black-tailed deer, moose, and red deer. Ova may be detected in feces but infections are more frequently identified by detection of the large parasite and the damage in the liver tissue. A parasiticide drenching protocol has been developed for cervid movement. The fluke currently has a limited distribution in North America, in part due to the complex lifecycle which includes the ungulate host of the adult, a free-living immature stage, and a freshwater snail intermediate host (Pybus 2001). Wildlife managers should consider livestock stakeholders, environmental factors and the current distribution of this parasite in translocation planning and avoid introducing it into new regions.

Meningeal worm. *Parelaphostrongylus tenuis* is present in populations of white-tailed deer in northeastern United States and eastern Canada. It does not affect white-tailed deer health, however, it causes an often fatal neurologic disease in many other species of cervids (mule deer, caribou, elk, and moose). The life-cycle is complex with a snail or slug as an intermediate host. While intermediate hosts in the historical range of the parasite are well-known, unrecognized intermediates may be present in similar habits in the northwest United States and western Canada. Movement of infected white-tailed deer (probably any originating east of the 100th meridian) into a non-endemic area with known or possible intermediate hosts has the potential to negatively affect susceptible wildlife and livestock species. There are no reliable antemortem tests. The modified



Baermann test is a reliable method for detecting larvae when present but prolonged prepatency and variable shedding rates make the test unreliable for identifying uninfected populations. Parasiticides can reduce shedding of infective larvae but a treatment regimen that is capable of eliminating the infection has not been established.

Conclusion

While wildlife managers should be very concerned about the potential for moving deer infected with CWD, other infectious agents should also be considered. For some there are adequate screening tests available that will identify the status of an individual animal or population. For others, such as external and internal parasites, treatment may be available during handling to reduce or potentially eliminate the risk of moving the organism to non-endemic areas. Ideally, the planning process for a translocation will include communications with the state or provincial veterinarian, as well as an assessment of health, habitat, and social factors including screening the source and recipient populations for pathogens of concern.

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